2020

Self-Efficacy of Endorsed and Nonendorsed Elementary Teachers of Gifted Students in STEM Education

Lianna L. Moss-Everhart
Virginia Commonwealth University

SELF-EFFICACY OF ENDORSED AND NONENDORSED

ELEMENTARY TEACHERS OF GIFTED STUDENTS

IN STEM EDUCATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

by

Lianna Lynn Moss-Everhart
B.A., University of Virginia, 2004
M.T., University of Virginia, 2005

Director: Joan A. Rhodes, Ph.D., Associate Professor
Department of Teaching and Learning, School of Education

Virginia Commonwealth University
Richmond, Virginia
December, 2020

Acknowledgement

To say that completing my dissertation was hard would be an understatement. Between a topic change after the first three chapters were initially written, a year off when my daughter was born, the start of two businesses with my husband, and numerous personal job promotions, my research was completed due to sheer stubbornness and the support of numerous people, only some of whom I will be able to thank below.

First, I would like to thank my husband, Drew, for encouraging me to finish my dissertation even when I was ready to "throw in the towel". My never-ending gratitude goes to my sister, Jessie, for meeting with me Sunday mornings and constantly encouraging me to write. I would also like to thank my daughter, Samantha, who has seen much less of her mommy since my doctoral program has begun. Additionally, I want to give my sincerest thanks to Dr. Joan Rhodes, who took a chance on me by agreeing to become my dissertation chair despite her overwhelming and busy schedule. Finally, I would like to thank the remainder of my committee, Dr. Sharon Zumbrunn, Dr. William Muth, and Dr. Matthew Edinger, for feedback and positivity through the entire process.

Table of Contents

List of Tables ix

List of Figures x

Abstract xi

Chapter 1: Introduction 1

    History of Gifted Education 4

    History of STEM Education 6

    Overview of the Current Study 7

    Rationale for the Study 8

    Literature Overview 9

        Gifted Education Overview 10

        STEM Overview 12

        Self-Efficacy Overview 15

    Research Questions 16

    Design and Methods 17

    Findings 19

    Conclusions and Recommendations 20

    Definitions of Terms 21

Chapter 2: Review of the Literature 23

    Method for Review of the Literature 23

Theoretical and Conceptual Frameworks 25

Training for Teachers of Gifted Students 26

Effectiveness of a Gifted Endorsement...29

Teacher Effectiveness and Other Characteristics 32

STEM: Science, Technology, Engineering, and Math 36

Teachers' Self-Efficacy in STEM Education 36

Gifted Instruction within the Disciplines of STEM...41

Introduction to Teachers of the Gifted and Elementary Science...............41

Elementary Science Teachers' Self-Efficacy.......................................42

Elementary Science Instructional Practices...43

Introduction to Teachers of the Gifted and Elementary Engineering........46

Elementary Engineering Teachers' Self-Efficacy 47

Elementary Engineering Instructional Practices..................................48

Introduction to Teachers of the Gifted and Elementary Technology 49

Elementary Technology Teachers' Self-Efficacy................................50

Elementary Technology Instructional Practices 51

Introduction to Teachers of the Gifted and Elementary Mathematics.......53

Elementary Mathematics Teachers' Self-Efficacy 53

Elementary Mathematics Instructional Practices.................................54

The Integration of STEM..56

The Relationship between Gifted Certification and STEM Education.........................57

Synthesis 58

Chapter 3: Methodology 60

Research Questions....60
Research Design and Rationale....61
Institutional Review Board....62
Instrumentation....62
The T-STEM Survey....62
The Modified Survey....64
Participants....68
Data Collection....71
Data Analysis....72
Delimitations....74
Chapter 4: Findings....75
Descriptive Analysis....76
Teacher Grade Levels....76
Teacher Years of Experience....77
Teacher STEM Training....77
Correlations....78
Science Self-Efficacy and Gifted Endorsement Status....80
Years of Teaching Experience in Relation to Science Self-Efficacy and Gifted Endorsement Status....82
Grade Level in Relation to Science Self-Efficacy and Gifted Endorsement Status....83
STEM training in Relation to Science Self-Efficacy and Gifted Endorsement Status....84

Science Self-Efficacy and Gifted Endorsement Status Regression 85
Mathematics Self-Efficacy and Gifted Endorsement Status..86
Years of Teaching Experience in Relation to Mathematics Self-Efficacy and Gifted Endorsement Status 88
Grade Level in Relation to Mathematics Self-Efficacy and Gifted Endorsement Status...89
STEM Training in Relation to Mathematics Self-Efficacy and Gifted Endorsement Status...90
Mathematics Self-Efficacy and Gifted Endorsement Status Regression..........90
Integrated STEM Self-Efficacy and Gifted Endorsement Status 91
Years of Teaching Experience in Relation to STEM Self-Efficacy and Gifted Endorsement Status...93
Grade Level in Relation to STEM Self-Efficacy and Gifted Endorsement Status...94
STEM Training in Relation to STEM Self-Efficacy and Gifted Endorsement Status...95
Integrated STEM Self-Efficacy and Gifted Endorsement Status Regression...96
Self-Reported Use of STEM Instructional Strategies and Gifted Endorsement Status...96
Years of Teaching Experience in Relation to Use of STEM Instructional Strategies and Gifted Endorsement Status...98
Grade Level in Relation to Use of STEM Instructional Strategies and Gifted Endorsement Status...99

STEM training in Relation to Use of STEM Instructional Strategies and Gifted Endorsement Status 99
STEM Instructional Strategies and Gifted Endorsement Status Regression ..101
Summary of Findings....101
Chapter 5: Conclusions and Recommendations 104
Science Self-Efficacy and Gifted Endorsement Status....105
Mathematics Self-Efficacy and Gifted Endorsement Status....106
Integrated STEM Self-Efficacy and Gifted Endorsement Status 107
Self-Reported Use of STEM Instructional Strategies and Gifted Endorsement Status....108
Implications for Theory, Research, and Practice 110
Limitations and Future Research 112
Conclusion 116
List of References 118
Appendix A: Survey 127
Appendix B: VDOE Regulations Governing Education Services for Gifted Students 138
Appendix C: VDOE Licensure Regulations for a Gifted Endorsement 140
Appendix D: Email Letter for Survey....142
Appendix E: Email Reminder Letter for Survey 144
Vita....146

List of Tables

1. Literature Review Search Results 2014-2017 24

2. Selected Literature on STEM Disciplines Self-Efficacy Key Phrases 37

3. T-STEM Survey Reliability for Elementary Teacher Participants 64

4. Grade Levels Taught by Teachers of Gifted Students 77

5. Number of Teachers who Reported Hours of STEM Training at Each Level 78

6. Correlations of Independent Variables and Covariates 79

7. Science Self-Efficacy Beliefs 81

8. Grade Level and Gifted Endorsement Interaction Significance Levels 83

9. Mathematics Self-Efficacy Beliefs 87

10. Integrated STEM Self-Efficacy Beliefs 92

11. STEM Instructional Strategies Use 97

12. Summary of Findings 102

13. Respondents' Ideas for Better Representation of Questions 114

List of Figures

1. A Framework for Model STEM Units..3

2. Representation of Efficacy Expectations as the Link between Person and Behavior...........26

3. G*Power 3 Power Analysis Data..70

Abstract

SELF-EFFICACY OF ENDORSED AND NONENDORSED ELEMENTARY TEACHERS OF GIFTED STUDENTS IN STEM EDUCATION

By Lianna Lynn Moss-Everhart, Ph.D.

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

Virginia Commonwealth University, 2020.

Director: Joan A. Rhodes, Ph.D. Associate Professor, Department of Teaching and Learning, School of Education

This study compared elementary endorsed and nonendorsed teachers of gifted students in science, mathematics, and STEM self-efficacy as well as self-reported use of STEM instructional strategies in central Virginia. The survey, adapted from the T-STEM survey by the Friday Institute at NC State University, focused on self-efficacy and use of STEM instructional strategies. ANOVAs, univariate linear analyses, were conducted on 39 responses to compare teachers' self-efficacy and use of STEM instructional strategies. ANCOVA and moderated regressions were used to compare the groups of teachers while controlling for the variables of grade level, years of experience, and recent STEM training. Multiple regressions were run for self-efficacy levels using predictors of endorsement status, grade level, years of experience, and recent STEM training. There were no significant results when analyzing ANCOVAs and moderated regression analyses for science self-efficacy and STEM self-efficacy. For science self-efficacy, significant predictors included kindergarten, fourth grade, and STEM training. For

STEM self-efficacy, significant predictors included second grade and years of teaching. Mathematics self-efficacy was statistically significant when controlling for years of teaching and grade level based on ANCOVAs. Significant predictors were fourth grade, years of teaching, and endorsement status. STEM instructional strategies were statistically significant when controlling for STEM training. Nonendorsed teachers had more strategy use. Significant predictors were second and third grades, years of teaching, and STEM training. Similar studies should be held due to limitations of survey self-report, small sample size, and limited generalization capability. Additional research should be conducted across varying grade levels and populations.

Keywords: self-efficacy, gifted and talented, endorsement, certification, STEM

Chapter 1: Introduction

In a diverse public-school system, teachers instruct students who are at different ability levels. Whether school divisions identify those students as special needs, English as a second language learners, or gifted, teachers seek to teach all the students in their classrooms at an appropriate level (Tomlinson & Callahan, 1992). Gifted education students are a smaller subset of the larger school population that teachers instruct. According to the 2011-2012 Office of Civil Rights data collection nationally, gifted students include 3,189,757 students in gifted education programs in public schools (Department of Education, 2012).

Gifted education has become less of a focus in the classroom (Hertberg-Davis, 2009; Scot, Callahan, & Urquhart, 2009; VanTassel-Baska, 2012) in part due to the policy of *No Child Left Behind* that the U.S. Department of Education enacted in 2001. The act required states to administer a standardized test to all students to assess a student's minimum competency (U.S. Department of Education, 2010). While ensuring that "no child is left behind" through standardized exams, often students identified as gifted are overlooked since they are already able to pass the competency tests prior to instruction (Hertberg-Davis, 2009).

To meet the needs of gifted students, some states require teachers to receive an endorsement or take endorsement classes in order to teach gifted students (Karnes & Whorton, 1996). Each state has its own procedures for determining which teachers are eligible to teach gifted students. Across the United States, 24 states require teacher certification to teach gifted students in the 1990s (Karnes & Whorton, 1996). In a 2015 survey, The National Association for Gifted Children (NAGC) and The Council of States Directors of Programs for the Gifted published a report on gifted education policy and practice. The researchers found 19 of the 29 responding states currently required gifted education credentials. Five of those states had other written qualifications, and 12 of the states reported 70% or more of their teachers had endorsements (NAGC, 2015).

Between the years of 1991 and 1996, Virginia, the site of this research study, initiated endorsement requirements for teachers teaching gifted students (Karnes & Whorton, 1996). However, the result of the endorsement requirement is variable based on the school division's enforcement of the endorsement status policy. "Since the districts are in charge of delegating who will educate their populations of students who are gifted, the equality of gifted programs may be negatively impacted depending on the experience of the teacher selected" (Nowikowski, 2011, p. 3). The literature suggests that teachers who receive a gifted endorsement can better meet the needs of gifted students over those teachers who do not have an endorsement because they have received specialized training and have experience in utilizing best practices for gifted students (Hansen & Feldhusen, 1994; Karnes & Whorton, 1991; Nowikowski, 2011).

One recent innovation in education that has a paucity of research in relation to gifted students addresses Science, Technology, Engineering, and Mathematics (STEM) education. Educators of gifted students have included STEM in their instruction after the inception of the phrase coined by the National Science Foundation (NSF) in the 1990s (Bybee, 2010; Sanders, 2009). Whereas STEM references the career fields related to the above subjects, it is important to note that STEM education focuses on teaching students how to use problem-solving skills in the broad areas of science, technology, engineering, and mathematics (Gonzalez & Kuenzi, 2012; Sanders, 2009). While many educators and researchers, including the NSF, address STEM education by focusing on its individual subject areas, the newest definitions purport STEM to be an integrative approach to curriculum and instruction that combines all subjects (Roberts, 2012). Bybee (2010) demonstrates the interaction among subjects for each of the STEM areas as well as the interdisciplinary approach (see Figure 1).

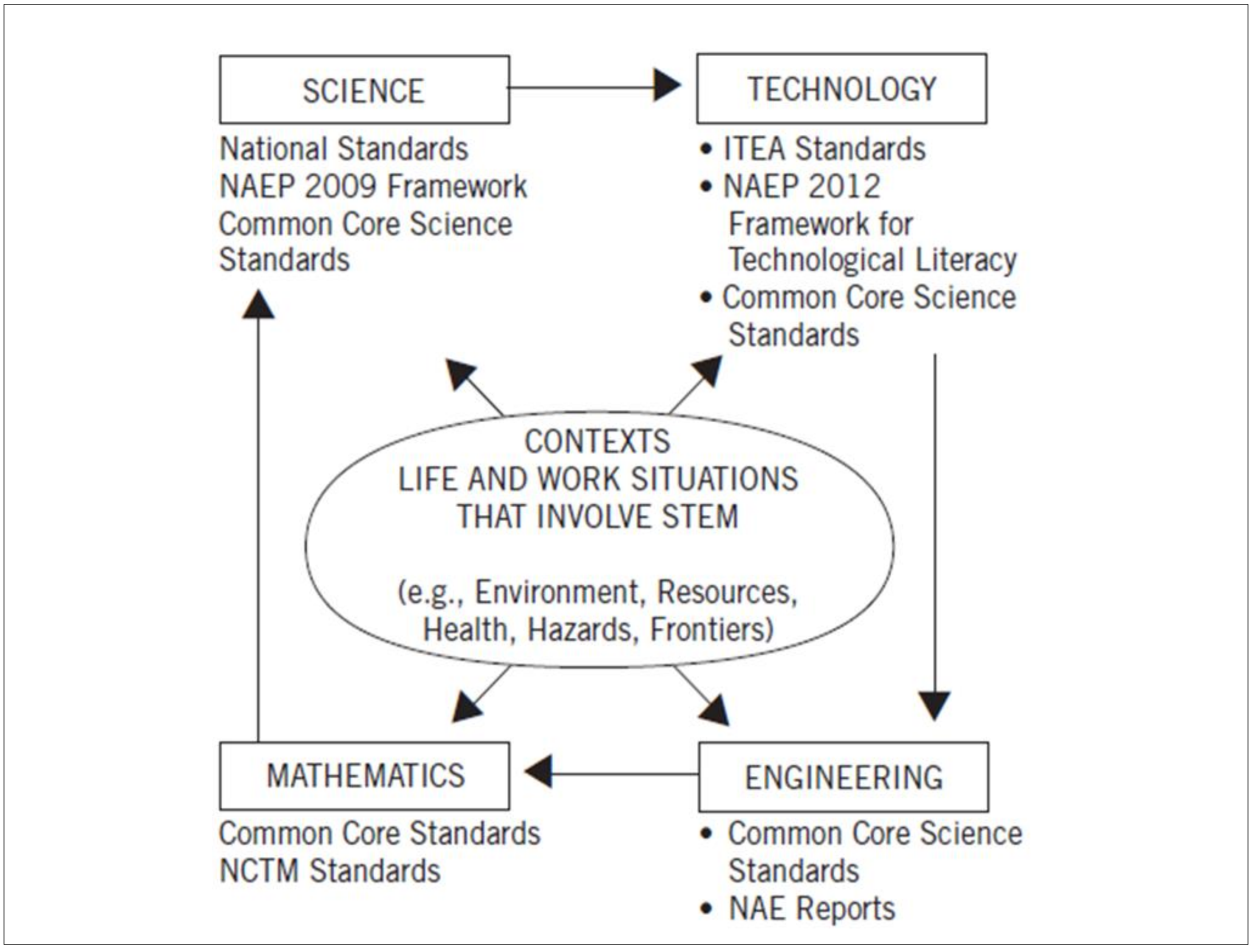

Figure 1. A Framework for Model STEM Units from "Advancing STEM education: a 2020 vision," by R. W. Bybee, 2010, *Technology and Engineering Teacher, 70*(1), p. 33.

Using STEM in the classroom at an early age encourages students to consider STEM careers in the future, which is important for a growing work force centered on STEM job opportunities. However, research shows that elementary teachers have a low level of self-efficacy, a person's belief in his or her own capability to perform a task successfully, for teaching STEM. Bandura (1977) states in his self-efficacy theory that low levels of self-efficacy can lead to diminished outcomes. If teachers have low self-efficacy in the area of teaching STEM, then they are less likely to teach STEM in the classroom, therefore resulting in students who are less likely to enter STEM careers (Bybee, 2010). Because a gifted endorsement is an indicator of teachers who can be best able to teach gifted students and because STEM instruction is rapidly becoming part of a teachers' gifted curriculum, the self-efficacy of teachers of gifted students for teaching STEM needs to be studied in order to determine if an endorsement is related to STEM self-efficacy.

History of Gifted Education

Educators largely overlooked gifted education until the 1970s when Congress requested a study on gifted students, partially in response to the Russian space launch of Sputnik and the fear that Russian students would surpass American students (Lea, 2010; Marland, 1972). The Marland Report (1972), Congress's first mandated report on the status of gifted students in the United States, defined gifted students as

> those identified by professionally qualified persons who by virtue of outstanding abilities are capable of high performance. These are children who require differentiated educational programs and/or services beyond those normally provided by the regular school program in order to realize their contribution to self and society. (p.3)

The Marland Report's definition of gifted students was the first designation of gifted students as a special needs category. The Report's authors emphasized that only 3-5% of students were identified as gifted and the programs in place for gifted students at that time were insufficient. The authors also referenced the minimal emphasis on gifted students in government policies. In addition, the Marland Report called for an action plan for gifted students. The plan included recommendations for gifted student programs as well as instituting gifted education research facilities (Marland, 1972).

The National Commission on Excellence in Education in 1983 published the next historical document that demonstrated the importance of gifted education to policy makers. *A Nation at Risk: The Imperative for Educational Reform* (1983) demonstrated low achievement and large gaps between the United States' achievement and other nation's achievement scores threatened the competitiveness of the United States. They also cited that half of gifted students were not working up to their potential. The report purported the need for federal mandates to increase services in gifted programs (U.S. Department of Education, 1983). The nationally published report spawned a reform movement across the United States in gifted education known as the "effective schools" movement (Lockwood, 2005). The effective schools movement emphasized enrichment for gifted students, but research that resulted from the movement was primarily anecdotal and did not include information about how to provide enrichment for gifted students.

In 1988, the U.S. Congress passed the Jacob Javits Gifted and Talented Students Education Act as part of the Elementary and Secondary Education Act (ESEA). The most widely accepted definition of a gifted student comes from the ESEA (Lea, 2010). The report defined gifted individuals as:

> Students, children, or youth who give evidence of high achievement capability in areas such as intellectual, creative, artistic, or leadership capacity, or in specific academic fields, and who need services and activities not ordinarily provided by the school in order to fully develop those capabilities (U.S. Department of Education, 2013).

The ESEA definition stresses that different instructional practices and programs must exist to serve the gifted student population. The Jacob Javits Gifted and Talented Students Education Act recommended providing grant money for research of gifted education, with a special focus on underrepresented populations (Lea, 2010; U.S. Department of Education, 2013).

When the government reauthorized the Higher Education Opportunity Act (U.S. Department of Education, 2010), three sections addressed gifted and talented children: teaching skills, required forms, and a state report card on the quality of teacher preparation (Johnsen, 2012). Despite the Higher Education Opportunity Act's (HEOA) focus on gifted children, little information about gifted students was included in the "No Child Left Behind" policy from the U.S. Department of Education. In fact, the policy only required each state to give a standardized test to all students that represents a student's minimum competency level (U.S. Department of Education, 2013). Because gifted students can often easily pass minimum competency tests, education of gifted students was not a focus in the classroom while teachers instruct students to ensure that no child was left behind and the majority of students passed the required standardized tests (Hertberg-Davis, 2009; Scot, Callahan, & Urquhart, 2009; VanTassel-Baska, 2012). Despite the recent inattention to gifted education, previous government reports and policies demonstrated gifted education is relevant to educators and the public.

History of STEM Education

Since the NSF coined the phrase STEM education in the 1990s (Bybee, 2010), STEM education has become increasingly important in the field of education. Concurrently to the HEOA, STEM education gained national attention as the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine published the report "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future" in

2007. The report urged policymakers to focus federal efforts on STEM education (National Academy of Sciences, 2007). The report

> led, in part, to passage of the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act (America COMPETES Act). Among other things, that act authorized STEM education programs at the National Science Foundation (NSF), National Oceanic and Atmospheric Administration (NOAA), Department of Energy (DOE), and Department of Education (ED). Congress reauthorized the America COMPETES Act in 2010 (P.L. 111-358), thereby advancing it to the implementation phase of the policy cycle (Gonzalez & Kuenzi, 2012, pg. 2).

Overview of the Current Study

The current study examined self-efficacy in the STEM disciplines of science, mathematics, and integrated STEM of elementary teachers of gifted students. Specifically, the study sought to determine if and if so, to what extent, there was a difference between teachers of the gifted who have an endorsement versus those who do not have an endorsement in gifted education based on a survey using a Likert scale in self-efficacy. The final component of the study investigated self-reported use of STEM instructional strategies used in the classroom by elementary teachers who have a gifted endorsement and those who do not. Because self-efficacy is the best indicator of outcomes (Bandura, 1977), it is necessary to have both self-efficacy and outcome levels reported. Based on the small number of teachers at the elementary level who teach the disciplines of engineering and technology reported in a pilot study of the T-STEM survey (Friday Institute for Educational Innovation, 2012), the study focused on the disciplines of science and mathematics as well as the integration of STEM.

The researcher sent teachers from three school divisions in suburban and rural Virginia an electronic survey adapted from the T-STEM survey created by the Friday Institute at NC State University's School of Education. The survey included demographic information and 47 questions with Likert scale answers to rank endorsed and not endorsed teachers of gifted students' self-efficacy in the disciplines of science and mathematics as well as the integration of STEM. The teachers also reported their use of instructional strategies in STEM education (see Appendix A). Finally, the researcher explored the differences, if any existed, by utilizing the covariates of current grade level, years of experience, or recent STEM training referenced in the demographics.

Rationale for the Study

The research study provided information regarding whether endorsement status is an indicator of teachers' STEM self-efficacy in the classroom. It is important for teachers of the gifted to have a high sense of self-efficacy for teaching STEM disciplines of science, mathematics, and integrated STEM in order to prepare students for working in STEM fields and for solving problems in the real world (Bybee, 2010). Bandura's theory of self-efficacy referenced that a higher sense of self-efficacy result in increased outcomes (Bandura, 1977). Therefore, if teachers with a gifted endorsement have a higher sense of self-efficacy with their ability to teach STEM education, the study results might suggest that there is a need for teachers who teach gifted students to be certified and/or that endorsed teachers are more qualified to teach gifted students in the area of STEM.

The results of the current study filled a gap in the literature by providing research on the relationship among gifted education, STEM education, endorsement status, and self-efficacy. In addition, the research contributed to the knowledge base for classroom practice and for preparation programs that provide courses for gifted endorsements. If a divide exists between endorsed and nonendorsed teachers' self-efficacy, the study results can inform advocates that quality professional development for teachers of gifted students who are not endorsed may be needed in order for those teachers to be successful with teaching STEM. However, if a divide did not exist, further studies may be needed to investigate what types of training or courses help teachers apply STEM education methods in the classroom, and whether those types of professional development opportunities should be embedded in gifted endorsement programs for teachers of gifted students. The research may help inform policy and administrative decisions related to professional development practices to enhance teachers' capacity to identify and implement best practices for STEM.

Literature Overview

The literature on gifted education and its policies helps to determine current relevance in the field of education. Gifted education research was widely overlooked until the 1970s when Congress requested a study be completed on gifted students in response to the Russian space launch of Sputnik (Lea, 2010; Marland, 1972), so there is little extant research on gifted students as a classification prior to the 1970s. Even more recently, gifted education has become less of a focus in the classroom (Hertberg-Davis, 2009; Scot, Callahan, & Urquhart, 2009; VanTassel-Baska, 2012) in part due to the Elementary and Secondary Education Act (U.S. Department of Education, 2011). For example, the emphasis on students passing a basic competency assessment from state standards has created an unspoken understanding that gifted students are already able to pass tests and so are less of a focus in the classroom (Hertberg-Davis, 2009; Scot, Callahan, & Urquhart, 2009; VanTassel-Baska, 2012).

Gifted Endorsement Overview

The literature suggests that teachers who receive a gifted endorsement can better meet students' needs over those teachers who do not have an endorsement (Hansen & Feldhusen, 1994; Karnes & Whorton, 1991; Nowikowski, 2011). Because the current research was completed in Virginia, the qualifications of Virginia's teachers of the gifted are specifically addressed. In Virginia, teachers can receive an endorsement by completing an approved teacher preparation program or completing four graduate level courses in gifted education and serving a practicum of 45 hours or completing one year of successful teaching of gifted students under the mentorship of a teacher who has received a gifted endorsement (Virginia Department of Education, 2020. However, not all teachers who teach gifted students in Virginia have an endorsement. For example, homeroom teachers do not have to be certified in order to teach students if there is a gifted specialist who provides support for those students (P. Griffin, personal communication, October 30, 2017). The most seminal piece of literature that discusses the effectiveness of a gifted endorsement is from Hansen and Feldhusen (1994). They determined trained teachers of gifted students were more effective in their classroom practices than those who were not trained. In addition, Nowikowski (2011) identified differences in teachers who were endorsed and not endorsed by interviewing teachers' beliefs on best practices. Specifically, she found teachers who did not have an endorsement did not have a deep understanding of what helps gifted students learn. While other literature discusses the importance of training for teachers of gifted students as stated by parents and policy makers (Mathews & Burns, 1992; Swanson, 2007), it does not necessarily reference the impact in the classroom. Finally, there are several court cases across the United States that treat teachers with training and certification in gifted education more favorably than those teachers without endorsements (Karnes & Marquardt, 1995).

There is a small body of research that states that other characteristics are important in the effective teaching of gifted students. Mills (2003) studied a group of teachers through the Center for Talented Youth at Johns Hopkins University. She used the Myers-Briggs Personality Test (MBPT) to determine that teachers designated as exemplary by a team of experts in the field used intuition, preferred abstract themes and concepts, were open and flexible, and valued logical analysis. She concluded that it was personality traits instead of endorsement status that explained why a teacher was deemed effective in the classroom. Hong, Greene, and Hartzell (2011), on the other hand, believed both endorsement status and self-reflection made a teacher effective in the classroom.

Other components, such as self-reflection, could be added to an endorsement program to make the program more effective (Hansen & Feldhusen, 1994; Hong, Greene, & Hartzell, 2011, Shaklee, 1997; Vidergor, 2012; Whitlock & DuCette, 1989). Hansen and Feldhusen (1994) claim that certain psychological traits of a teacher may need to be embedded in programs in order to foster these traits in teachers. Whitlock and DuCette (1989) also found key differences among teachers of the gifted, including characteristics such as enthusiasm and self-confidence as well as the role of the facilitator, how to apply knowledge, achievement orientation, and commitment. The idea that teacher characteristics differ between teachers of the gifted slightly varies from Vidergor's (2012) summation of her own work, in which she stated recognizing cultural bias and encouraging teachers to expose students to different cultures needed to be at the forefront in gifted education programs instead of teacher characteristics. Finally, Shaklee (1997) believed that an endorsement was not enough to make teachers effective teachers of gifted students. Instead, Shaklee believed that teachers need support from specialists in order to be effective in the classroom. Overall, it appears that many indicators may come into play when looking at the quality of teachers of gifted students, although the literature clearly states that an endorsement does make a difference when teaching gifted students.

STEM Overview

A recent and popular innovation in the field of gifted education is STEM (Science, Technology, Engineering, and Math) education (Gonzalez & Kuenzi, 2012; Roberts, 2012). In each discipline of STEM, there is a body of research that referenced teachers of the gifted and their self-efficacy for teaching the content at the elementary level, as referenced in the following section.

Elementary science teachers expressed a lack of confidence in teaching science content based on an insufficient science background, their comfort level of teaching science to gifted students, and their own enjoyment of science (Kelble, Howard, & Tapp, 1994; Swanson, 2006; Tilgner, 1990). Tilgner (1990) also found teachers' attitudes about science instruction included dissatisfaction with science. Lack of experience and understanding made teachers feel less certain about their own knowledge. An additional concern in teaching gifted students was a lack of confidence in answering more advanced questions asked by gifted students (Kelbe, Howard, & Tapp, 1994). Swanson (2006) found teachers' attitudes toward science changed as a result of professional development.

Instructionally, teachers of science at the elementary level have focused on problem-based learning and inquiry (Field, 2010; Hennessey, 2004; Karademir, 2016; Reeves, Fostvedt, Laugerman, Baenziger, & Shelley, 2013; Reis, Gentry, & Maxfield, 1998; Swanson, 2006; VanTassel-Baska, Bass, Reis, Poland, & Avery, 1998). Karademir (2016) and Hennessey (2014) focused on the relationship between project-based activities and creativity. Hennessey (2014) claimed that students had higher levels of creativity if not provided with extrinsic rewards. Student achievement appeared to improve when using problem-based or inquiry-based learning (Rias, Gentry, & Maxfield, 1998; Swanson, 2006; VanTassel-Baska et al., 1998). However, some studies found scientific inquiry teaching does not foster greater growth in gifted students than a regular curriculum (Field, 2010; Reeves et al., 2013).

The Next Generation Science Standards (NGSS) connected engineering to the sciences, referencing the similarities between these two fields of problem solving and creation (NGSS Lead States, 2013). Engineering adds an additional component to the sciences where students may be able to find possible solutions to real world problems (National Research Council, 2012). As in the field of science, elementary teachers of engineering struggle with teaching content that they do not understand. Moreover, teachers may not perceive engineering as an accessible career for students (Brophy, Klein, Portsmore, & Rogers, 2008). In the fields of science and engineering, professional development appeared to help teachers feel more comfortable with teaching science, change their use of questioning in the classroom, and help them to support students to think critically (Brophy et al., 2008; Kelble, Howard, and Tapp, 1994; Swanson, 2006). However, professional development only appears to affect short-term changes by teachers of the gifted in the field of science (Tilgner, 1990).

Two programs were created at the elementary level in order to provide teachers with a curriculum to support engineering in the classroom: Engineering is Elementary and LEGO Engineering (Brophy et al., 2008). Based on a NASA project, and additional curricular activity referenced building a rocket in the classroom (Dare, Childs, Cannaday, & Roehrig, 2014). Students reported enjoyment of all activities in these research studies (Brophy et al., 2008; Dare et al., 2014); however, there were no data supporting the increased achievement levels of gifted students because of these curricula.

There is also little research regarding elementary teachers of the gifted and use of instructional or educational technology such as computers, iPads, interactive whiteboards, or instructional software (Grimes & Warschauer, 2008; Periathiruvadi & Rinn, 2013). Rapidly changing technology may lead to teachers' attitudes about technology including opportunities to explore the technology to feel more comfortable using it with students (Shaunessy, 2007; Zimlich, 2015). Professional development in technology was beneficial and was the strongest predictor of teachers' attitudes toward email, the Web, and multimedia. The researchers considered professional development separately from graduate coursework. Graduate coursework did not have a positive correlation with teachers' attitudes (Shaunessy, 2007).

Incorporating technology into the classroom is important for gifted students (Polzella, 1997; Shaunessy, 2007; Tassell, Maxwell, & Stobaugh, 2013; Zimlich, 2015). Students enjoy working with technology in the classroom (Polzella, 1997), and it is important for students to collaborate with experts in the real world (Tassell et al., 2013). Additionally, one of the reasons teachers may feel less confident with technology could be the lack of access to equipment (Zimlich, 2015).

As with science and engineering, elementary teachers of the gifted who instruct mathematics in the classroom may also worry about their ability to instruct students in higher-level mathematics (Rubenstein, Gilson, Bruce-Davis, & Gubbins, 2015). Differentiated instructional practices that appeared to be beneficial for student learning and achievement included flexible grouping, acceleration through curriculum compacting, and enrichment (Gavin & Adelson, 2008; Pierce et al., 2011; Rubenstein, Gilson, Bruce-Davis, & Gubbins, 2015;

Schultz, 1991). Some studies, including online platforms based on Renzulli's model (Renzulli & Reis, 2007) and Project CLUE (Pierce et al., 2011) demonstrated teachers needed experience with the materials in order to feel comfortable and be successful in mathematics instruction.

A teacher's comfort level relates directly to the incorporation of STEM in the elementary classroom. STEM can be nurtured in the classroom through teaching students different instructional strategies on how to think about problems (Root-Bernstein, 2015). The lack of literature that connects STEM education to gifted students and the absence of literature on teachers of gifted students who are endorsed versus those who are not endorsed lead to a significant gap in the literature that needs further research.

Self-Efficacy Overview

Finally, there is a body of research that references self-efficacy and STEM education. Bandura (1977) coined the term self-efficacy as a person's belief in his or her own capability to perform a task successfully. He posited that the four sources of self-efficacy, mastery experiences, vicarious experiences, verbal persuasions, and psychological states lead to a person's sense of self-efficacy (Bandura, 1977; Pajares, 2005; Rittmayer & Beier, 2008; Zeldin & Pajares, 2000). Often researchers use different terms to describe self-efficacy, such as self-confidence, self-concept, self-esteem, teacher attitudes, and teacher beliefs, causing much confusion in the literature (Heslin & Klehe, 2006). In addition, the research largely agrees that teacher self-efficacy is the easiest area to improve (Heslin & Klehe, 2006).

However, the research does not agree on what helps STEM instruction self-efficacy levels improve. Nadelson et al. (2013) believed that coursework and training support self-efficacy levels in STEM. Maher, Bailey, Etheridge, and Warby (2013) researched the pairing of faculty mentors in the STEM fields to preservice teachers to improve their beliefs and confidence levels and found mentors and classroom experience contributed to this improvement.

Measuring self-efficacy levels is also challenging, as The Friday Institute at the NC State University (2012) found while creating a survey that measured teacher and student attitudes and beliefs about STEM education. The Institute described The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey as measuring changes in teachers' confidence and self-efficacy in STEM subject content and teaching. The first part of the survey measured the construct Personal Teaching Efficacy and Beliefs using the measurement application of self-efficacy and confidence related to teaching the specific STEM subjects (Friday Institute for Educational Innovation, 2012). It is notable that the instrument uses many of the same terms for self-efficacy interchangeably in the design of their study as well. Because self-efficacy is the best predictor of performance (Bandura, 1977; Heslin & Klehe, 2006; Nadelson et al., 2013), this research study used the term "self-efficacy" to encompass all beliefs a teacher may have regarding his or her ability to teach STEM.

Research Questions

The current research study focused on the differences in self-efficacy between elementary teachers who have a gifted endorsement and those who do not. Specifically, this research focused on teachers' self-efficacy in the STEM disciplines of science, mathematics, and integrated STEM. It also investigated whether grade level, years of teaching experience, or recent STEM training impact teachers' self-efficacy. The researcher also investigated self-reported use of STEM instructional strategies used in the classroom by elementary teachers who have a gifted endorsement and those who do not. This study conducted research to determine:

1. Is there a difference, and if so, to what extent is there a difference between the self-efficacy in teaching science, mathematics, and integrated STEM content by endorsed and nonendorsed elementary teachers of gifted students?
    a. Do grade level, years of teaching experience, or recent STEM training impact, and if so, to what extent do they impact self-efficacy in teaching science, mathematics, and integrated STEM content of endorsed and nonendorsed elementary teachers of gifted students?
2. Is there a difference, and if so, to what extent is there a difference between reported instructional strategies used during classroom STEM sessions by endorsed and nonendorsed elementary teachers of gifted students?
    a. Do grade level, years of teaching experience, or recent STEM training impact and if so, to what extent do they impact self-reported instructional strategies used during classroom STEM sessions of endorsed and nonendorsed elementary teachers of gifted students?

Design and Methods

The study focused on self-efficacy in STEM education by teachers of elementary gifted students. Therefore, it is important to garner data directly from those teachers by collecting and analyzing the information about their self-efficacy regarding instruction in the STEM disciplines of science, mathematics, and integrated STEM. A survey is an appropriate method to collect data about participants' beliefs (Creswell, 2003). Because self-efficacy is a belief in one's own ability (Bandura, 1977), a self-report survey is also an appropriate method to collect data on a teacher's self-efficacy.

The survey research data collection used a modified version of the T-STEM survey (see Appendix A), designed by the Friday Institute at NC State University's School of Education (2012). The T-STEM survey was vetted for validity and reliability through the Institute (Friday Institute for Educational Innovation, 2012). The researchers piloted the survey with 218 elementary teachers. The researchers edited and eliminated survey items based on factor analysis and feedback confirmation. The construct of STEM Instruction in addition to the four other content constructs was added after the initial pilot. The construct reliability levels demonstrated strong internal consistency for Personal STEM Teaching Efficacy and Beliefs for science ($\alpha = 0.905$), mathematics ($\alpha = 0.939$), and STEM instruction ($\alpha = 0.95$).

The survey used in the study was modified by including demographic items asking about teachers' endorsement status, current teaching status, current grade level of instruction, years of experience, and recent STEM training. The researcher surveyed teachers electronically who have taught gifted students within the past three years from three school divisions.

The researcher collected and analyzed survey data using an ANCOVA for each research question. The independent variable was the endorsement status of elementary teachers (2 levels). The dependent variables were:

- science self-efficacy,
- mathematics self-efficacy,
- integrated STEM self-efficacy, and
- self-reported use of STEM instructional strategies,

as outlined in the T-STEM survey. The modified survey included the disciplines of mathematics and science from the T-STEM survey. The T-STEM survey eliminated the disciplines of technology and engineering due to the limited number of elementary teachers who teach these subjects. The researcher also chose to eliminate these two subjects because the school divisions in the research study do not teach engineering or technology as separate subjects. Due to the importance of integrated STEM to this research study, the researcher added an additional survey section on STEM self-efficacy that mirrors the mathematics and science sections (see Appendix A) but was not vetted for reliability and validity.

The researcher first ran the homogeneity of regression slopes and checked ran correlation analyses by analyzing Pearson's correlation for interval variables and Kendall's tau analyses for the nonparametric variables. The researcher then ran ANCOVAs or moderated regression analyses depending on whether the assumptions were met or not to determine if there was a difference between the self-efficacy in teaching science, mathematics, and integrated STEM content between endorsed and nonendorsed elementary teachers of gifted students. The ANCOVAs or moderated regression analyses were also run to determine if there was a difference between self-reported use of STEM instructional strategies used during STEM classroom sessions by endorsed and nonendorsed elementary teachers of gifted students. The covariates used were current grade level, years of experience, or recent STEM training. The researcher ran the analysis to prevent these confounding variables from influencing the data in order to determine if there was a difference for each part of each research question. To determine if there was a statistically significant prediction for self-efficacy or STEM instructional strategy use, the researcher ran multiple regression analyses utilizing the independent variable endorsement status in addition to the three covariates as predictor variables for science self-efficacy, mathematics self-efficacy, STEM self-efficacy, and self-reported use of STEM instructional strategies. Finally, the researcher also ran ANCOVAs with all covariates to determine if all of the covariates impacted the difference between endorsements statuses.

Findings

There were no significant results found when analyzing the ANCOVAs and moderated regression analyses for individual covariates and predictors in the area of science self-efficacy and STEM self-efficacy. In the area of science self-efficacy, 23% of the variance was explained by all predictor variables. The significant predictors were kindergarten, fourth grade, and STEM training. In the area of STEM self-efficacy, 19% of the variance was explained by all predictor variables. The significant predictors were second grade and years of teaching.

Mathematics self-efficacy was statistically significant when looking at the differences between endorsed and nonendorsed teachers when controlling for years of teaching and grade level according to the individual ANCOVAs and moderated regression analyses. All predictor variables explained 21% of the variance. The significant predictors were fourth grade, years of teaching, and endorsement status.

The self-reported use of STEM instructional strategies was statistically significant when looking at the differences between endorsed and nonendorsed teachers when controlling for STEM training according to the individual moderated regression analysis. There was a difference found between the means of self-reported instructional strategies used during classroom STEM sessions by endorsed and nonendorsed elementary teachers of gifted students, when controlling for STEM training. Teachers who were not endorsed had a higher level of self-efficacy according to these findings. All predictor variables explained 37% of the variance. The significant predictors were second grade, third grade, years of teaching, and STEM training.

Conclusions and Recommendations

The survey results did not fall in line with the body of research in which trained teachers had more self-efficacy and used self-reported STEM instructional strategies in the classroom.

However, it is possible that the training may have made endorsed teachers more aware of their own limitations in the classroom, thus indicating there is no significant difference between the two groups in all areas. Therefore, the researcher has determined a similar study will need to be conducted due to several limitations to the current study, including survey self-reports, a small sample size, the limited generalization capability, and possible survey fatigue. In addition to a similar study that should be held, more research should be conducted in the areas of STEM self-efficacy and endorsement status across a variety of grade levels and populations.

Definitions of Terms

For the purpose of this research study, the researcher operationally defined the terms as follows:

Endorsed teachers of gifted students: teachers who instruct gifted students and have earned an approved endorsement in gifted education through the Virginia Department of Education (VDOE)

Gifted endorsement: an approved certification in gifted education through the Virginia Department of Education as denoted by 8VAC20-22-370 (see Appendices B and C)

Gifted students: Students, children, or youth who give evidence of high achievement capability in areas such as intellectual, creative, artistic, or leadership capacity, or in specific academic fields, and who need services and activities not ordinarily provided by the school to fully develop those capabilities (U.S. Department of Education, 2013)

Nonendorsed teachers of gifted students: teachers who teach gifted students and have not earned an approved endorsement in gifted education through the Virginia Department of Education

Self-efficacy: the belief in a person's capability to produce a designated level of performance (Bandura, 1977) and encompasses all beliefs, attitudes, and confidence levels relating to one's own ability

STEM education: the integrative approach to curriculum and instruction merging science, technology, engineering, and mathematics (Roberts, 2012)

Chapter 2: Review of the Literature

Method for Review of the Literature

In reviewing the literature on the self-efficacy in STEM education by teachers of gifted students who are endorsed and not endorsed in gifted education, the researcher found three bodies of literature: endorsement status of teachers of gifted students in gifted education, self-efficacy, and STEM education. To first identify if an intersection existed between research in STEM and gifted education, the researcher performed a Google Scholar search in the fall of 2015 for these terms, identifying 60,300 results. The researcher conducted an additional search in the spring of 2017 and the total increased to 68,100, demonstrating a growing interest in the field of STEM and gifted education.

The researcher then identified terms and synonyms by using the thesaurus affiliated with the ERIC.ed.gov website, which provided a list of descriptors to start the search, including Teacher Certification, Gifted, and STEM Education. In order to garner the largest amount of possible literature, the researcher used the asterisk at the end of the terms certif*, endorse*, engineer* and math*, which allowed the search engine to find words with similar endings in the Anywhere search bar in tandem with identified key terms. Key terms were identified from "ERIC via ProQuest", a database "sponsored by the U.S. Department of Education to provide extensive access to education-related literature. ERIC provides coverage of journal articles, conferences, meetings, government documents, theses, dissertations, reports, audiovisual media, bibliographies, directories, books and monographs" (ProQuest, 2014). The researcher completed all searches in the social sciences databases between fall of 2014 and spring of 2017.

Table 1

Literature Review Search Results 2014-2017

Search Term	Article Number in Search Results	Article Number in Search Results that are Peer Reviewed	Articles reviewed for Literature Review	Research found from Literature Reviews
Gifted AND "teacher preparation"	104	26	2	0
Gifted certif*	186	38	8	3
Gifted endorse*	46	23	3	0
Gifted AND Science AND teachers AND elementary	495	94	6	7
Gifted AND Technology AND teachers AND elementary	288	49	4	2
Gifted AND Engineer* AND teachers AND elementary	16	3	1	3
Gifted AND Math* AND teachers AND elementary	166	23	3	0
Gifted AND STEM AND teachers AND elementary	14	8	1	4
STEM AND elementary AND self-efficacy	36	24	2	9

Approximately 1,351 works were identified after reducing the search results by eliminating duplicates and selecting only peer reviewed articles with an empirical research focus, following the standards put into place by the American Education Research Association (American Education Research Association, 2006). Any studies that were not sufficiently rigorous, such as those that were narrative or story based, were also removed from the literature review. The researcher reviewed all abstracts to include articles focused on research pertaining to teachers using STEM education in an elementary classroom, eliminating those articles that were based on the secondary level or were written about programs outside of the United States, as these are outside the purview of the research study. Finally, the researcher reviewed each article's literature review to determine other articles relevant to the current study to add to the body of literature. After careful analysis, the final number of articles, books, and other works used for the study totaled 58 (see Table 1).

Theoretical and Conceptual Frameworks

The study of teacher self-efficacy is rooted in social cognitive theory (Bandura, 1986). Social cognitive theory suggests that one's behavior is determined by observing and learning from others' behaviors (Bandura, 1986). Bandura (1977) used his social cognitive theory to describe the idea of human learning, including self-efficacy, which is a person's belief in his or her own capability to perform a task successfully. In Bandura's description of self-efficacy, he adds to the social cognitive theory by claiming that one's beliefs or judgment about his ability to succeed are as important to performance as skill or aptitude. In fact, he stated that self-efficacy might be the best predictor for performance (1977). The research questions in the study focus on self-reported data from teachers regarding their STEM teaching self-efficacy. The study seeks to determine if there is a difference and if so to what extent there is a difference in self-efficacy between endorsed and nonendorsed teachers of gifted students. The researcher will address further information about the relationship of self-efficacy to STEM education in the section entitled *Teachers' Self-Efficacy in STEM Education*.

Bandura (1977), Pajares (1992), and Bryan and Atwater (2002) have linked self-efficacy and behavior (Figure 2) which suggests that self-efficacy in STEM education will impact how teachers teach STEM education in the classroom. The current study also focused on STEM instructional practices of teachers of gifted students, which represents the behavior of teachers.

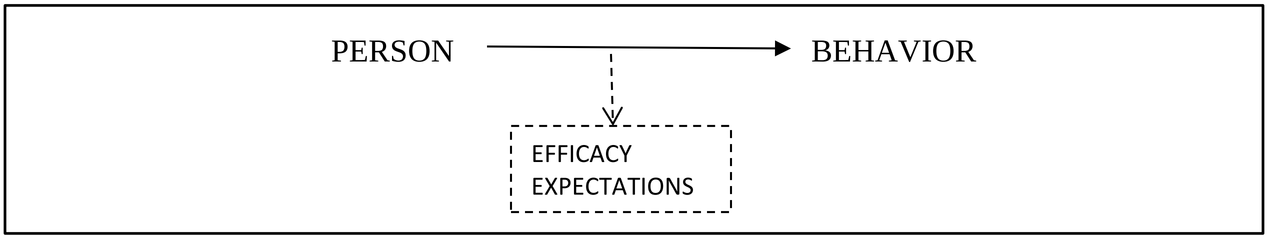

Figure 2. Representation of Efficacy Expectations as the Link between Person and Behavior. Adapted from "Diagrammatic representation of the difference between efficacy expectations and outcome expectations" from *Self-efficacy theory* by A. Bandura, 1977.

Training for Teachers of Gifted Students

When the government reauthorized the HEOA in 2008, there were three sections of the act that referenced gifted and talented students: teaching skills, required forms, and a state report card on the quality of teacher preparation (Higher Education Opportunity Act, 2008). The section addressing teacher preparation required teacher education programs to "implement research-based teaching practices in their classrooms for gifted and talented students and to use student academic achievement data to improve instruction" (Johnsen, 2012, p. 51). In addition, states used a state report card to determine the quality of teacher preparation by determining if the teacher preparation program met the spirit of the standards required by HEOA (Johnsen, 2012; U.S. Department of Education, 2010).

The National Association for Gifted Children (NAGC) created national teacher preparation standards in 2013 in conjunction with the Council for Exceptional Children and the Association for the Gifted to reinforce the concepts shared by the HEOA (National Association for Gifted Children, 2013). They updated the national teacher preparation standards in 2013. The NAGC asserted their standards should be the basis for state standards in teacher preparation. There were two sets of standards: those for beginning gifted education professionals and those for gifted education specialists. These standards focused on characteristics of teachers of the gifted as well as actions these teachers should use to be effective teachers and leaders in gifted education (Johnsen, 2012; NAGC, 2013).

The NAGC recommended the first set of standards for beginning gifted education professionals for colleges and universities who are instructing preservice teachers. These standards included ideas and curriculum that colleges should include in their regular curriculum or gifted education courses embedded into the undergraduate sequence of courses for preservice teachers. The gifted education specialists' standards were for those teachers who had received their teaching license and were seeking a certification or masters' degree. Thus, the gifted education specialist programs consisted of a master's degree level program and/or a certification or endorsement program (NAGC, 2013).

In 1995, only 24 states required teacher certification in order to teach gifted students; however, there were differences among the states in the methods that teachers could use to earn certifications (Karnes & Whorton, 1996). For example, because of the *Working on Gifted Issues* (WOGI) program, Florida revised five endorsement modules by moving them online to make the modules more accessible for teachers. There was a need for the modules to move online because in 2008, 40% of the teachers of gifted students hired were not certified and 22% of the teachers of gifted students were not certified (Eriksson & Weber, 2012). In South Carolina, the mandates changed to require teachers to have six graduate hours in gifted education to receive certification with an optional add-on endorsement in 1999 (Swanson, 2007).

The focus of this research study was on the Commonwealth of Virginia, where school divisions are required to follow the *Regulations Governing Educational Services for Gifted Students* (2012). These state that:

school divisions provide professional development based on the teacher competencies outlined in 8VAC20-542-310 related to gifted education. Each school division specifies the required annual training expected of personnel. This training or professional development should include, but not limited to, classes offered by the division, courses at a local university or college, conference attendance, and options tailored to meet the needs of the specific educator or group of educators. Teachers of the gifted may also choose to complete the coursework to obtain an add-on endorsement in gifted education. (Virginia Department of Education, 2012, para. 17)

The Commonwealth of Virginia added certification requirements for teachers teaching gifted students between the years of 1991 and 1996 (Karnes & Whorton, 1991, 1996). Teachers can receive an endorsement by completing an approved teacher preparation program or taking four courses in gifted education and serving a practicum of 45 hours or one year of successful teaching of gifted students under the mentorship of a teacher who received a gifted endorsement (Virginia Department of Education, 2020) (see Appendices C and D). In addition, teachers can earn a master's degree or a doctorate in gifted education. In 2010-2011, there were only 354 graduates from a master's degree program in gifted education and three doctorates in gifted education awarded in the Commonwealth of Virginia (Snyder & Dillow, 2013).

The VDOE mandated that teachers of gifted students have certifications (Virginia Department of Education, 2020). Nevertheless, there can be teachers who teach gifted students who do not have an endorsement. These teachers might be homeroom teachers who work in tandem with gifted resource teachers or other teachers who teach special classes throughout the students' day. They also may be teachers who are working towards their endorsements but have not completed them yet. Thus, there are teachers who are both endorsed and not endorsed teaching gifted students in the Commonwealth of Virginia.

Effectiveness of a Gifted Endorsement

Does a gifted endorsement mean a teacher is more effective in teaching gifted students than a teacher who is not certified? There appears to be a slight disagreement in the research on the topic of endorsement status. Much of the research claimed teachers who received a gifted endorsement could best meet student needs over those who do not have an endorsement (Hansen & Feldhusen, 1994; Karnes, 1995; Mathews & Burns, 1992; Nowikowski, 2011; Swanson, 2007). On the other hand, some research asserted other factors are critical for identifying teachers of the gifted as exemplary based on higher student outcomes or by being designated by experts in the field (Hansen & Feldhusen, 1994; Hong, 2011; Mills, 2003; Shaklee, 1997). The researcher will address both positions in detail below.

In a seminal piece of research, Hansen and Feldhusen (1994) sought to determine if training indicated more effective teaching of gifted students by comparing skills and classroom climate of trained and nontrained teachers. Eight researchers evaluated 82 teachers, 54 with training and 28 without training, using the Teacher Observation Form (TOF). Hansen and Feldhusen administered the Class Activities Questionnaire (CAQ) as well as designed and administered the Participant Information Questionnaire in order to evaluate class climate and demographic information respectively. Students rated their teachers using the CAQ, and the teachers completed the questionnaire. Researchers then evaluated the TOF with t-tests for the composite score, finding that the trained teachers scored significantly higher at a $p > 0.001$ significance level. In addition, the researchers used a MANOVA and determined out of the 12 subcategories, 11 had a statistically significant higher mean score of evidence in the classroom for the trained teachers. These subcategories included subject matter coverage, clarity of teaching, motivational techniques, pace of instruction, student-directed activities, variety or student experience, teacher-student interaction, higher-level thinking, creativity, teacher planning, and learning aids. The only subcategory mean not found to be significantly stronger was homework. Lastly, the researchers used a Pearson product-moment correlation coefficient to assess the relationship between the background information and the CAQ to determine if any background information appeared to influence the results. Researchers found trained teachers scored significantly higher than untrained teachers on the composite score of the TOF (t [77] = 9.51, $p < .001$). Additionally, the trained teachers were rated significantly higher on the CAQ (t [72] = 2.66, $p < .006$). Finally, the researchers also found trained teachers were more likely to support gifted learners than their untrained counterparts. In fact, they found trained teachers:

> fostered high-level thinking in their classes by focusing classroom discussions on in-depth analysis, synthesis, and evaluation of information. Untrained teachers often limited discussion to knowledge-level questions. Students with trained teachers were engaged in activities to promote critical thinking and application of information (Hansen & Feldhusen, 1994, p. 119).

More recently, Nowikowski (2011) found there were differences between endorsed teachers and nonendorsed teachers. As part of her dissertation research, she interviewed 30 pre-service and in-service education teachers who taught gifted students through focus groups. Using a grounded theory method, she compared underlying themes in gifted education across the three unequal sized groups (preservice, regular education teachers, and gifted education teachers). In addition, she evaluated gifted education documents as part of her qualitative analysis. She found differences among teachers' perceptions of best practices in education, such as what strategies and methods should be implemented in the classrooms to best support the needs of gifted students. She found those who did not have an endorsement needed support in learning about best practices for gifted education (Nowikowski, 2011).

In another study, Swanson (2007) interviewed 50 key members in South Carolina gifted education (five policymakers, 19 "linkers" who connect the policy makers to the adopters, and 26 "adopters" who put the policy into place). The researcher qualitatively analyzed in-depth interviews, focus group notes, and document reviews of their snowball sample. The documents consisted of key South Carolina legislation and gifted education reports from 1984 to 2004. Once the researcher identified themes from the data, Swanson discovered the adopters felt that teachers with six graduate hours in gifted education for certification were beneficial for gifted students. Swanson claimed the courses positively influenced the "teachers' understanding about whom the gifted are and how to teach them" (Swanson, 2007, p. 159).

Mathews and Burns (1992) indicated teacher certification made a difference in instruction in a gifted preschool, but the article did not include student observation data. Researchers used a self-created survey to solicit answers from 146 parents, which comprised 76% of the total population of parents of gifted three-year-olds, four-year-olds and kindergartners. Researchers found parents believed certification status improved the instruction that their students were receiving. They also believed the school should mandate teacher certification with a 95.1% agreement rating on a five-point Likert scale (Mathews & Burns, 1992). While this number appears strong, there were no statistical analyses on the strength or effect size of this value.

Finally, school divisions mandate certifications for gifted specialists or teachers, which demonstrated the importance of certifications. For example, Karnes and Marquardt (1995) utilized a computer search of federal and state court cases and found four cases in which the key issue surrounded teacher certification or endorsement (two from West Virginia and two from Pennsylvania). These cases dealt with teachers who were hired and/or let go from their positions and were concerned another teacher was less qualified based on having less years of experience but had more training in gifted education. Karnes and Marquardt found the court system treated teachers who have a certification in gifted education more favorably than they treated teachers with more years of experience. They cited three of the court cases where the courts supported the teacher who had certification in the area of gifted education over the teacher who had more years of experience for employment purposes. Karnes and Marquardt used a narrative approach to relate each of the cases to the policies and stated these court cases could set precedents in other states that teacher certification was a top priority in employment (Karnes & Marquardt, 1995).

Teacher Effectiveness and other Characteristics

While research appears to support the idea that teachers who receive a gifted endorsement can best meet students' needs over those who do not have an endorsement, some research indicates other characteristics make a difference in effectively teaching gifted students.

In one instance, Mills (2003) used a background questionnaire and the Myers-Briggs Personality Test (MBPT) to survey 63 teachers and 147 highly able students who went to the Center for Talented Youth (CTY) at Johns Hopkins University. The administrators of the program chose exemplary teachers out of a pool of teachers who taught at CTY summer programs "based on observations and performance ratings from CTY administrators and evaluations of teachers completed by students (objective ratings of teacher effectiveness as judged along a number of dimensions, including knowledge of content, preparedness, concern for individual learning, and openness to differing opinions)" (Mills, 2013, p. 274). While many of the teachers held advanced degrees, only 17.4% of the teachers had at least one course in gifted education. Mills analyzed the teachers' MBPTs to determine the characteristics exemplary teachers had in common. The researchers analyzed the MBPT in two ways: Golay's 1982 model, based on the SJ (Structured-Realist), SP (Action-Oriented Realist), NF (Idealistic-Humanist), and NT (Rational-Theorist) dimension pairs and Kalsbeek's 1989 model which used the IN (Abstract-Reflective), EN (Abstract-Active), IS (Concrete-Reflective), and ES (Concrete-Active) dimension pairs. In addition to these scoring systems, the researchers used the typical scoring procedure utilizing frequency distributions for each dimension to explore the data more fully (Mills, 2003, p.276). Using the frequency distributions, Mills found exemplary teachers were more likely to prefer intuition to sensing, as opposed to a normative sample of middle school teachers. In addition, Mills found intuition was the same as the gifted students they surveyed based on the Kalsbeek model of analyzing the MBPT. Utilizing the Golay model of analyzing the MBPT, Mills found exemplary teachers preferred abstract themes and concepts, being open and flexible, and valuing logical analysis and objectivity. Mills concluded because teacher certification rate was so small, a match between student and teacher personalities and a strong background in the subject matter could identify exemplary teachers instead of certification status (Mills, 2003).

Hong (2011) completed another study referring to teacher characteristics as an indicator of quality teaching. Hong used the quantitative Epistemological Beliefs in Teaching and Learning Questionnaire (EBTL), in which teachers answered questions using a four-point Likert scale. The researcher surveyed 182 teachers, 117 teachers in general education classes and 65 in gifted education programs. Fifty-nine percent of the teachers who taught gifted education were certified whereas only 22% of the general education teachers were certified. Hong concluded general education teachers and those teaching gifted programs had different beliefs and goals. He shared that teachers in gifted programs had characteristics that had a more positive impact on student achievement (Hong, 2011, p 257). Hong found certification *and* training remain important, but he suggested teacher training programs needed modifications to embed self-reflection on individual teacher beliefs and attributes because individual characteristics had a strong impact on student achievement. In addition, Hong asserted more research should occur to determine if training encouraged the characteristics indicative of an effective teacher (Hong, 2011).

Other researchers believed a variety of other components should be included in certification classes (Hansen & Feldhusen, 1994; Whitlock & DuCette, 1989). For example, Hansen and Feldhusen (1994) asserted teacher preparation courses should include the psychological traits of an effective teacher in addition to teacher skills and competencies. They also believed certification status did make a difference in teacher effectiveness.

Whitlock and DuCette (1989) compared 20 teachers of the gifted in a mixed method study in order to develop a competency model that lists traits of outstanding teachers of the gifted. They randomly selected 20 teachers, 10 identified as outstanding based on nominations of peers out of a group of 15, and 10 of the remaining teachers out of a group of 50 teachers who were not nominated as outstanding but taught at the same school districts as their peers. The researchers interviewed the teachers and developed a list of 12 competencies from an analysis of the transcripts, identifying themes, and coding the results: enthusiasm, personal flexibility, self-confidence, empathy, openness, motivating students, facilitator role, building program support, advocacy, applying knowledge, achievement orientation, and commitment. After developing this list, the researchers designed a survey utilizing a four-point Likert scale to cross check against the interview competencies. Based on a Mann-Whitney test on the survey results of the outstanding and average teachers, there were several differences found between these two groups. There were significantly higher means for the outstanding teachers in the areas of enthusiasm, self-confidence, role of the facilitator, applying knowledge, achievement orientation, and commitment. The area of building program support was close on the Mann-Whitney (p = .05) and was significant using the t-test (p = .02). The mean values were the same for motivating students and very close for empathy but were not statistically significant according to the t-test results or the Mann-Whitney test analyses. The only category where the mean value was higher for average teachers was openness, although it was not statistically significant (p = .08) (Whitlock & DuCette, 1989, p. 18).

Shaklee (1997) asserted an endorsement by itself is not sufficient, and therefore should not be the only indicator of an exemplary teacher of gifted students. Shaklee emphasized teachers of gifted students should work with specialists trained to support teachers emotionally and fiscally in providing enrichment opportunities for all students (Shaklee, 1997).

In conclusion, only a small body of research existed on the differences between endorsed and nonendorsed teachers of gifted students. However, much of the research suggested that holding an endorsement demonstrated a teacher's effectiveness. Research referenced other indicators such as teacher characteristics and emotional support may also make a teacher effective (Shaklee, 1997; Whitlock & DuCette, 1989), but no researchers studied the inclusion of these elements in a gifted endorsement.

STEM: Science, Technology, Engineering, and Math

A growing body of research supports the use of STEM (science, technology, engineering, and mathematics) education techniques to encourage 21st century skills, such as creativity, critical thinking, collaboration, and problem solving in gifted students (Gonzalez & Kuenzi, 2012; Roberts, 2012). The many goals of STEM education include increasing career awareness, making students globally competitive, and supporting a child's learning through transferring learning experiences, such as making connections (Roberts, 2012). In fact, the skills represented in STEM education will apply to other fields as well, thus increasing the importance of STEM education (Gonzalez & Kuenzi, 2012).

This section of the literature review will focus on teachers of the gifted in elementary grades and 1) self-efficacy in STEM education and 2) instructional practices used in STEM education.

Teachers' Self-Efficacy in STEM Education

Bandura's (1977) social cognitive theory described self-efficacy, a person's belief in his or her own capability to perform a task successfully. Researchers, however, often use the following operational terms interchangeably when discussing self-efficacy: self-confidence, self-concept, self-esteem, teacher attitudes, and teacher beliefs. Within each of these sources (see Table 2), terms used such as beliefs, attitudes, and confidence fall under the umbrella category of self-efficacy despite the omission of this specific term in the selected research. The following section in this literature review clarifies these terms to provide the context for the research. Bandura (1977) stated there were four sources of self-efficacy: mastery experiences, vicarious experiences, verbal persuasions, and psychological states. As one masters a skill, a sense of effectiveness lends itself to being able to accomplish similar tasks in the future. However, when one fails, it leads to a lower self-efficacy and thus lower performance. Learners must also learn vicariously to improve self-efficacy. By observing successes and failures of others, one can develop higher levels of self-efficacy than those based on one's own abilities (Bandura, 1977; Zeldin & Pajares, 2000).

Table 2

Selected Literature on STEM Disciplines: Self-Efficacy Key Phrases

Subject	Author(s), Year	Key Phrases (Page Number)
Science	Kelble, Howard, & Tapp, 1994	**Lack of confidence** is pronounced among teachers of the gifted (p. 163), as a result, science is poorly taught in gifted education (p. 164)
Science	Swanson, 2006	Changes in teacher **attitudes** about students' abilities (p. 18), "I know I am a better teacher now" (p. 22)
Science	Tilgner, 1990	Teachers' **attitudes** about science: dissatisfaction with science (p. 422), if teachers lack experience and understanding they **feel** less certain of their knowledge (p. 422), if teachers don't like science, their students don't like science (p. 422)
Engineering	Brophy, Klein, Portsmore, and Rogers, 2008	Teachers **felt** uncomfortable teaching content they do not understand well, significant problem for K-8 teachers attempting to deal with engineering content (p. 381)
Technology	Zimlich, 2015	Professionalism: **Attitudes** of participants included a desire to seek out new technology (p, 117), long-term exposure to technology influenced teachers' technology use with students (p. 117)
Technology	Shaunessy, 2007	Teacher training positively affected teacher **attitudes** toward technology integration (p. 119)
Technology	Grimes & Warschauer, 2008	Teachers **believed** one-to-one laptop program was beneficial for gifted students (p. 315); teaching with laptops made teachers **believe** they more effective than teaching without laptops (p. 315)
Mathematics	Rubenstein, Gilson, Bruce-Davis, & Gubbins, 2015	Teachers lack pedagogical content knowledge (p.143), theme of teachers as **reflective practitioners** arose from research, which included teachers' level of **discomfort** with mathematics material (p. 156)

Bandura also states that verbal persuasions from others help convince individuals of their own sense of competence and therefore help them to develop a sense of self-efficacy. Finally, psychological or emotional states can influence self-efficacy. Positive emotions encourage positive self-efficacy levels whereas negative emotions reduce these levels (Bandura, 1977; Zeldin & Pajares, 2000).

Heslin and Klehe (2006) further clarified the differences between these terms by describing the difference between self-efficacy, self-confidence, and self-esteem. Self-efficacy, a more specific belief that can be fostered or taught to learners, is also a stronger predictor than self-confidence or self-esteem of how a learner will perform. The researchers claimed people with high levels of self-efficacy perform better than their colleagues with low levels of self-efficacy and that self-efficacy can be more readily developed than self-confidence or self-esteem (Heslin & Klehe, 2006). Rittmayer and Beier (2008) claims self-efficacy is based on one's own perceptions of abilities rather than a self-perception of concept (self-concept) or a feeling of worth (self-esteem). Pajares (2005) shares self-efficacy, self-concept, and self-esteem are similar concepts but differ in significant ways. Self-efficacy is a judgment of one's confidence in one's own abilities, self-concept is a description of one's self with a judgment of self-worth, and finally, self-esteem is a judgment of one's own personal and social value (Pajares, 2000).

Nadelson et al. (2013) studied 32 teachers from elementary schools by sending participants surveys requesting information about demographics, confidence for teaching STEM, efficacy for teaching STEM, and attitudes towards engineering in order to determine if teachers participating in a STEM professional development institute, the SySTEMic Solution Project, had increased confidence, knowledge, and efficacy in teaching STEM. To evaluate efficacy for teaching STEM, the researchers used Riggs and Enochs' Science Teaching Efficacy Belief

Instrument (1990) in which teachers used a Likert scale to agree with efficacy statements. They also used a confidence survey adapted from the Teaching Confidence Scale from Woolfolk Hoy and a perceptions of engineering scale using a modified Pittsburgh Freshman Engineering Attitudes Survey (Nadelson et al., 2013). However, Woolfolk Hoy's 2000 paper presented at AERA demonstrated the survey was related to teacher efficacy instead of confidence, thereby further muddying the waters. Nadelson et al. (2013) found after running repeated measures analysis of variance on the pretest and posttest scores that there were significant increases in teachers' efficacy for teaching STEM, $F(1, 66) = 61.60$, $p < .01$ with an effect size of .48, confidence in teaching STEM; $F(1, 66) = 29.91$, $p < .01$ with an effect size of .31; and attitudes toward engineering $F(1, 66) = 84.76$, $p < .01$ with an effect size of .56. The researchers found that each area increased due to professional development (Nadelson et al., 2013).

Maher, Bailey, Etheridge, and Warby (2013) studied how faculty mentors in the STEM fields can impact preservice teachers' beliefs and confidence levels. Preservice teachers could volunteer to participate in the program affiliated with a NASA Space Grant Consortium Preservice Educator Program. Each of the 50 teachers who volunteered was given a Likert scale pre-survey on their confidence and beliefs that they held in their ability to teach STEM subjects. After creating a STEM centered lesson, teachers were paired with a faculty member who had a STEM background that matched the teachers' lesson focus. Teachers met with their mentor, taught the lesson to elementary students, and received feedback on the implementation of the lesson, and were finally surveyed again to determine if there were any changes in their levels of confidence through self-analysis reporting and selected interviews (n=6). The researchers analyzed the quantitative data from the Likert scales as well as the qualitative data from the interviews and found participants did not enjoy STEM teaching subjects and had low self-efficacy for learning which related to their teaching. The most beneficial parts to increasing self-efficacy levels according to this research were the opportunity to teach to current students as well as learning from a STEM mentor (Maher et al., 2013).

The Friday Institute at the NC State University created a survey that measured teacher and student attitudes and beliefs about STEM education. "The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey is intended to measure changes in teachers' confidence and self-efficacy in STEM subject content and teaching, use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness" (Friday Institute for Educational Innovation, 2012, pg. 1). The first part of the survey, The Personal Teaching Efficacy and Beliefs, was derived from a 1990 science survey called the Science Teaching Efficacy Belief Instrument from Riggs and Enoch (as cited in Friday Institute for Education Innovation, 2012). The construct the Friday Institute measured in the T-STEM survey was Personal Teaching Efficacy and Beliefs whereas the measurement application was self-efficacy and confidence related to teaching the specific STEM subject (Friday Institute for Educational Innovation, 2012). This survey also used Bandura's self-efficacy model as its primary conceptual framework, which aligns with the research study's model. Additional surveys were reviewed, and none tied in to the conceptual framework of Bandura's self-efficacy model.

Due to the confusion in the literature, the researcher needed to operationalize the term self-efficacy. Since self-efficacy is the best predictor of performance and is related to a specific task in each domain, Bandura's operational definition of self-efficacy, the belief in a person's capability to produce a designated level of performance, was used for the study.

Gifted Instruction within the Disciplines of STEM

The more recent focus on STEM education as an interdisciplinary approach emerged in 2008. Because of this recent addition to the literature base, there is a paucity of research about the use of STEM education as an interdisciplinary method of teaching. Therefore, this review begins by addressing the literature about teachers of elementary gifted students in each of the individual discipline areas of science, technology, engineering, and mathematics before moving on to the limited research on the interdisciplinary topic of elementary teachers of the gifted and STEM education. Research demonstrated that the earlier teachers exposed students to a strong STEM education the more it contributed to achieving the aforementioned goals of increasing career awareness, making students globally competitive, and fulfilling a child's learning experience by aiding him or her in the ability to transfer their understanding (Gonzalez & Kuenzi, 2012; Roberts, 2012). Therefore, the research review and the research study focused on elementary education consisting of kindergarten through fifth grades.

Introduction to teachers of the gifted and elementary science. The National Science Education Standards stated that students who can move beyond the basic science program should receive opportunities for enrichment beyond the typical curriculum (National Research Council, 2012). This statement was the only mention of challenging academically gifted students in the document. However, other research demonstrates the importance of meeting the needs of gifted students in the area of science through relevant, inquiry-based teaching (Field, 2010; Hennessey, 2004; Karademir, 2016; Reeves et al., 2013; Reis, Gentry, & Maxfield, 1998; Swanson, 2006; VanTassel-Baska et al., 1998) as well as finding confident, effective teachers (Kelble, Howard, & Tapp, 1994; Swanson, 2006; Tilgner, 1990).

Elementary science teachers' self-efficacy. One theme that arose from the research was a growing concern that teachers may not be equipped to teach science if they do not feel comfortable with the content or in their belief that they can teach science, which relates to Bandura's (1977) theory of self-efficacy. A body of research referenced science teacher self-efficacy and how it influenced teacher performance in the classroom (see Table 2) (Kelble, Howard, & Tapp, 1994; Swanson, 2006; Tilgner, 1990).

Teachers felt professional development helped them to become stronger teachers of science (Swanson, 2006). In fact, through the interviews of the teachers, the researchers of Project Breakthrough found teachers demonstrated shifts in their attitudes towards student learning. Their thoughts changed on what students were capable of doing as well as how students learn which resulted in a change in teachers' use of questioning as well as teaching students how to think critically (Swanson, 2006).

Kelble, Howard, and Tapp (1994) also referenced teaching students to think critically. Based on their six years of teaching elementary school science summer workshops for teachers in a project funded by the National Science Foundation (NSF), Kelble et al. (1994) asserted that a lack of confidence in teaching the physical sciences was one reason why elementary school science education for gifted students faces special challenges. Although the authors did not cite empirical research in this article, the financial support from the NSF was indicative of the quality of the opinions described in this article and provided credence to their conclusion that teachers of gifted and talented students must develop a feeling of confidence in teaching science.

As a matter of fact, elementary school teachers found teaching science intimidating and ranked science at or near the bottom of the subjects they preferred to teach according to Manning et al. (1981), Mechling (1982), and Westerback (1984) (as cited in Tilgner, 1990). Tilgner's literature review emphasized teachers who do not like science fostered students who do not like science, and while professional development appeared to impact teachers' attitudes in the short-term, Tilgner claimed it was not a long-term solution (Tilgner, 1990). Although this research did not focus *only* on teachers of the gifted, it is reasonable to assume because it focused on a body of elementary school teachers, it likely included teachers who teach gifted students.

Elementary science instructional practices. Since the 2000s, science instruction has moved from memorization of facts and recall to more relevant experiences such as problem-based learning and inquiry (Field, 2010; Hennessey, 2004; Karademir, 2016; Reeves et al., 2013; Reis, Gentry, & Maxfield, 1998; Swanson, 2006; VanTassel-Baska et al., 1998). Karademir (2016) executed a qualitative study of 14 third and fifth grade students identified as gifted. She used interviews and student and teacher observations to determine how effective project-based learning could be in linking scientific process skills and scientific creativity. After identifying common themes, the researcher noted the frequency of opinions documented on categories of interviews and observations forms. Karademir (2016) found a positive correlation between project-based activities and levels of creativity. Hennessey (2014) claimed in her literature review of intrinsic versus extrinsic motivation of gifted students funded by The National Research Center on the Gifted and Talented that students had higher levels of creativity if not prompted by a reward.

By using predesigned problem-based lessons and curriculum for gifted students, student achievement can improve as well (Swanson, 2006). In Project Breakthrough, teachers instructed third through fifth grade students in South Carolina using the *William and Mary Center for Gifted Education* units that encompassed a high level of complexity of skills and concepts. In a mixed methods study, researchers collected data on achievement scores from the Metropolitan

Achievement Test-7, pretest and posttest data, teacher observations, logs, questionnaires and interviews. Researchers analyzed the student achievement scores using a t-test for the first year of the study to compare the pretest and posttest scores. For the following two years, researchers ran a repeated-measures analysis on student data. For science achievement, researchers found medium to large effect sizes, demonstrating increased science achievement over time. Using the qualitative interviews of teachers, Swanson (2006) determined that teachers found the problem-based learning approach to curriculum effective.

VanTassel-Baska et al. (1998) also performed a study utilizing a William and Mary unit. In this study, trained instructors implemented the unit called "Acid, Acid Everywhere" with 1,471 fourth through sixth grade students in 45 classes across 15 school districts in seven states. This unit focused on "advanced content, high level process and product, and a concept dimension" (VanTassel-Baska et al., 1998). An additional 17 classrooms served as the comparison group. Researchers gave students a pretest and posttest of the Diet Cola Test (DCT), designed to identify promising science students in the 1990s. The researchers ran an ANCOVA on the posttest, using the pretest at a covariate and found significant differences between the experimental and comparison groups on scientific process skills with higher scores favoring those teachers who used the Acid, Acid Everywhere unit (VanTassel-Baska et al., 1998).

Reis, Gentry, and Maxfield (1998) used the enrichment clusters from Renzulli's Schoolwide Enrichment Model to provide a learning experience for 120 students in two urban school divisions. Enrichment clusters allow for small groups of students to work in a pull-out setting to design an individualized project without predetermined activities, allowing for a high level of differentiation and student interest. Teachers received professional development on the model, and trained facilitators implemented the enrichment clusters in a pull-out setting in classrooms. The researchers collected data from written descriptions of the clusters, transcribed interviews, evaluations of the facilitators, and questionnaires to perform a content analysis. They found the most frequent strategies students were exposed to during this experience were challenging new concepts and advanced content, developing a product or service, teaching authentic methodologies, using advanced vocabulary, authentic tools, advanced resources and reference materials, and advanced thinking and problem-solving strategies. In addition, 58% of the teachers shared they started implementing additional differentiation strategies because of the professional development given in this research project (Reis et al., 1998).

While most research supported the use of inquiry in the classroom for gifted students, some studies found this mode of instruction not as beneficial for gifted students as other students (Field, 2010; Reeves et al., 2013). For example, Reeves et al. (2013) found the Science Writing Heuristic (SWH) approach more beneficial for special education and traditional students based on results on the standardized Iowa Test of Basic Skills (ITBS) test. Teachers using the SWH approach taught students to ask and write down questions and answers to foster argumentation and science inquiry. The treatment group of third and fourth grade students in Iowa received instruction using the SWH approach and the teachers of the treatment group of students received training on how to include scientific inquiry skills in the classroom through the SWH approach. By using structural equations modeling, the researchers found no significant difference between the control and treatment groups of gifted students who used the SWH model (Reeves et al., 2013). This method of inquiry teaching, therefore, did not support increased achievement for gifted students.

Another study that did not reference an increased level of student science performance was the use of an online model of Renzulli learning, where researchers matched students' instruction to their interests, abilities, and expression and learning styles (Field, 2010). The Renzulli Learning System is an online management system based on the Enrichment Triad Model that "promotes advanced level learning, creative productivity, and high levels of student engagement by focusing on the *application* of knowledge rather than the mere acquisition and storage of information" (Renzulli & Reis, p. 1, 2007). RLS uses compacting in order to help students accelerate through the curriculum by using a computer-based strengths assessment finder to match students' learning by subject, grade, state standards, and complexity level (Renzulli & Reis, 2007). Field (2010) found no impact on science achievement in a study of southern California students at a suburban elementary school for third through fifth graders when using this model. The treatment group received access to the 16-week Renzulli learning program. For their third research question, the researchers focused on science achievement by analyzing the ITBS science pretests and posttests through a repeated-measures ANOVA. They found no specific group differences between the control and treatment groups in science achievement. However, a classroom teacher in the study commented a standardized test could not solely measure science achievement. She believed the Renzulli model of learning encouraged students to make connections with the real world, which appeared contradictory to Field's finding that the program did not result in increased science achievement (Field, 2010).

Research on elementary science education for gifted students referenced the need for teachers to feel confident in their knowledge of science and their ability to teach the science curriculum and the need for inquiry and problem-based learning activities in the classroom to meet the needs of gifted students.

Introduction to teachers of the gifted and elementary engineering. A link exists between science and engineering in education. The Next Generation Science Standards (NGSS) included engineering in the 2013 standards. Despite its inclusion, engineering education with elementary students remains a little researched topic. In Critical Issues and Practices in Gifted Education: What the Research Says, Plucker and Callahan (2008) did not include the area of engineering with gifted students for either secondary or elementary education. In fact, out of the 16 articles found on elementary engineering with gifted students through the ProQuest ERIC search, only three were peer-reviewed, demonstrating how little research exists on engineering at the elementary level notwithstanding the importance reflected in the NGSS standards.

In its executive summary of the 2013 release of the standards, NGSS (2013) determined each standard should embed engineering. NGSS tied engineering to science stating, "science and engineering are integrated into science education by raising engineering design to the same level as scientific inquiry in science classroom instruction at all levels, and by emphasizing the core ideas of engineering design and technology applications" (NGSS, 2013, p. 1). The NGSS's standards included a commitment to elevating engineering design to the same importance as science in the classroom. Their reasoning focused on providing students with exposure to engineering design in order to have students solve real world problems (NGSS, 2013, p. 10). The National Research Council (2012) stated that to teach students engineering, students must experience a systematic process in which they follow a set of steps to identify a problem, define criteria (specifications and constraints), identify possible solutions, test, modify, and solve a problem. "This optimization process typically involves trade-offs between competing goals, with the consequence that there is never just one 'correct' solution to a design challenge" (National Research Council, 2012, p. 48).

Elementary engineering teachers' self-efficacy. Brophy, Klein, Portsmore, and Rogers (2008) performed a review of engineering programs to document challenges for P-12 engineering education. The first challenge the researchers mentioned was teachers are often uncomfortable teaching content if they do not understand it, which relates directly to self-efficacy levels from Bandura (1977). Because engineering content and science content are included in STEM education, it may be a particular problem for elementary teachers who have not learned engineering or how to teach it (Brophy et al., 2008, p. 381). Brophy et al. (2008) also claimed teachers do not perceive engineering as an accessible career for their students and asserted that teachers need professional development to be successful in teaching engineering (Brophy et al., 2008).

Elementary engineering instructional practices. In their review of engineering programs, Brophy et al. (2008) found two programs focused on improving elementary engineering: Engineering is Elementary and LEGO Engineering. LEGO Engineering was held as an after-school club and the organization designed Engineering is Elementary for classroom use to supplement the curriculum. The researchers shared information on the program history and overview, program design/content, program implementation and assessment, and research findings. They also pointed out the lack of data on each program's efficacy and impact on STEM learning outcomes. The common thread between these two programs appeared to be an opportunity for students to create a solution to a problem that is open-ended, allowing for many ways to solve the same problem (Brophy et al., 2008).

Dare, Childs, Cannaday, and Roehrig (2014) wrote about an action research study they completed in one fifth grade classroom. They worked with students on designing a rocket by using the Engineering Design Process, a series of steps in which students collected and used data, designed a rocket, tested the prototype, and created a final marketing product for their rocket. The class included gifted students. After the project, the researchers asked the students to complete a satisfaction survey using a Likert scale and open-ended responses. Students reported enjoying the project and could verbalize what they had learned (Dare et al., 2014). This research highlighted a classroom example of engineering that appeared beneficial for students, despite its lack of statistical measures to determine significance.

There were no other empirical research studies found on teachers, elementary gifted students, and engineering.

Introduction to teachers of the gifted and elementary technology. The inclusion of technology in the overarching STEM movement demonstrates how important it is for students to learn and access digital technology in order to become ready for college as well as remain globally competitive (Zimlich, 2015). Individual researchers define technology in the classroom differently. According to Zimlich (2015), some standards cited technology as anything that aids in completing tasks, but others referenced the instructional or educational technology tools students employ in the classroom, such as computers, iPads, interactive whiteboards and the software that supports these devices (Zimlich, 2015). For the purpose of the current research study, the latter, more specific definition of technology as "electronic devices that allow transfer of information and products between people and locations" (Katic, 2008) which much of the STEM research referenced was used.

In Critical Issues and Practices in Gifted Education: What the Research Says, Plucker and Callahan (2008) did not include the area of technology with gifted students as a critical issue. However, technology has become relevant in the years that have passed since 2008, because in a meta-analysis of literature, Periathiruvadi and Rinn (2013) found many articles about gifted students using technology but found only 23 based on empirical research and related to the NAGC's programming standards.

Elementary technology teachers' self-efficacy. Because technology is pervasive in current classrooms and changes rapidly, teachers may have varying beliefs regarding technology and their own self-efficacy that influence student outcomes. In a qualitative phenomenological case study of six teachers in Alabama, Zimlich (2015) interviewed, observed, and analyzed lesson plans in order to discover "in what ways teachers' uses of technology with G/T [gifted and talented] students shape students' technology experiences" (Zimlich, 2015, p. 107). Zimlich found a relationship between teacher attitudes about technology and their use in the classroom. The teachers enjoyed exploring with technology on their own and teachers who had long-term exposure to technology embedded it in their own teaching. In fact, these teachers pursued professional development in technology in order to incorporate this technology in the classroom (Zimlich, 2015).

Shaunessy (2007) found technology training of teachers of gifted students was the strongest predictor of their attitudes towards technology. Focusing on email, internet, and multimedia use, Shaunessy surveyed 418 teachers of gifted students in a southeastern state with the Teachers' Attitudes Toward Information Technology Questionnaire (TAT). This survey had 100 questions with 10 subscales about teacher and student attitudes toward email, the Web, multimedia, computers, email, and use of computers. Shaunessy found teacher training was a large indicator in positively affecting teacher attitudes toward technology integration. However, researchers did not find graduate coursework in gifted education a statistically significant predictor of teachers' attitudes toward technology, which may be in part due to graduate courses not addressing the use of technology. Shaunessy suggested future studies should investigate how, when, and why teachers of gifted students use technology (Shaunessy, 2007).

Another study about technology examined providing students with one-to-one laptops (Grimes & Warschauer, 2008) in schools in Southern California and was the precursor for a multi-methods study that included a review of longitudinal achievement data, surveys of students and teachers, focus groups of students, observations, and written documents. The researchers studied three school programs. One of the schools consisted solely of gifted elementary students in third through fifth grades, and the remaining two schools consisted of a kindergarten through sixth grade population and a middle school population. The researchers analyzed the aggregated teacher data presented below for all three schools. Data showed teachers believed a one-to-one laptop program was most beneficial for gifted students (97%) in comparison to English language learners (72%), Special Education (65%), at-risk (67%), or general education (90%) students. Teachers also believed their teaching with laptops made them more effective than teaching without laptops at an 88% agreement rate (Grimes & Warschauer, 2008).

These research studies (Grimes & Warschauer, 2008; Shaunessy, 2007; Zimlich, 2015) demonstrated self-efficacy correlates to teachers' performance in their classrooms, which lends credence to Bandura's theory that self-efficacy is the best predictor of performance.

Elementary technology instructional practices. Research demonstrated incorporating technology in classroom activities for student use was important for gifted students (Polzella, 1997; Shaunessy, 2007; Tassell et al., 2013; Zimlich, 2015). For example, in Shaunessy's study (2007), researchers surveyed teachers on technology tools used by students in the classroom. Although this article did not reference the specific qualitative process the researchers used in order to determine themes, according to the survey results, hours in information technology training, staff development in information technology, and age were predictors for student use (Shaunessy, 2007). Students also crave the use of technology in the classroom, as demonstrated by Polzella's (1997) survey of gifted fourth through eleventh graders at a gifted summer program. Through an open-ended survey and follow-up interviews, the researcher found many areas the students were seeking to improve in their own education, such as hands-on science and technology. Specifically, Polzella found "students need to experience the world in both concrete and abstract ways and must have enthusiastic, capable teachers to facilitate their learning" (Polzella, 1997, p. 33).

An additional educational technology framework for gifted students was the Cognitive complexity, Real world learning, Technology integration, and Engagement (CReaTE) framework (Tassell et al., 2013). The researchers cite technology integration as an opportunity for learners to communicate and access data. Learners can integrate technology with content, include multiple technologies, and include collaboration with experts in the field of interest to solve a real-world problem. Although Tassell et al.'s work was not empirical research, the authors noted this framework is accessible for teachers in the classroom and can help teachers to extend their understanding of STEM concepts (Tassell et al., 2013).

In Zimlich's (2015) research, she found when students collaborated with partners or in small groups, it was as often due to having limited equipment instead of being a purposeful pairing. In addition, the teachers did not have up-to-date technology they wanted to use in the classroom. Limited equipment, restricted access to computer labs, and blocked websites inhibited the use of the type of technology teachers employed with their students. The codes of assets (having the equipment) and supports (having the needed supports in order to use the equipment) were the two most frequently occurring challenges reported in the data (Zimlich, 2015). Therefore, the instructional practices integrating technology were not only linked to a need for using technology and professional development but also impacted by a lack of access to technology.

Introduction to teachers of the gifted and elementary mathematics. There is little research on teachers of gifted elementary students and mathematics. In the dearth of research, two key themes occurred. First, the research referenced teachers' self-efficacy in teaching mathematics (Rubenstein et al., 2015). Second, the researchers discussed instructional practices that contribute to a teachers' success with gifted students (Gavin & Adelson, 2008; Pierce et al., 2011; Reis et al., 1992; Rubenstein, Gilson, Bruce-Davis, & Gubbins, 2015; Schultz, 1991; Ysseldyke, Tardew, Betts, Thill, & Hannigan, 2004).

Elementary mathematics teachers' self-efficacy. One recent study used a researcher created predifferentiated and enriched mathematics curriculum based on Carole Tomlinson's Differentiation of Instruction Model, Kaplan's Depth and Complexity Model, and Renzulli and Reis's Schoolwide Enrichment Model to meet the needs of gifted students. The researchers required teachers to pretest students, flexibly group them according to their needs, and use a variety of differentiated materials provided by the research team to meet the needs of the students. The researchers used a mixed methods design to examine the effects of the curricula and two days of professional development. The instruments used consisted of researcher created surveys, classroom observations, and interviews of focus groups consisting of teachers and administrators. Rubenstein et al. (2015) noted in their study a concern about the level of comfort of teachers who instruct mathematics in the classroom as well as shared teachers' concerns about their level of discomfort with the mathematics material. For example, one teacher in the study claimed, "math is not my bag." After analyzing the teachers' comments about not understanding mathematics or making mistakes, the researchers suggest a lack of mathematics conceptual knowledge may prevent some teachers from providing differentiation in the classroom (Rubenstein et al., 2015).

Elementary mathematics instructional practices. In order to meet the needs of gifted students in the area of mathematics, researchers share that teachers should differentiate their instruction. Differentiation can occur through flexible grouping by ability or interest within the class, between classes, cross grade level, or through pull-out programs (Gavin & Adelson, 2008). Once grouping occurs, teachers can differentiate by using acceleration in the classroom. For example, curriculum compacting is how teachers can move students through curriculum by streamlining learning activities that students have already mastered for them to move onto more advanced material at a quicker pace (Gavin & Adelson, 2008; Reis et al., 1992; Schultz, 1991).

Schultz (1991) investigated the mathematics achievement of 132 fourth graders. Teachers who taught the treatment group used curriculum compacting in order to accelerate the students. Teachers taught the control group the entire fourth grade mathematics curriculum. Through the evaluation, there was no significant difference between the students' scores on the end of the year ITBS test of those students who teachers instructed using the curriculum compacting model as those students who were taught the entire curriculum (Schultz, 1991). Reis et al. (1992) also used the ITBS test to compare students' scores between a treatment group of third and fourth grade students. They found the scores were also not statistically different for each group of students.

In lieu of acceleration, providing enrichment activities is a source of differentiating for gifted students (Rubenstein et al., 2015). One theme the researchers found in their study on using a grouping curriculum (referenced above in *Elementary mathematics teachers' self-*

efficacy) was that preassessments allowed teachers to gauge prior knowledge and group students appropriately in order to provide appropriate differentiation (Rubenstein et al., 2015).

Pierce et al. (2011) also researched mathematics enrichment lessons for gifted students in a grant called Project CLUE that provided training for teachers and use of directed material geared toward enriching the content areas of algebra and geometry. The teachers were divided into two groups in the first year of the study: those teachers who implemented the treatment fully and those who did not. The researchers compared the two groups through a repeated-measures ANOVA by grouping identified gifted students. The researchers found students scored the highest if they participated in the implementation group and held gifted status for the algebra unit. The geometry unit modeled similar results; however, there was a higher incident of pretest to posttest increases during the geometry unit despite implementation status. The researchers concluded that gifted students needed appropriately leveled curriculum to meet their needs. Students should be grouped with other gifted students, and teachers needed professional development. Most importantly, they noted that teachers needed experience with the materials and longitudinal exposure to the resources. These exposures were beneficial for teacher and student success (Pierce et al., 2011).

Another study where curriculum impacted gifted students' achievement was in relation to a computer-based management system that allowed students to work at their own pace and provided teachers with information on prior levels of achievement, instruction matched to appropriate levels, and a management system of feedback on student performance (Ysseldyke et al., 2004). The researchers administered the Accelerated Math program to 1130 third through sixth grade students and compared the pretest and posttest data from the Accelerated Math program to a control group of 1072 students in 15 states. Out of this large sample, the researchers focused on 10 schools that had 48 gifted students using the mathematics program and 52 gifted students who did not use the mathematics program. The researchers conducted an ANCOVA to compare the differences in mathematics achievement between the two groups. While the pretest scores were not significantly different, they found a significant difference between the two groups ($F = 6.77$, $p < .01$) with a higher mean for the treatment group. The researchers assert that the individualized instruction students received was helpful for gifted students (Ysseldyke et al., 2004).

Acceleration, enrichment, and grouping were important instructional approaches in teaching mathematics to gifted students according to the literature. However, it also is important to note teacher self-efficacy was an important factor according to qualitative studies although there was little quantitative data found to support this assertion.

The Integration of STEM

It is apparent from the literature that teachers need to have a strong sense of self-efficacy and understand the current best practices in each discipline of STEM education in order to perform in the classroom, as Bandura (1977) claimed self-efficacy is the best predictor of performance. However, the extant research studies individual disciplines, rather than combining the STEM disciplines into a fully integrated STEM education, which is a more meaningful way of instructing our students (Bybee, 2010; Roberts, 2012). A fully integrated STEM curriculum is achieved more easily at the elementary level versus embedding a STEM curriculum at the secondary level (Roberts, 2012). in teaching STEM self-efficacy.

Root-Bernstein (2015) asserted that STEM can be taught to students and is not necessarily linked to IQ. He advocated for STEM to be nurtured through creativity lessons in six ways:

> (1) mental skills such as observing, imaging and abstracting; (2) sensual and manipulative skills; (3) analogies that provide novel approaches to solving STEM problems; (4) experience with materials, structures, phenomena and techniques; (5) practice with the creative process; and (6) recreation to relax and re-energize their minds" (Root-Bernstein, 2015, p. 207).

Based on his own research and a review of literature, he claimed these descriptors are ways STEM professionals can build their skills and determine how teachers should approach STEM instruction in the classroom.

In addition to the research and identified best practices for STEM programs, one of the four primary policy areas for STEM education, according to the National Science and Technology Council's 2011 report, was focused on STEM teacher quality. In the report, there is some disagreement on how to provide STEM education support to teachers. One option consists of creating a STEM Master Teacher Corps that would use already exemplary mathematics and science teachers to mentor other teachers or to create online resources to support teachers in STEM education (as cited in Gonzalez & Kuenzi, 2012). Pierce et al. (2011) stated the intentionality of training and implementation make the biggest difference in STEM education. Atkinson and Mayo (2010) advocated that it may not be sufficient to train teachers how to teach STEM in the classroom, as the "STEM for All" model may not result in increased and better students in STEM fields.

The Relationship between Gifted Certification and STEM Education

While professional development appeared to play an integral part in teachers feeling successful with STEM education, there was no literature found studied a relationship between

STEM education and gifted certification. Thus, there is a need for future research to explore this relationship in more detail.

Synthesis

Endorsements for teachers of gifted students are beneficial for student achievement; however, some teachers do not have a certification in gifted education and teach gifted students. Some researchers supported the idea that an endorsement makes a teacher exemplary. Other researchers include specific training components in courses or certain individual teacher characteristics that can make a teacher of gifted students exemplary. These studies asserted that the other indicators are as beneficial in determining whether a teacher is effective. Thus, it is important to determine whether an endorsement relates to self-efficacy and instructional use in the classroom.

Integrating STEM activities in the classroom is considered a best practice for gifted students, allowing gifted students the opportunity to use cross-curricular projects to further their understanding for solving real world problems. The research demonstrated that within each discipline, self-efficacy, the belief in a person's capability to produce a designated level of performance, is a key predictor for performance, or instructional practices, that support STEM learning and students' achievement.

There was no research found that used endorsement status to differentiate between teachers who feel comfortable using STEM strategies in the classroom. "With the prevalence of gifted students in general education classrooms, all teachers will be responsible for providing appropriate programming for them" (Bangel et al., 2010, p. 209). Therefore, it appears more research needs to occur to determine if there is a difference between teachers of the gifted who have an endorsement versus those who do not have an endorsement in their self-efficacy in

STEM education because self-efficacy is the best predictor of performance (Bandura, 1977). In the research study, endorsement status was used as a variable to measure whether differences in self-efficacy exist between endorsed and nonendorsed educators of gifted students.

Chapter 3: Methodology

As the literature shows, there is a small volume of research that includes self-efficacy of teachers of gifted students in relation to STEM education. Based on Bandura's (1977) theory that self-efficacy is the best predictor of performance, the study focused on self-reported self-efficacy levels. This study utilized quantitative survey methods in order to determine if there is a difference in mean values between the teachers of the gifted who are endorsed and those who are not endorsed by collecting data on endorsement status, current grade level, years of experience, recent STEM training, self-efficacy in the disciplines of math, science, and integrated STEM education, and self-reported use of STEM instructional strategies.

This chapter will describe the methodology used for the study starting with the research questions, followed by explanations of the research design and rationale, participants, instrumentation, Institutional Review Board, data collection, data analysis, and delimitations.

Research Questions

The major aim of the study addressed the following research questions:

1. Is there a difference, and if so, to what extent is there a difference between the self-efficacy in teaching science, mathematics, and integrated STEM content by endorsed and nonendorsed elementary teachers of gifted students?
    a. Do grade level, years of teaching experience, or recent STEM training impact, and if so, to what extent do they impact self-efficacy in teaching science,

mathematics, and integrated STEM content of endorsed and nonendorsed elementary teachers of gifted students?

2. Is there a difference, and if so, to what extent is there a difference between reported instructional strategies used during classroom STEM sessions by endorsed and nonendorsed elementary teachers of gifted students?
    a. Do grade level, years of teaching experience, or recent STEM training impact and if so, to what extent do they impact self-reported instructional strategies used during classroom STEM sessions of endorsed and nonendorsed elementary teachers of gifted students?

Research Design and Rationale

Because Bandura (1977) postulated that self-efficacy reflects a person's beliefs in their ability, it was necessary to collect data directly from the participants. The study utilized a nonexperimental research design. In a nonexperimental research design, the researcher has not manipulated any factors that may influence subjects (McMillan, 2008). The study consisted of descriptive as well as *ex post facto* research, in that it provides information about the participants but also seeks to determine if an intervention in the past, a gifted endorsement, may relate to subsequent responses in order to draw causal relationships (McMillan, 2008). Using a quantitative survey design method in order to answer the above research questions, the researcher collected survey data directly from participants at one time and place. The value of this information is that it was not biased and reflected a teacher's self-reported self-efficacy.

The survey data consisted of demographic information as well as questions with Likert scale answers on self-efficacy of teachers of the gifted in the area of STEM education. The researcher chose to include three sections of the initial survey and add an additional section to the survey in order to match the intent of the research. The first two sections from the initial survey focused on self-efficacy for mathematics and science. The researcher added an additional section to the survey based on integrated STEM education self-efficacy to help identify teachers' self-efficacy levels in integrated STEM education. The section on STEM Instruction from the initial survey (for more details see *Instrumentation* section) encompasses the best practices in integrated STEM education. Because it is shown that self-efficacy directly relates to behavior (Bandura, 1977), it is important to evaluate teachers' instructional behaviors in classrooms.

Institutional Review Board

Before data collection began, the researcher submitted the research proposal to three individual school divisions as well as to the Virginia Commonwealth University Institutional Review Board (VCU IRB) for approval. The VCU IRB approval for HM20011413 was provided on December 18, 2018.

Instrumentation

The research was modeled primarily on the T-STEM survey created by the Friday Institute for Educational Innovation (2012). After analyzing seven surveys on self-efficacy in the subjects of science, technology, engineering, and math, only one survey focused on self-efficacy in relation to STEM instructional practices, therefore best representing the researcher's conceptual framework based on Bandura's theory of self-efficacy.

The T-STEM Survey

The Friday Institute at the NC State University's School of Education created surveys based on Enoch and Rigg's (19909) science self-efficacy survey in order to measured teacher and student attitudes and beliefs about STEM education. *The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey – Elementary Teacher* uses a ranked 5-point Likert scale

(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, or Strongly Agree) for each respondent to rank their support (Friday Institute for Educational Innovation, 2012).

The intent of the survey is to measure teachers' self-efficacy and beliefs in their understanding of STEM subject content and teaching of STEM subjects. The researchers intended the first part of the survey to be able to measure the construct Personal Teaching Efficacy and Beliefs and the second part of the survey to measure Outcome Expectancy (Friday Institute for Educational Innovation, 2012). The two STEM subjects represented in the Elementary version of the survey were mathematics and science. Although the T-STEM survey initially included the disciplines of technology and engineering, the creators of the survey eliminated these areas after the pilot due to the small number of elementary teachers who teach these subjects (Friday Institute for Educational Innovation, 2012).

To determine the reliability and validity of the initial survey, the Friday Institute piloted the survey with 218 elementary teachers (Friday Institute for Educational Innovation, 2012). The researchers used the Cronbach's alpha to measure whether participants' answers in a survey are consistently measuring the same construct (McMillian, 2008). The Cronbach's alpha levels from the researchers at the Friday Institute are listed in Table 3, indicating higher levels of internal consistency for the areas of Personal Teaching Efficacy and Beliefs and STEM Instruction, the two sections of the original test that were included in this study.

The researchers from the Friday Institute also edited and eliminated survey items based on factor analysis and feedback confirmation. The factor analysis consisted of combining similar questions that measured the same construct and the feedback confirmation was received from experts in the field who ranked the questions as essential, useful but not essential, or not necessary. The researchers then added the construct of STEM Instructional Practices in addition to attitudes toward teacher leadership, student technology use, attitudes toward 21st century learning, and awareness of STEM careers and career resources after the initial pilot (Friday Institute for Educational Innovation, 2012).

Table 3

T-STEM Survey Reliability for Elementary Teacher Participants

Construct	Cronbach's Alpha Elementary
Personal STEM Teaching Efficacy and Beliefs	.905 (Science)
	.939 (Mathematics)
STEM Instruction	.950

Note. Adapted from "Teacher Efficacy and Attitudes toward STEM (T-STEM) Survey: Development and Psychometric Properties" by Friday Institute for Educational Innovation, 2012, Raleigh, NC.

The Modified Survey

The survey utilized for this study was distributed to participants electronically using REDCap (Research Electronic Data Capture), a web-based survey design and collection tool. The researcher collected and managed study data using REDCap electronic data capture tools hosted at Virginia Commonwealth University. The first part of the survey consisted of demographic questions. The preliminary question asked if the participant was currently teaching or had taught gifted students within the past three years. Participants who selected that they were not currently teaching gifted students or had not taught gifted students in the past three years were given a thank you screen and exited from the survey. The remaining demographic questions included items asking about teachers' endorsement status, current grade level of instruction, years of experience, and recent STEM training (see Appendix A). Data were collected on these variables because self-efficacy may vary based on endorsement status, grade level, experience, and training.

The second part of the survey included 36 Likert scale questions from the Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey – Elementary Teacher (Friday Institute for Educational Innovation, 2012). The sections of the original survey included in the current adapted survey were Science Teaching Efficacy and Beliefs (11 questions), Mathematics Teaching Efficacy and Beliefs (11 questions), and Elementary STEM Instruction (14 questions).

The research included the construct Elementary STEM Instruction, as the researcher found these survey questions closely aligned to the strategies considered quality practices from the literature review. Based on Bandura's (1977) theory that a high sense of self-efficacy can result in performance, it is necessary to include instructional practices to see what teachers in each group (endorsed and nonendorsed) are doing in the classroom.

In order to focus on overall STEM self-efficacy, an additional section that mirrors the Science and Mathematics section was added regarding STEM Teaching Efficacy and Beliefs (11 questions). The Friday Institute gave permission to use the survey in its entirety or modify it based on the survey research (Friday Institute for Educational Innovation, 2012). The addition of this section focused on integrated STEM self-efficacy, which was a missing component in the current research that exists. The added section mimicked the Mathematics and Science sections by using the same questions with a focus on integrated STEM sessions in the classroom. The researcher emailed the Friday Institute lead authors to posit whether there was a reason integrated STEM was not included initially, and to determine what barriers may play into adding this section to the survey based on their research with the initial survey. The initial researchers did not consider creating an additional section that measured teachers' self-efficacy regarding integrated STEM. Because the intent of the survey was focused on interventions causing a change in self-efficacy, the initial researchers' intent was on their licensed content background of mathematics and science rather than integrated STEM (M. Faber, personal communication, October 30, 2017).

At the close of each self-efficacy section (science, mathematics, and integrated STEM), an open-ended question was included to garner responses from the participants about whether the questions captured their beliefs about self-efficacy. This question was included to collect information that may have impacted participants' responses and help the researcher for future research opportunities.

The researcher discussed the survey with three experts in the field. The first expert was a division-wide professional development coordinator from a school division with a similar population to those that received the survey. The second was a science specialist who was also from a school division with a similar population to those that received the survey. Both experts had experience observing STEM lessons. The third expert was a professor for elementary science at a local university. The researcher asked for feedback on the quality and length of the survey and individual questions.

The modifications of the survey were based on concerns from these experts. The first concern noted was the discrepancy in the definitions of STEM. In order to rectify this, the operative definition of STEM used for the purpose of this research study was placed at the beginning of each questions that referenced STEM on the survey. Another concern was survey fatigue.

After modifications based on the experts' feedback, a pilot test was administered. The updated survey was sent electronically through REDCap to a convenience sample of five individuals who teach gifted students in grades kindergarten through fifth grade in a school division with a similar population to those included in the research. Participants were asked to complete the survey in order to verify that the branches in the survey work as well as the questions are readily understandable for the additional section on STEM self-efficacy. A follow-up email was sent to participants to garner answers to the questions posited below.

1. Are there any questions that are confusing?
2. Were there any questions that you could not answer when thinking about the STEM lessons that you have completed in your classrooms?
3. Are there any other thoughts that you have regarding this survey?

As a result of this pilot, there were several changes made to the survey. One change was in the branching logic of the survey, adding a list of all survey questions still to be completed in order to allow participants an opportunity to skip sections and proceed without thinking they were already finished with the survey. Additional clarification was also included in the raffle survey question to provide consistency across the initial survey email and the survey itself.

After the survey was sent to participants, one participant emailed the researcher stating they were having trouble completing the demographics section, as once the participant filled in their email address, the REDCap system redirected the user to the initial question. The researcher emailed the REDCap system directly, and the technological contact reported the redirection could result as a rare bug that occurred when using the web browser Google Chrome and a multiple-choice question is followed by a fill in the blank email address that a participant uses AutoFill to complete. Due to this concern, the researcher resubmitted VCU IRB approval with a request to adapt survey question number three “Please type in the email address this survey was sent to in order to avoid duplicate answers. This email will be used in the drawing for one of two $25 amazon e-certificates but will be separated from any data collected." The addition of the phrase "do not use auto-fill" was added at the end of the first sentence.

Participants

Participants were selected using nonprobability convenience sampling (McMillan, 2008). The researcher contacted seven school divisions in a geographic proximity to an urban center in Virginia. Of the seven school divisions, three school districts agreed to participate and were included in the survey in order to garner information from rural and suburban elementary schools. The school divisions were chosen because they have gifted teaching opportunities for their teachers if they are endorsed or not endorsed in gifted education at the elementary school level. By including three school divisions in the survey, the researcher had more opportunities to receive responses from teachers who teach gifted students who were endorsed and not endorsed.

School Division A consists of 46 elementary schools with students in prekindergarten through fifth grade. This school division's model includes gifted resource teachers and center-based teachers who teach identified gifted students clustered in one class at the fourth and fifth grade levels. There are 18 gifted resource teachers across the county and 50 center-based teachers who are all endorsed (P. Griffin, personal communication, October 30, 2017). After communicating with the research department, this school division determined the school division research department representative would send the email survey directly to all third through fifth grade teachers, which consisted of 550 total teachers to whom the survey was sent.

School Division B consists of 13 elementary schools with students in prekindergarten through fifth grade. This school division's model includes one gifted resource teacher at each school and classroom teachers who teach gifted students as well. The school division allowed the researcher to send the email survey to between three and five participants per school, based on email addresses collected by the gifted coordinator by the county and sent to the researcher. The survey was sent to approximately 50 teachers in this school division.

School Division C consisted of three elementary schools with students in prekindergarten through fifth grade. The school division asked the researcher to send the email survey to each of the three principals who then forwarded the email to their staff. Approximately 150 teachers received the survey in the school division.

Prior to beginning, the researcher determined the sample size needed in order to detect a real difference between two groups' means through a power analysis. Because this analysis was completed a priori and therefore without a data set, the researcher made decisions regarding the values of power, effect size, and degrees of freedom. Using the G*Power 3 analyses software (Faul, Erdfelder, Lang, & Buchner, 2007), the researcher determined a medium effect size of 0.25 would be appropriate for the research, using Cohen's (1992) well known model of effect size measures, in order to garner 0.95 power. For degrees of freedom, the researcher chose to use three pairs of data for six cells which resulted in a $df = 5$. With two groups and three levels in each group, the sample size would need to be 323 in order to garner actual power at 0.95.

A participation rate of 39% would have provided an appropriate number of teacher responses. In order to have equal groups, 53 participants were needed in each cell. This allowed for an anticipated 55% participation rate from teachers who are endorsed or not endorsed in gifted education. While McMillan (2008) states that survey rates of around 70% are considered adequate (p. 206), it is commonly understood that external web-based surveys often realize a lower response rate.

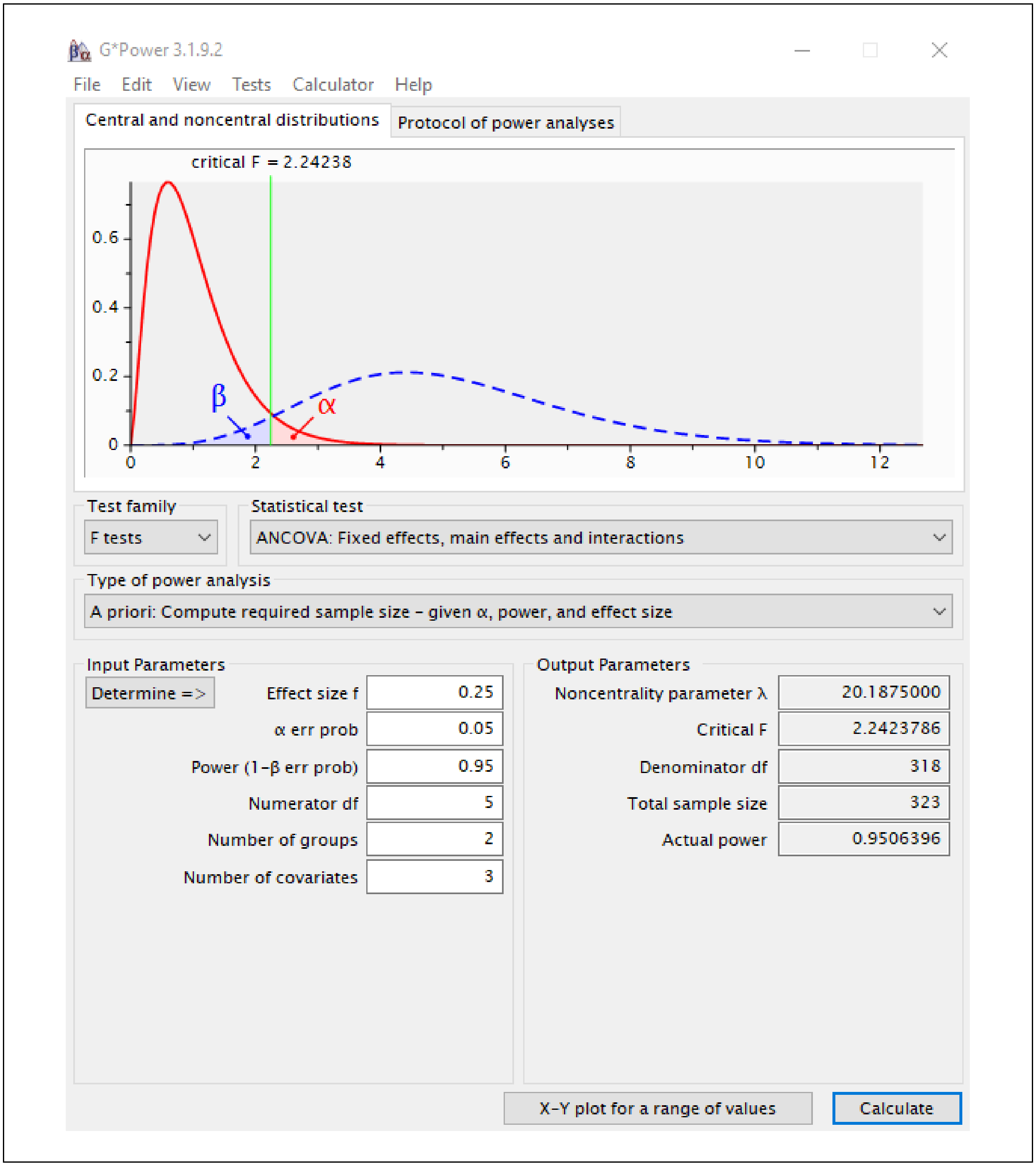

Figure 3. G*Power 3 Power Analysis Data

The survey was sent to approximately 750 teachers who teach elementary school students. This number was determined based on the prevalence of research in STEM available in the past three years that might impact teachers' knowledge and understanding of STEM education. Participants included in the study were those teachers who willingly volunteered to participate. Through the survey format, participants were eliminated if they had not taught gifted students within the past three years. Participants did not complete questions in a particular section if they did not teach that discipline. For example, if a fifth-grade teacher only taught reading and science, they were not asked to participate in the mathematics or STEM sections through the branches in the online survey. In order to garner the largest number of teachers who participate in STEM instructional sections, the phrasing for this section included the definition of STEM as well as a brief description of what STEM instruction looks like in the classroom. Division B hires dedicated STEM teachers at the elementary school level who teach collaboratively with classroom teachers, further increasing the likelihood of teachers participating in the section on STEM.

Data Collection

Data collection took place during a four-week window from February to March 2019 and an additional two-week window in May 2019. The electronic survey was distributed to participants using REDCap. An email was sent including the REDCap link. The email discussed the purpose for the study while inviting educators to participate (see Appendix D). All data were stored in the secure web-based platform. The only people who had access to the secure information were the researcher and dissertation committee. There was no information collected that could be linked back to a participant; the name of the individual, school division and the elementary school were not included in the demographic questions. The first email was sent in February. One follow-up reminder (see Appendix E) was sent to all participants two weeks after the initial distribution of the survey. During the initial review process, a participant reported an issue with the survey in which answering a question in the demographic information redirected the participant to the initial question, not allowing participants to continue moving forward. After following up with REDCap, they confirmed that this is an error that can occur when a participant uses the auto-fill response option within Google Chrome. As a result of this concern, the researcher submitted a request to the IRB to update the survey to reflect a verbiage change to add survey questions three to “Please type in the email address this survey was sent to in order to avoid duplicate answers. This email will be used in the drawing for one of two $25 amazon e-certificates but will be separated from any data collected.” The addition of the phrase “do not use auto-fill” was added at the end of the first sentence. These additions required an additional two-week window for survey collection. The survey was sent out electronically in May and all responses were completed by the end of May.

Data Analysis

First, the researcher collected and analyzed demographic data using frequencies and descriptive statistics to describe the sample. Then, the researcher ran ANCOVAs using the Statistical Package for the Social Sciences (SPSS) software version 26 to determine if there was a significant difference in the means of the answers between the two groups of teachers for each research question.

The independent variable consisted of the endorsement status of elementary teachers: nonendorsed teachers of the gifted and endorsed teachers of the gifted. The dependent variables included science self-efficacy, mathematics self-efficacy, integrated STEM self-efficacy, and self-reported use of STEM instructional strategies.

The researcher used covariates in order to prevent the confounding, or nuisance, variables of current grade level, years of experience, and recent STEM training from influencing the relationship between the independent and dependent variables. For example, it is possible that a teacher with more experience teaching, but no gifted endorsement, may have a stronger sense of self-efficacy than a teacher that started teaching but who has a gifted endorsement regardless of endorsement status.

The researcher worked through the following assumptions before running the ANCOVAs. First, the researcher checked the assumptions of the ANCOVA by determining the relationship between the covariates and the dependent variable were constant by running homogeneity of regression slopes. Next, the researcher determined the covariate was independent of the treatment effects by running correlation analyses, Pearson's correlation for interval variables and Kendall's tau analyses for the nonparametric variables.

In this study, the researcher chose to use one-way ANCOVAs and univariate linear analyses rather than t-tests because of the ability to prevent the nuisance variables from influencing the results. Creswell (2003) stated that it might be appropriate to use an ANCOVA in a situation where you need to compare similar groups who may have other factors influencing the variables. For the covariate grade level, it was necessary to create dummy variables to run the ANCOVA because grade level is a categorical variable, a variable made up of categories of objects/entities (Field, 2018). Therefore, the researcher was unable to run this variable in an ANCOVA as the assumption is that the variable would be ratio or interval and therefore would place more weight on higher values. The dummy variable format was designed for each level of the variable to be signified by a zero or a one if the level was in evidence. In the current study, a teacher who taught each grade level was assigned a value of zero for not teaching that grade level and one if the teacher did teach that grade level. If an ANCOVA was not appropriate based on the assumptions, then the researcher ran moderated regression analyses.

Then, the researcher was able to compare the means from the ANCOVAs between the two groups rather than running post hoc tests in order to determine to what extent the data were significant. The researcher ran multiple regression analyses to determine whether the independent variable and the covariates (used as predictor variables) were able to and to what strength each were able to predict self-efficacy. Lastly, the researcher ran ANCOVAs with all covariates as an alternate means to determine relationships with the covariates to address the multicollinearity concerns and explain the extent of the relationship.

Delimitations

The delimitations of the research study are rooted in the choices that the researcher has made (McMillan, 2008). First, the researcher chose to focus on the relationship of self-efficacy to performance based on Bandura's (1977) theory. The choice to use self-efficacy theory in lieu of another theoretical framework was purposeful in that it demonstrated a relationship from self-efficacy to performance, which is important when collecting self-report information from participants. In addition, the researcher chose to focus on endorsement status of teachers of gifted students due to a personal interest in the topic rather than focus on other indicators of effective teachers. These choices have delimited the study because the focus was only on these specific areas of gifted endorsements and self-efficacy rather than other areas that may be of interest.

Second, because the researcher's intent was to determine if there was a difference between teachers of the gifted who are endorsed and those who are not, it was necessary to delimit the results to the population included in this investigation. Due to using a convenience sampling of teachers who choose to participate in the study, the study can only be generalizable to elementary school teachers who teach gifted students in a public-school setting in a metropolitan area in central Virginia and teach the subjects of mathematics, science, and integrated STEM.

Chapter 4: Findings

The purpose of the current study was to determine if educators who teach gifted children with an endorsement differ from those who do not have an endorsement in the areas of STEM instructional practices and science self-efficacy, mathematics self-efficacy, and integrated STEM self-efficacy. The differences in self-efficacy between elementary teachers who have a gifted endorsement and those who do not were represented by self-report data of teacher self-efficacy in the STEM disciplines of science, mathematics, and integrated STEM. The covariates of grade level, years of teaching experience, and recent STEM training impact teachers' self-efficacy were also investigated. Finally, the researcher investigated self-reported use of STEM instructional strategies used in the classroom by elementary teachers who have a gifted endorsement and those who do not. The specific research questions were:

1. Is there a difference, and if so, to what extent is there a difference between the self-efficacy in teaching science, mathematics, and integrated STEM content by endorsed and nonendorsed elementary teachers of gifted students?
    a. Do grade level, years of teaching experience, or recent STEM training impact, and if so, to what extent do they impact self-efficacy in teaching science, mathematics, and integrated STEM content of endorsed and nonendorsed elementary teachers of gifted students?

2. Is there a difference, and if so, to what extent is there a difference between reported instructional strategies used during classroom STEM sessions by endorsed and nonendorsed elementary teachers of gifted students?
    a. Do grade level, years of teaching experience, or recent STEM training impact and if so, to what extent do they impact self-reported instructional strategies used during classroom STEM sessions of endorsed and nonendorsed elementary teachers of gifted students?

Descriptive Analysis

Using the data collected during February through May of 2019, the researcher conducted an analysis of the frequencies and descriptive statistics to describe the sample. Participants opened a total of 60 surveys. Six participants clicked the link to the survey and did not answer any questions. The first two questions screened out five participants who had not taught gifted students in a classroom setting in any capacity, such as classroom mainstreaming, pull-out services, collaborative services, etc. within the past three years. Seven participants did not answer the question about teaching gifted students in grades kindergarten through fifth grade. An additional three participants indicated they did not teach gifted students in grades kindergarten through fifth grade. Survey participants' responses that were screened out and those not completed were deleted from the sample. This review of data resulted in a sample of 39 usable surveys. Based on the total survey number sent of 705, the response rate was 9% with a usable response rate of 5.5%.

Teacher Grade Levels

Teachers who responded represented a variety of grade levels. Teachers selected one or more grade levels in which they taught gifted students during the past three years. The fewest number of respondents answered they taught Kindergarten (*n* = 14). The greatest number of respondents equally answered they taught second, third, or fifth grades (*n* = 23). The table below shows the number of teachers who provided instruction at each grade level. There were 126 grade level responses by the 39 teachers (see Table 4).

Table 4

Grade Levels Taught by Teachers of Gifted Students

Grade	N	Percentage of Teachers
Kindergarten	14	11.1
First Grade	21	16.7
Second Grade	23	18.3
Third Grade	23	18.3
Fourth Grade	22	17.4
Fifth Grade	23	18.3

Teacher Years of Experience

Teachers in the current study included teachers who taught a minimum of two years and a maximum of 36 years with a mean of 18.26 (*SD* = 8.94) years of experience. Out of the 14 teachers who did not have a gifted endorsement, there was a lower mean for years of experience (*M* = 15.21, *SD* = 11.89). For the 25 teachers who reported they did have a gifted endorsement, the mean years of experience was 19.96 years (*SD* = 6.56).

Teacher STEM Training

There were no respondents who reported they had completed more than 30 hours of STEM training. Table 5 includes details about the participants' amount of STEM training within the past three years. While 64.1% of the sample reported having a gifted endorsement from the VDOE, less than half of the sample (*N* = 19) reported they received training in STEM. Out of the teachers who did not have a gifted endorsement (*N* = 9), eight did not have any STEM training. Out of those teachers who did have a gifted endorsement (N = 23), seven did not have STEM training.

Table 5

Number of Teachers who Reported Hours of STEM Training at Each Level

Levels of Training	0 hours	1-10 hours	11-20 hours	20-30 hours
School	6	11	1	
District/Division	4	14	1	
State	12	5		
University or College	13	2	1	1

Correlations

The researcher determined a need to complete a correlation analysis among the independent variables and covariates. The purpose of this was to check the assumptions before running ANCOVAs and univariate general linear models and determine if it would be more appropriate to run a regression model. The variables STEM training and years of experience were ratio variables. The variable gifted endorsement was a categorical variable, with only two categories. Therefore, the researcher was able to run a biserial correlation, a standardized measure of the strength of relationship between two variables when one of the two variables is dichotomous (Field, 2018). The data also were not found to have significant outliers when utilizing a P-P plot. With these assumptions checked, a Pearson's correlation was run for these variables. The variable grade level is considered ordinal, and so a Kendall's tau analysis was run for the interaction between grade level and the remaining variables. A bootstrap, a statistical technique in which the sampling distribution is estimated by taking repeated samples from the data set and the mean is calculated for each sample, creating a standard error from the standard deviations that can be used, was also run to assess confidence intervals to alleviate concerns about the distribution (Field, 2018). All correlation values are listed in Table 6.

Table 6

Correlations of Independent Variables and Covariates

	Endorsement	STEM Training	Grade Level	Years of Experience
Endorsement	1	0.45	-0.08 [-.22, 0.56]	0.19
STEM training	0.45	1	-0.11 [-.25, .05]	0.18
Grade Level	-0.08 [-.22, 0.56]	-0.11 [-.25, .050]	1	-0.11 [-.23, .04]
Years of Experience	0.19	0.18	-0.11 [-.23, .04]	1

Note: BCa bootstrap analysis CIs reported in brackets

When running a Pearson's correlation, the variables gifted endorsement and STEM training had a low positive correlation (r = 0.45, p = .00). Pearson's correlation value of R^2 = 0.20 means that gifted endorsement shares 20 percent of the variability in STEM training and are linearly related. There was not a significant relationship found between gifted endorsement and years of teaching (r = 0.19, p = .04) or between STEM training and years of teaching (r = 0.18, p = .04). Correlations with grade levels are listed below.

The researcher chose to use the Kendall's tau nonparametric correlation rather than the Spearman's coefficient because the sample size was smaller than anticipated. In fact, the Kendall's tau statistic could be considered a better estimate of the correlation in the population, further adding to the researcher's decision to use this statistical analysis (Howell, 2012, as cited in Fields, 2018, p. 263).

When running Kendall's tau nonparametric correlation, the variables gifted endorsement and grade level had a correlation of -0.08. The significance level was .000, which is less than 0.05, but the robust confidence interval of -.22 to .06 crosses zero, which means that this is not a significant correlation. An additional nonsignificant correlation was found between the variables STEM training and grade level, in which the correlation was -0.11 (p = .18, CI = -.25, .05). The final Kendall's tau nonparametric correlation run was between years of teaching and grade level (r = -0.11, p = .12, CI = -.23, .04). This correlation was also found not to be significant.

Science Self-Efficacy and Gifted Endorsement Status

There were 32 teachers (82%) who reported they taught science to gifted students within the past three years. Five teachers reported they did not teach science. Two teachers left this question blank and therefore the subsequent questions about science self-efficacy were not included in their survey. Nine of the 32 teachers who reported that they taught science did not have a gifted endorsement.

Teachers were asked to report whether they Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, or Strongly Agree to 11 questions about science self-efficacy (see Appendix A). Except for the question "I wonder if I have the necessary skills to teach science," the first 11 questions were coded respectively one to five on a Likert scale. The "I wonder…" question was coded from five to one.

Teachers reported the greatest amount of self-efficacy (M = 4.28, SD = .68) in teaching science when answering the question "When teaching science, I am confident enough to welcome student questions." Table 7 includes more details about the participants' science self-efficacy.

The researcher also sought to determine if the 11 survey questions encompassed the participants' beliefs about science instruction, and so added a four-point Likert scale question asking the teachers "To what degree are you satisfied this survey captured your beliefs about science instruction" which answers ranged from Very Satisfied to Very Unsatisfied. Overall participants were satisfied that the questions reflected their beliefs, with only 9.4% (N =3) of the respondents stating that they were unsatisfied or very unsatisfied.

Table 7

Science Self-Efficacy Beliefs

	Strongly Disagree		Disagree		Neither Agee nor Disagree		Agree		Strongly Agree			
	N	%	N	%	N	%	N	%	N	%	M	SD
Improve practice	0	0.0	1	3.1	4	12.5	16	50.0	11	34.4	4.16	.77
Know steps to teach	0	0.0	0	0.0	1	3.1	25	78.1	6	18.8	4.16	.45
Explain experiments	0	0.0	1	3.1	1	3.1	22	68.8	8	25.0	4.16	.63
Can teach effectively	0	0.0	0	0.0	1	3.1	23	71.9	8	25.0	4.22	.49
Wonder if have skills[a]	0	0.0	6	15.4	5	15.6	16	50.0	5	15.6	2.38	.98
Understand concepts	0	0.0	0	0.0	2	6.3	21	65.6	9	28.1	4.22	.55
Invite evaluation	0	0.0	3	9.4	7	21.9	15	46.9	7	21.9	3.81	.90
Can answer questions	0	0.0	2	6.3	4	12.5	20	62.5	6	18.8	3.94	.76
Help understanding	0	0.0	1	3.1	3	9.4	24	75.0	4	12.5	3.97	.60
Welcome questions	0	0.0	1	3.1	1	3.1	18	56.3	12	37.5	4.28	.68
Increase interest	0	0.0	1	3.1	1	3.1	20	62.5	10	31.3	4.22	.66

[a]This question was coded from five to one

A combined variable of all 11 science self-efficacy questions was created to represent the construct of science self-efficacy. The combined variable for science self-efficacy (*M* = 3.95, *SD* = 0.38), was used as the dependent variable in the one-way between subjects ANOVA to answer research question one as well as used in the one-way ANCOVAs and univariate general linear model analyses referenced below. The final question about teacher satisfaction with survey items was not included in the combined variable, as it was used to inform the researcher what participants thought about the survey questions.

In order to address research question one, the researcher conducted a one-way between subjects ANOVA to compare the effect of endorsement status on science self-efficacy. Teachers without an endorsement reported a higher mean self-efficacy score in the area of science (*M* = 4.02, *SD* = 0.30) versus those teachers who do have an endorsement (*M* = 3.93, *SD* = 0.41). However, there was not a significant effect at the $p < .05$ level [$F(1, 30) = 0.36$, $p = 0.55$].

Years of Teaching Experience in Relation to Science Self-Efficacy and Gifted Endorsement Status

The researcher then sought to determine if years of teaching experience impacted self-efficacy in teaching science of endorsed and nonendorsed elementary teachers of gifted students. If an impact was found, to what extent teaching experience impacted self-efficacy in teaching science of endorsed and nonendorsed elementary teachers of gifted students. The results of these two analyses answered research question 1a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 ($p = .23$). Because the researcher failed to reject the null hypothesis, the assumption of homogeneity holds. The assumption of homogeneity being met meant that the relationship between the covariates and the dependent variable were constant across the different treatment levels (Field, 2018). When looking at the significance value of years of teaching by gifted endorsement interaction for science self-efficacy, the effect was not found to be significant ($p = .49$) and therefore the assumption of homogeneity of regression slopes was tenable.

This allowed the researcher to continue with the analysis of a one-way ANCOVA to determine if there was a statistically significant difference between gifted endorsement status on the dependent variable of science self-efficacy controlling for years of teaching experience. There was not a statistically significant effect after controlling for years of teaching experience ($F(1, 29) = .19$, $p = .66$). The researcher did not run a post hoc test to ascertain whether gifted endorsed or nonendorsed teachers had a higher level of science self-efficacy when controlling for years of teaching experience due to the lack of statistical significance.

Grade Level in Relation to Science Self-Efficacy and Gifted Endorsement Status

The researcher then sought to determine if grade level impacted, and if so, to what extent it impacted self-efficacy in teaching science of endorsed and nonendorsed elementary teachers of gifted students to continue addressing research question 1a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 (p = .31). When looking at the significance value of grade level by gifted endorsement interaction for science self-efficacy, dummy variables were run for each grade level. The effect was not found to be significant for five of the six grade levels (see table 8) but was significant for the interaction between kindergarten and gifted endorsement (p = .00). While the assumption of homogeneity of regression slopes was tenable for most of the grade levels, there may be some concerns about running an ANCOVA with all the grade levels together because kindergarten was significant, and therefore the variance was significantly different, which is reflected in chapter five.

Table 8

Grade Level and Gifted Endorsement Interaction Significance Levels

	Grade Level					
	Kindergarten	First	Second	Third	Fourth	Fifth
Science Self-Efficacy	.00	.47	.39	.33	.05	.93
Mathematics Self-Efficacy	.90	.96	.33	.19	.06	.49
STEM Self-Efficacy	.90	.06	.01	.01	.05	.24
STEM Strategies	.51	.38	.00	.00	.49	.10

Due to the variable of grade level being categorical rather than continuous, the univariate general linear model analysis was run by using dummy variables to separate each grade level into categories of 0 for not teaching that grade level and 1 for teaching that grade level. There was not a statistically significant difference after controlling for grade level (F(1, 104 = .73, p =

.40) and therefore no need to run a post hoc test or look at the partial eta squared to find the strength of the significance.

STEM Training in Relation to Science Self-Efficacy and Gifted Endorsement Status

The researcher then sought to determine if the amount of STEM training impacted, and if so, to what extent it impacted self-efficacy in teaching science of endorsed and nonendorsed elementary teachers of gifted students in order to answer part of research question 1a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 ($p = .33$). Because the researcher failed to reject the null hypothesis, the assumption of homogeneity holds. When looking at the significance value of STEM training by gifted endorsement interaction for science self-efficacy, the effect was found to be significant ($p = .00$) and therefore the assumption of homogeneity of regression slopes was not tenable. Due to this significance, it was appropriate to run a moderated regression analysis.

The moderated regression analysis was run with the interaction between the gifted endorsement status and STEM training. The regression analysis results indicated that the increase in variation explained by the addition of the interaction between gifted endorsement status and STEM training explained 2.9% of the variance at the $p < .05$ level ($R^2 = .03$, $F(1, 108) = 3.43$, $p = .07$), demonstrating that the interaction between that the moderator effect of gifted endorsement and STEM training had no statistical significant difference on the relationship between gifted endorsement and science self-efficacy.

The researcher wanted to be cautious about using the regression analysis as the only form of analysis because there are concerns with multicollinearity in moderated regressions because the coefficients tend to be estimated with higher standard errors and greater uncertainty (Fields, 2018). In addition, the multiple regression used all variables as predictors rather than the covariate models, describing the strength of the prediction, but not whether endorsement status was related to self-efficacy. Therefore, a univariate general linear model analysis was conducted in addition to the regression model to also determine if there was a statistically significant difference between groups of teachers who are endorsed versus those who are not endorsed on the dependent variable of science self-efficacy when controlling for the amount of STEM training teachers reported. There was not a statistically significant difference between gifted endorsement and science self-efficacy after controlling for STEM training ($F(1, 28) = 1.86$, $p = .18$). The researcher did not run a post hoc test to ascertain whether gifted endorsed or nonendorsed teachers had a higher level of science self-efficacy when controlling for STEM training due to the lack of statistical significance.

Science Self-Efficacy and Gifted Endorsement Status Regression

The researcher then sought to determine if all three covariates together impacted, and if so, to what extent, impacted self-efficacy in teaching science of endorsed and nonendorsed elementary teachers of gifted students in order to answer part of research question 1a. The researcher determined that a multiple linear regression analysis would be the most accurate way to reflect the differences between those teachers with a gifted endorsement and those without a gifted endorsement. Multiple regression analysis was used to test if the independent variable and the covariates significantly predicted science self-efficacy. The results of the regression indicated that there was a collective significant effect of the predictors endorsement status, grade level, years of experience, and STEM training, which explained 23% of the variance of science self-efficacy ($R^2 = .23$, $F(9, 102) = 3.39$, $p = .00$). It was found that at $p < .05$, the grade levels kindergarten (β = .67, *p* = .00) and fourth grade (β = .-.32, *p* = .01), significantly predicted science self-efficacy as did STEM training (β = -.336, *p* = .00).

Mathematics Self-Efficacy and Gifted Endorsement Status

There were 82.1% (*N* = 26) of the teachers who reported they taught mathematics to gifted students within the past three years. Four teachers reported they did not teach mathematics and three teachers left this question blank and therefore the subsequent questions about mathematics self- efficacy were not included in their survey. Eight of the 32 teachers did not have a gifted endorsement.

Teachers were asked to report whether they Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, or Strongly Agree to 11 questions about mathematics self-efficacy (see Appendix A). Except for the question "I wonder if I have the necessary skills to teach mathematics," the first 11 questions were coded respectively one to five on a Likert scale. The "I wonder…" question was coded from five to one.

Teachers felt strongest about teaching mathematics effectively (*M* = 4.56, *SD* = .504). The largest percentage of teachers responded Strongly Agree to the survey question that when teaching mathematics, they are confident enough to welcome student questions (62.5%). Table 9 includes more details about the participants' mathematics self-efficacy.

The researcher also sought to determine if the 11 survey questions encompassed the participants' beliefs about mathematics instruction, and so added a four-point scale question asking the teachers "To what degree are you satisfied this survey captured your beliefs about mathematics instruction?" which answers ranged from Very Satisfied to Very Unsatisfied. Overall participants were satisfied that the questions reflected their beliefs, with 93.8% (*N* = 30) of the respondents stating that they were satisfied or very satisfied.

Table 9

Mathematics Self-Efficacy Beliefs

	Strongly Disagree		Disagree		Neither Agee nor Disagree		Agree		Strongly Agree			
	N	%	N	%	N	%	N	%	N	%	M	SD
Improve practice	0	0.0	1	3.1	0	0.0	14	43.8	17	53.1	4.47	.67
Know steps to teach	0	0.0	0	0.0	0	0.0	16	50.0	16	50.0	4.50	.51
Explain mathematics	0	0.0	3	9.4	0	0.0	11	34.4	18	56.3	4.38	.91
Can teach effectively	0	0.0	0	0.0	0	0.0	14	43.8	18	56.3	4.56	.50
Wonder if have skills[a]	5	15.6	5	15.6	3	9.4	12	37.5	7	21.9	2.66	1.41
Understand concepts	0	0.0	0	0.0	3	9.4	12	37.5	17	53.1	4.44	.67
Invite evaluation	1	3.1	2	6.3	3	9.4	12	37.5	14	43.8	4.12	1.04
Can answer questions	0	0.0	2	6.3	1	3.1	11	34.4	18	56.3	4.41	.84
Help understanding	0	0.0	3	9.4	1	3.1	11	34.4	17	53.1	4.31	.93
Welcome questions	0	0.0	2	6.3	1	3.1	9	28.1	20	62.5	4.47	.84
Increase interest	0	0.0	1	3.1	1	3.1	17	53.1	13	40.6	4.31	.69

[a]This question was coded from five to one

A combined variable of all 11 mathematics self-efficacy questions was created to represent the construct of mathematics self-efficacy. The combined variable for mathematics self-efficacy (M = 4.24, SD = 0.55), was used as the dependent variable in the one-way between subjects ANOVA to answer research question one as well as be used in the one-way ANCOVAs and univariate general linear model analyses referenced below. The final question about teacher satisfaction with survey items was not included in the combined variable, as it was used to inform the researcher how participants thought about the survey questions.

In order to address research question one, the researcher conducted a one-way between subjects ANOVA to compare the effect of endorsement status on mathematics self-efficacy. Teachers with an endorsement reported a higher mean for self-efficacy in the area of mathematics (M = 4.33, SD = 0.54) versus those teachers who do not have an endorsement (M = 3.98, SD = 0.53). However, there was not a significant effect at the $p < .05$ level [$F(1, 30) = 2.49$, $p = 0.13$].

Years of Teaching Experience in Relation to Mathematics Self-Efficacy and Gifted Endorsement Status

The researcher then sought to determine if years of teaching experience impacted, and if so, to what extent they impacted self-efficacy in teaching mathematics of endorsed and nonendorsed elementary teachers of gifted students to continue the exploration of research question 1a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 (p = .84). Because the researcher failed to reject the null hypothesis, the assumption of homogeneity holds. When looking at the significance value of years of teaching by gifted endorsement interaction for mathematics self-efficacy, the effect was found to be significant (p = .00) and therefore the assumption of homogeneity of regression slopes was not tenable. Due to this significance, it was appropriate to run a moderated regression analysis.

The moderated regression analysis was run with the interaction between the gifted endorsement and the years of teaching. The regression analysis results indicated that the increase in variation explained by the addition of the interaction between gifted endorsement status and years of teaching explained 4.2% of the variance at the $p < .05$ level ($R^2 = .04$, $F(1, 111) = 5.95$, $p = .02$), demonstrating that the interaction between gifted endorsement and years of teaching showed a statistical significant effect on the relationship between gifted endorsement and mathematics self-efficacy.

The researcher chose to run an ANCOVA in addition to the moderated regression for the same reasons stated in *STEM Training in Relation to Science Self-Efficacy and Gifted Endorsement Status.* Therefore, an analysis of a one-way ANCOVA was run to determine if there was a statistically significant difference between gifted endorsement status on the dependent variable of mathematics self-efficacy controlling for years of teaching experience. There was not a statistically significant effect after controlling for years of teaching experience ($F(1, 29) = 2.28$, $p = .14$), which differs from the regression analysis. The researcher did not run a post hoc test to ascertain whether gifted endorsed or nonendorsed teachers had a higher level of mathematics self-efficacy when controlling for years of teaching experience.

Grade Level in Relation to Mathematics Self-Efficacy and Gifted Endorsement Status

The researcher then sought to determine if grade level impacted, and if so, to what extent it impacted self-efficacy in teaching mathematics of endorsed and nonendorsed elementary teachers of gifted students to continue addressing research question 1a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 ($p = .33$). When looking at the significance value of grade level by gifted endorsement interaction for mathematics self-efficacy, dummy variables were run for each grade level. The effect was not found to be significant for any of the grade levels (See Table 8).

Due to the variable of grade level being categorical rather than continuous, the univariate general linear model analysis was run using dummy variables to separate each grade level into categories of 0 for not teaching that grade level and 1 for teaching that grade level. The researcher found there was a statistically significant difference after controlling for grade level (F(1, 107 = 8.48, $p = .00$).

In order to determine the strength of the statistical difference, the researcher looked at the estimated marginal means. Because there were two groups, looking at the means was a more appropriate way to look at the significance of the relationship rather than running a post hoc test.

Participants who had no gifted endorsement reported a lower mean in mathematics self-efficacy (M = 3.53) than those who had a gifted endorsement (M = 4.33).

STEM Training in Relation to Mathematics Self-Efficacy and Gifted Endorsement Status

The researcher then sought to determine if the amount of STEM training impacted, and if so, to what extent it impacted self-efficacy in teaching mathematics of endorsed and nonendorsed elementary teachers of gifted students in order to answer part of research question 1a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 (p = .89). Because the researcher failed to reject the null hypothesis, the assumption of homogeneity holds. When looking at the significance value of STEM training by gifted endorsement interaction for mathematics self-efficacy, the effect was found to not be significant (p = .13) and therefore the assumption of homogeneity of regression slopes was tenable.

This assumption allowed the researcher to continue with the univariate general linear model analysis to determine if there was a statistically significant difference between gifted endorsement status on the dependent variable of mathematics self-efficacy when controlling for STEM training teachers reported. There was not a statistically significant difference between gifted endorsement and mathematics self-efficacy after controlling for STEM training ($F(1, 28) = .88$, p = .36). The researcher did not run a post hoc test to ascertain whether gifted endorsed or nonendorsed teachers had a higher level of mathematics self-efficacy when controlling for STEM training due to the lack of statistical significance.

Mathematics Self-Efficacy and Gifted Endorsement Status Regression

The researcher then sought to determine if all three covariates together impacted, and if so, to what extent, they impacted self-efficacy in teaching mathematics of endorsed and nonendorsed elementary teachers of gifted students in order to answer part of research question 1a. Multiple regression analysis was used to test if endorsement status significantly predicted mathematics self-efficacy. The results of the regression indicated that there was a collective significant effect of the predictors endorsement status, grade level, years of experience, and STEM training, which explained 21% of the variance ($R^2 = .21$, $F(9, 105) = 4.26$, $p = .00$). It was found that at $p < .05$, the grade level fourth grade ($\beta = .36$, $p = .01$), significantly predicted science self-efficacy as did years of teaching ($\beta = .38$, $p = .00$) and endorsement status ($\beta = .36$, $p = .01$).

Integrated STEM Self-Efficacy and Gifted Endorsement Status

There were 76.9% (*N* =30) of the teachers who reported they taught integrated STEM to gifted students within the past three years. Five teachers reported they did not teach STEM and four teachers left this question blank and therefore the subsequent questions about STEM self-efficacy were not included in their survey. Eight of the 30 teachers who taught STEM did not have a gifted endorsement.

Teachers were asked to report whether they Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, or Strongly Agree to 11 questions about integrated STEM self-efficacy (see Appendix A). Except for the question "I wonder if I have the necessary skills to teach STEM," the first 11 questions were coded respectively one to five on a Likert scale. The "I wonder…" question was coded from five to one.

The greatest mean was regarding the continual improvement of STEM teaching practice (*M* = 4.00, *SD* = .91). Nine respondents (30%) selected Strongly Agree that they are continually improving their STEM practice. Table 10 includes more details about the participants' STEM self-efficacy.

The researcher also sought to determine if the 11 survey questions encompassed the participants' beliefs about STEM instruction, and so added a four-point Likert scale question asking the teachers "To what degree are you satisfied this survey captured your beliefs about STEM instruction?" which answers ranged from Very Satisfied to Very Unsatisfied. Overall participants were satisfied that the questions reflected their beliefs, with 93.3% (*N* = 28) of the respondents stating that they were satisfied or very satisfied and none of the participants stating that they were unsatisfied or very unsatisfied with the questions.

Table 10

Integrated STEM Self-Efficacy Beliefs

	Strongly Disagree		Disagree		Neither Agee nor Disagree		Agree		Strongly Agree			
	N	%	N	%	N	%	N	%	N	%	M	SD
Improve practice	0	0.0	3	10.0	3	10.0	15	50.0	9	30.0	4.00	.91
Know steps to teach	0	0.0	5	16.7	6	20.0	14	46.7	5	16.7	3.63	.96
Explain STEM	0	0.0	2	6.7	4	13.3	22	73.3	2	6.7	3.80	.66
Can teach effectively	0	0.0	2	6.7	5	16.7	19	63.3	4	13.3	3.83	.75
Wonder if have skills[a]	2	6.7	9	30.0	8	26.7	8	26.7	3	10.0	2.97	1.13
Understand concepts	0	0.0	3	10.0	5	16.7	19	63.3	3	10.0	3.73	.79
Invite evaluation	1	3.3	4	13.3	6	20.0	16	53.3	3	10.0	3.53	.97
Can answer questions	0	0.0	3	10.0	5	16.7	19	63.3	3	10.0	3.73	.79
Help understanding	0	0.0	3	10.0	5	16.7	19	63.3	3	10.0	3.73	.79
Welcome questions	0	0.0	2	6.7	4	13.3	19	63.3	5	16.7	3.90	.76
Increase interest	1	3.3	1	3.3	5	16.7	18	60.0	5	16.7	3.83	.87

[a]This question was coded from five to one

A combined variable of all 11 STEM self-efficacy questions was created to represent the construct of STEM self-efficacy. The combined variable for integrated STEM self-efficacy (*M* = 3.70, *SD* = 0.57), was used as the dependent variable in the one-way between subjects ANOVA to answer research question one as well as used in the one-way ANCOVAs and univariate general linear model analyses referenced below. The final question about teacher satisfaction with survey items was not included in the combined variable, as it was used to inform the researcher how participants thought about the survey questions.

In order to address research question one, the researcher conducted a one-way between subjects ANOVA to compare the effect of endorsement status on STEM self-efficacy. Teachers without an endorsement reported a higher mean for self-efficacy in the area of STEM (M = 3.76, SD = 0.52) versus those teachers who do have an endorsement (M = 3.68, SD = 0.59). However, there was not a significant effect at the $p < .05$ level [$F(1, 28) = 0.12$, $p = 0.73$].

Years of Teaching Experience in Relation to STEM Self-Efficacy and Gifted Endorsement Status

The researcher continued the exploration of research question 1a by determining if years of teaching experience impacted, and if so, to what extent they impacted STEM self-efficacy of endorsed and nonendorsed elementary teachers of gifted students. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 ($p = .70$). Because the researcher failed to reject the null hypothesis, the assumption of homogeneity holds. When looking at the interaction between years of teaching and gifted endorsement, the effect was found to be significant ($p = .00$) and therefore the assumption of homogeneity of regression slopes was not tenable. Due to this significance, it was appropriate to run a moderated regression analysis.

The moderated regression analysis was run with the interaction between the gifted endorsement status and STEM training. The regression analysis results indicated that the increase in variation explained by the addition of the interaction between gifted endorsement status and STEM training explained 1.7% of the variance at the $p < .05$ level ($R^2 = .02$, $F(1, 104) = 1.77$, $p = .19$), demonstrating that the interaction between that the moderator effect of gifted endorsement and STEM training had no statistical significant difference on the relationship between gifted endorsement and STEM self-efficacy.

The researcher chose to run an ANCOVA in addition to the moderated regression for the same reasons stated in *STEM Training in Relation to Science Self-Efficacy and Gifted Endorsement Status.* An analysis of a one-way ANCOVA was run to determine if there was a statistically significant difference between gifted endorsement status on the dependent variable of STEM self-efficacy controlling for years of teaching experience. There was not a statistically significant effect after controlling for years of teaching experience ($F(1, 27) = .09$, $p = .76$). The researcher did not run a post hoc test to ascertain whether gifted endorsed or nonendorsed teachers had a higher level of STEM self-efficacy when controlling for years of teaching experience due to the lack of statistical significance.

Grade Level in Relation to STEM Self-Efficacy and Gifted Endorsement Status

The researcher continued exploring research question 1a by determining if grade level impacted, and if so, to what extent it impacted self-efficacy in teaching STEM of endorsed and nonendorsed elementary teachers of gifted students. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 ($p = .95$). When looking at the significance value of grade level by gifted endorsement interaction for STEM self-efficacy, dummy variables were run for each grade level. The effect was not found to be significant for four of the six grade levels (see table 8) but was significant for the interaction between second grade and gifted endorsement ($p = .01$) and third grade and gifted endorsement ($p = .01$). While the assumption of homogeneity of regression slopes was tenable for most of the grade levels, there may be some concerns about running an ANCOVA with all the grade levels together because second grade and third grade were significant, therefore the variance was significantly different, as reflected in the chapter five.

Due to the variable of grade level being categorical rather than continuous, the univariate general linear model analysis was run using dummy variables to separate each grade level into categories of 0 for not teaching that grade level and 1 for teaching that grade level. There was not a statistically significant difference after controlling for grade level (F(1, 100 = .08, p = .58) and therefore no need to run a post hoc test or look at the partial eta squared to find the strength of the significance.

STEM Training in Relation to STEM Self-Efficacy and Gifted Endorsement Status

The researcher then sought to determine if the amount of STEM training impacted, and if so, to what extent it impacted self-efficacy in teaching STEM of endorsed and nonendorsed elementary teachers of gifted students in order to answer part of research question 1a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 (p = .38). Because the researcher failed to reject the null hypothesis, the assumption of homogeneity holds. When looking at the significance value of STEM training by gifted endorsement interaction for STEM self-efficacy, the effect was found to be not significant (p = .06) and therefore the assumption of homogeneity of regression slopes was tenable.

This allowed the researcher to continue with the analysis. A univariate general linear model analysis was conducted to determine if there was a statistically significant difference between gifted endorsement status on the dependent variable of STEM self-efficacy when controlling for STEM training teachers reported. There was not a statistically significant difference between gifted endorsement and STEM self-efficacy after controlling for STEM training (F(1, 26) = 2.32, p = .14). The researcher did not run a post hoc test to ascertain whether gifted endorsed or nonendorsed teachers had a higher level of STEM self-efficacy when controlling for STEM training due to the lack of statistical significance.

Integrated STEM Self-Efficacy and Gifted Endorsement Status Regression

The researcher then sought to determine if all three covariates together impacted, and if so, to what extent, impacted self-efficacy in teaching integrated STEM of endorsed and nonendorsed elementary teachers of gifted students in order to answer part of research question 1a. Multiple regression analysis was used to test if endorsement status significantly predicted mathematics self-efficacy. The results of the regression indicated that there was a collective significant effect of the predictors endorsement status, grade level, years of experience, and STEM training, which explained 19% of the variance ($R^2 = .19$, $F(9, 98) = 2.54$, $p = .01$). It was found that at $p < .05$, the grade level second grade ($\beta = .37$, $p = .02$) significantly predicted STEM self-efficacy as did years of teaching ($\beta = -.30$, $p = .00$).

Self-Reported Use of STEM Instructional Strategies and Gifted Endorsement Status

Teachers who reported they taught STEM to gifted students within the past three years were also given the opportunity to complete the section on self-reported use of STEM instructional strategies. There were 30 teachers (76.9%) who completed the section on use of STEM instructional strategies.

Teachers were asked to report how often students engaged in certain instructional strategies during elementary STEM instructional time. Respondents could choose Never, Occasionally, About half the time, Usually, or Every time to 14 questions (see Appendix A). All questions were coded respectively one to five on a Likert scale.

Working in small groups was the highest reported use of strategies ($M = 3.10$, $SD = .71$) whereas learning about careers related to the instructional content had the lowest mean reported use (M = 1.97, SD = 1.22). Table 11 includes more details about the participants' self-reported use of STEM instructional strategies.

Table 11

STEM Instructional Strategies Use

	Never		Occasionally		About half the time		Usually		Every time			
	N	%	N	%	N	%	N	%	N	%	M	SD
Problem solving skills	1	3.3	4	13.3	7	23.3	14	46.7	4	13.3	2.53	1.00
Work in small groups	0	0.0	1	3.3	3	10.0	18	60.0	8	26.7	3.10	.71
Testable predictions	0	0.0	5	16.7	3	10.0	15	50.0	7	23.3	2.80	1.00
Observations/measurements	0	0.0	3	10.0	2	6.7	18	60.0	7	23.3	2.97	.85
Tools to gather data	0	0.0	4	13.3	3	10.0	16	53.3	7	23.3	2.87	.94
Patterns in data	1	3.3	9	30.0	3	10.0	15	50.0	2	6.7	2.27	1.08
Explain results	1	3.3	3	10.0	6	20.0	14	46.7	6	20.0	2.70	1.02
Choose models for results	1	3.3	7	23.3	7	23.3	11	36.7	4	13.3	2.33	1.09
Real-world activities	0	0.0	4	13.3	2	6.7	19	63.3	5	16.7	2.83	.87
Content-driven dialogue	0	0.0	2	6.7	6	20.0	17	56.7	5	16.7	2.83	.79
Reason abstractly	1	3.3	3	10.0	11	36.7	12	40.0	3	10.0	2.43	.93
Reason quantitatively	1	3.3	3	10.0	11	36.7	11	36.7	4	13.3	2.47	.97
Critique others' reasoning	2	6.7	9	30.0	8	26.7	9	30.0	2	6.7	2.00	1.08
Careers	4	13.3	6	20.0	11	36.7	5	16.7	4	13.3	1.97	1.22

A combined variable of all 14 STEM strategies questions was created to represent a construct of the use of STEM strategies. The combined variable for use of STEM strategies (M = 2.58, SD = 0.73), was used as the dependent variable in the one-way between subjects ANOVA to answer research question two as well as used in the one-way ANCOVAs and univariate general linear model analyses.

In order to address research question two, the researcher conducted a one-way between subjects ANOVA to compare the effect of endorsement status on use of STEM strategies. Teachers without an endorsement reported a higher mean for self-efficacy in the area of use of STEM strategies (M = 2.62, SD = 0.72) versus those teachers who do have an endorsement (M =

2.56, *SD* = 0.75). However, there was not a significant effect at the $p < .05$ level [$F(1, 28) = 0.03$, $p = 0.87$].

Years of Teaching Experience in Relation to Use of STEM Instructional Strategies and Gifted Endorsement Status

The researcher then sought to determine if years of teaching experience impacted, and if so, to what extent they impacted self-reported use of STEM instructional strategies of endorsed and nonendorsed elementary teachers of gifted students to answer part of research question 2a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 ($p = .77$). Because the researcher failed to reject the null hypothesis, the assumption of homogeneity holds. When looking at the significance value of years of teaching by gifted endorsement interaction for self-reported use of STEM instructional strategies, the effect was not found to significant ($p = .00$) and therefore the assumption of homogeneity of regression slopes holds.

An analysis of a one-way ANCOVA was conducted to determine if there was a statistically significant difference between gifted endorsement status on the dependent variable of self-reported use of STEM instructional strategies controlling for years of teaching experience. There was not a statistically significant effect after controlling for years of teaching experience [$F(1, 27) = .02$, $p = .90$]. The researcher did not run a post hoc test to ascertain whether gifted endorsed or nonendorsed teachers had a higher level of science self-efficacy when controlling for years of teaching experience due to the lack of statistical significance.

Grade Level in Relation to Use of STEM Instructional Strategies and Gifted Endorsement Status

The researcher then sought to determine if grade level impacted self-reported use of STEM instructional strategies by endorsed and nonendorsed elementary teachers of gifted students to address the next part of research question 2a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 (p = .47).

When looking at the significance value of grade level by gifted endorsement interaction for self-reported use of STEM instructional strategies, the dummy variables were run for each grade level. The effect was not found to be significant for four of the six grade levels (see table 8). It was significant for the interaction between second grade and gifted endorsement (p = .00) and the interaction between third grade and gifted endorsement (p = .00). While the assumption of homogeneity of regression slopes was tenable for most of the grade levels, it does raise some concern about the main analysis, as reflected in the chapter five.

Due to the variable of grade level being categorical rather than continuous, the univariate general linear model analysis was run with the variable grade level as a fixed variable in SPSS. There was not a statistically significant difference found after controlling for grade level (F(1, 100 = .73, p = .20), and therefore no need to run a post hoc test or look at the partial eta squared to find the strength of the significance.

STEM Training in Relation to Use of STEM Instructional Strategies and Gifted Endorsement Status

The researcher also sought to determine if the amount of STEM training impacted, and if so, to what extent it impacted self-reported use of STEM instructional strategies of endorsed and nonendorsed elementary teachers of gifted students in order to answer part of research question 2a. When using Levene's Test of Equality of Error Variances to test whether the null hypothesis of the error variance is equal across the groups, the level of significance was greater than .05 (p = .80). Because the researcher failed to reject the null hypothesis, the assumption of homogeneity holds.

When looking at the significance value of STEM training by gifted endorsement interaction for self-reported use of STEM instructional strategies, the effect was found to be significant (p = .00) and therefore the assumption of homogeneity of regression slopes was not tenable. Due to this significance, it was appropriate to run a moderated regression analysis.

The moderated regression analysis was run with the interaction between the gifted endorsement status and STEM training. The regression analysis results indicated that the increase in variation explained by the addition of the interaction between gifted endorsement status and STEM training explained 6.1% of the variance at the $p < .05$ level ($R^2 = .06$, $F(1, 104) = 7.57$, $p = .00$), demonstrating that the interaction between that the moderator effect of gifted endorsement and years of teaching has a statistical significant difference on the relationship between gifted endorsement and mathematics self-efficacy.

The researcher chose to run an ANCOVA in addition to the multiple regression for the same reasons stated in *STEM Training in Relation to Science Self-Efficacy and Gifted Endorsement Status.* An univariate general linear model analysis was conducted to determine if there was a statistically significant difference between gifted endorsement status on the dependent variable of self-reported use of STEM instructional strategies when controlling for the amount of STEM training teachers reported. The researcher found there was a statistically significant difference between endorsed and nonendorsed teachers' self-reported use of STEM instructional strategies after controlling for STEM training [$F(1, 26) = 4.74$, $p = .04$, $\eta p^2 = .15$].

In order to determine the strength of the statistical difference, the researcher looked at the estimated marginal means. Because there were two groups, looking at the means was a more appropriate way to look at the significance of the relationship rather than running a post hoc test. Participants who had no gifted endorsement had a higher mean of use of self-reported STEM instructional strategies (*M* = 2.62, *SD* = .72) than those participants with a gifted endorsement (*M* = 2.56, *SD* = 0.75) Specifically, teachers with no endorsement and no training had the highest mean (*M* = 2.81, *SD* = .64).

STEM Instructional Strategies and Gifted Endorsement Status Regression

The researcher then sought to determine if all three covariates together impacted, and if so, to what extent, impacted self-efficacy in using STEM strategies of endorsed and nonendorsed elementary teachers of gifted students in order to answer part of research question 2. Multiple regression analysis was used to test if endorsement status significantly self-reported use of STEM instructional strategies. The results of the regression indicated that the collective significant effect of the predictors endorsement status, grade level, years of experience, and STEM training explained 37% of the variance ($R^2 = .37$, $F(9, 98) = 6.41$, $p = .00$). It was found that at $p < .05$, the grade levels second grade (β = .60, $p = .00$) and third grade (β = -.61, $p = .00$) significantly predicted STEM instructional strategies as did years of teaching (β = -.44, $p = .00$) and STEM training (β = .37, $p = .00$).

Summary of Findings

There were no significant results found when analyzing the ANCOVAs and moderated regression analyses for individual covariates and predictors in the area of science self-efficacy and STEM self-efficacy (see Table 12). In the area of science self-efficacy, 23% of the variance was explained by all predictor variables. The statistically significant predictors were kindergarten, fourth grade, and STEM training. In the area of STEM self-efficacy, 19% of the variance was explained by all predictor variables. The predictors that were found to be statistically significant were second grade and years of teaching.

Table 12

Summary of Findings

Relationship to Dependent Variable	Dependent Variable: Self-Efficacy: Science	Mathematics	Integrated STEM	Use of STEM Strategies
Endorsement Status ANOVA	Not Significant	Not Significant	Not Significant	Not Significant
Years of Teaching and Endorsement Status ANCOVA or Moderated Regression	Not Significant	Not Significant	Not Significant	Not Significant
Grade Level and Endorsement Status ANCOVA	Not Significant	Significant	Not Significant	Not Significant
STEM Training and Endorsement Status ANCOVA or Moderated Regression	Not Significant	Not Significant	Not Significant	Significant
Endorsement Status, Grade Level, Years of Teaching, and STEM Training Multiple Regression	Significant 23% variance	Significant 21% variance	Significant 19% variance	Significant 37% variance

Mathematics self-efficacy was statistically significant when looking at the differences between endorsed and nonendorsed teachers when controlling for years of teaching and grade level according to the individual ANCOVAs and moderated regression analyses. All predictor variables explained 21% of the variance. The statistically significant predictors were fourth grade, years of teaching, and endorsement status.

The self-reported use of STEM instructional strategies was statistically significant when looking at the differences between endorsed and nonendorsed teachers when controlling for STEM training according to the individual moderated regression analysis. There was a difference found between the means of self-reported use of STEM instructional strategies used during classroom STEM sessions by endorsed and nonendorsed elementary teachers of gifted students, when controlling for STEM training. Teachers who were not endorsed had a higher level of self-efficacy according to these findings. All predictor variables explained 37% of the variance. The statistically significant predictors were second grade, third grade, years of teaching, and STEM training.

Chapter 5: Conclusions and Recommendations

The purpose of this study was to determine whether gifted endorsement status made a difference in the self-efficacy of teachers in the areas of mathematics, science, and integrated STEM. A secondary purpose of this study was to determine if there was a difference in self-reported use of STEM instructional strategies based on endorsement status. The researcher sought to determine if the covariates of grade level, years of teaching experience, and recent STEM training affected the relationship. This chapter includes a discussion of major findings and conclusions followed by limitations of this study. Also included in this chapter are a list of implications for theory, research, and practice regarding the areas of gifted endorsements, self-efficacy, and STEM education and suggestions for future research.

This chapter's discussion refers to the following research questions:

1. Is there a difference, and if so, to what extent is there a difference between the self-efficacy in teaching science, mathematics, and integrated STEM content by endorsed and nonendorsed elementary teachers of gifted students?
    a. Do grade level, years of teaching experience, or recent STEM training impact, and if so, to what extent do they impact self-efficacy in teaching science, mathematics, and integrated STEM content of endorsed and nonendorsed elementary teachers of gifted students?

2. Is there a difference, and if so, to what extent is there a difference between reported instructional strategies used during classroom STEM sessions by endorsed and nonendorsed elementary teachers of gifted students?
    a. Do grade level, years of teaching experience, or recent STEM training impact and if so, to what extent do they impact self-reported instructional strategies used during classroom STEM sessions of endorsed and nonendorsed elementary teachers of gifted students?

Science Self-Efficacy and Gifted Endorsement Status

The data demonstrated no statistically significant relationship between gifted endorsement status and science self-efficacy when using the individual covariates of years of experience, grade level, or STEM training. The three covariates and gifted endorsement status run as predictor variables explained 23% of the variance. There was a statistically significant relationship found when using all covariates together in the areas of kindergarten and fourth grade as well as STEM training. The strongest predictor with a beta weight of .67 was the grade level kindergarten, demonstrating that teaching kindergarten was the strongest predictor of science self-efficacy. When looking at the means in the area of science, it appears that teachers without endorsements (M = 4.02, SD = 0.30) have a higher mean for self-efficacy than those who do have a gifted endorsement (M = 3.93, SD = 0.41) before looking at the data accounting for covariates. This might be explained by the idea that once teachers receive a gifted endorsement, they are more reflective on their own teaching ability styles, as Greene and Hartzell (2011) thought it was self-reflection and endorsement status together that resulted in a higher achievement. In addition, Yoo (2016) found that teachers reported decreased self-efficacy levels after receiving training. One of the teachers that Yoo (2016) interviewed described that she was more confident before she received training. Once she received training, she realized her own deficiencies and her self-efficacy decreased.

From the current research study, another interesting note is that of the teachers who reported they taught science and did not have a gifted endorsement (N = 9) either of these teachers also did not have any STEM training. Out of those teachers who did have a gifted endorsement (N = 23), only 7 did not have STEM training. Therefore, 11% of nonendorsed teachers had STEM training whereas 69.6% of endorsed teachers had received STEM training. Although this is interesting to note, the STEM training within the past three years is not directly linked to the endorsement status in this study. It is possible that the teachers with endorsements sought out STEM training, but it is also possible that the training occurred as a result of mandated training for teachers in a specific job position.

Mathematics Self-Efficacy and Gifted Endorsement Status

Prior to adding covariates, there was no statistically significant difference between teachers with and without a gifted endorsement in mathematics teaching self-efficacy. There was also no statistically significant difference between the means of the self-efficacy in teaching mathematics by endorsed and nonendorsed elementary teachers of gifted students when utilizing the covariate of STEM training.

However, there was a statistically significant result found for the interaction between gifted endorsement and years of teaching as well as the relationship between gifted endorsement and grade level when looking at mathematics self-efficacy. There was also a statistically significant result when combining all variables into the regression analysis, which explained 21% of the variance. The largest factor in this analysis was years of experience (β = .38, p = .00).

Participants who had no gifted endorsement reported a lower mean in mathematics self-efficacy (*M* = 3.65) than those who had a gifted endorsement (*M* = 4.31). This follows Pierce et al.'s (2011) conclusion that teachers needed professional development in the area of mathematics, experience with mathematics materials and longitudinal exposure to the resources for teacher and student success. In addition, a respondent mentioned in the qualitative comments about beliefs of mathematics that they were required to teach math at a grade outside of their comfort level (see Table 13). The researcher postulated that this could decrease self-efficacy, regardless of endorsement status.

Integrated STEM Self-Efficacy and Gifted Endorsement Status

There was no statistically significant difference in the means between the self-efficacy in teaching integrated STEM by endorsed and nonendorsed elementary teachers of gifted students when controlling for grade level, years of teaching experience, and recent STEM training. In fact, only 19% of the variance can be explained by these predictors and gifted endorsement. This supports the assertion that Atkinson and Mayo (2010) made that it may not be enough to train teachers how to teach STEM in the classroom. In addition, research supported the idea that elementary teachers are uncomfortable with teaching engineering since they have not learned engineering (Brophy et al., 2008). Teachers reported limited STEM training which may have impacted self-efficacy. Although the data in this research study appears to support Brophy's assertion, it is more challenging to support this with only 39 respondents. Brophy claimed that teachers need professional development in order to be successful in teaching engineering (Brophy et al., 2008).

In the area of technology, Shaunessy (2007) found technology training for teachers of gifted students was the strongest predictor of their attitudes towards technology. This connection between training in technology could be linked to STEM training as well, which differed from the findings here that STEM training was not a significant predictor of self-efficacy. Moreover, Pierce et al. (2011) stated the intentionality of training and implementation make the biggest difference in STEM education. One respondent noted that school administration may not be supportive of STEM education (see Table 13), which may also impact the efficacy of teachers, as hypothesized by the researcher. The relationship between STEM training and self-efficacy levels could be an area to focus on in future studies.

Self-Reported Use of STEM Instructional Strategies and Gifted Endorsement Status

The scale for self-reported use of STEM instructional strategies included a five-point Likert scale in which teachers chose whether they used the instructional strategy Never (0), Occasionally (1), About half the time (2) Usually (3), or Every time (4). Responses to 13 out of the 15 strategies resulted in a mean between 2.00 and 2.99, representing about "half the time" and "usually". The area of problem solving (*M* = 2.53, *SD* = 1.01) fell in this range which documents agreement with Swanson (2006), who found teachers believed the problem-based learning approach to curriculum effective in the area of gifted education. The highest strategy used was working in small groups (M = 3.10, *SD* = .71), which is commonly used in elementary instruction regardless of use with gifted students.

There was no difference found between means for grade level and for years of teaching. However, there was a difference found between the means of self-reported use of STEM instructional strategies used during classroom STEM sessions by endorsed and nonendorsed elementary teachers of gifted students, when controlling for STEM training. Teachers with no gifted endorsement had a higher reported mean (*M* = 2.62, *SD* = .72) of STEM instructional strategy use than teachers who had a gifted endorsement (*M* = 2.56, *SD* = .75). In addition, the regression analysis demonstrated that STEM training ($\beta = .37$, $p = .00$) was a predictor of self-reported use of STEM instructional strategies.

Included in the definition of a gifted student, the U.S. Department of Education (2013) stresses that different instructional strategies must exist to serve the gifted student population, but this research seemed to show that a gifted endorsement does not lead to a higher use of self-reported use of STEM instructional strategies. This contrasts with Bandura's (1977) theory that in observing successes and failures of others, one can develop higher levels of self-efficacy than those based on one's own abilities. It also differs from Rubenstein et al. (2015) who after analyzing the teachers' comments about not understanding mathematics or making mistakes, suggested a lack of mathematics conceptual knowledge may prevent some teachers from providing differentiation in the classroom (Rubenstein et al., 2015).

The researcher hypothesized this difference might result because those teachers who have received their endorsements have developed more self-reflection regarding their teaching, and it is possible that endorsement status in conjunction with self-reflection, as noted by Greene and Hartzell (2011), may make a teacher effective in the classroom. Yoo (2016) adds to this idea in an interview with a teacher who shared that she did not know her deficiencies until after she received professional development. Thus, while instructional strategy use may appear to have a higher mean by teachers who are not endorsed in this study, this result could be attributed to endorsed teachers being more reflective of what they are doing in the classroom, but this is not supported in the current study's research findings.

Finally, when analyzing the regression, 37% of the variance in self-reported use of STEM instructional strategies was explained by endorsement status, grade level, years of experience, and STEM training. The grade level third grade was the strongest predictor ($\beta = -.61$, $p = .00$)

with second grade the next strongest predictor ($\beta = .60$, $p = .00$). Interestingly, years of teaching ($\beta = -.44$, $p = .00$) also was a significant predictor for self-reported use of STEM instructional strategies, just as it did for math self-efficacy and integrated STEM self-efficacy, but not for science self-efficacy.

Implications for Theory, Research, and Practice

There is disagreement about the effectiveness of training teachers who do not have a gifted endorsement how to differentiate in the regular education classroom (Archambault et al., 1993; Hertberg-Davis, 2009; Johnsen, Haensly, Ryser, & Ford, 2002; Scot et al., 2009). Professional development can be considered ineffective, either because it is insufficient without appropriate support for teachers or because professional development often consists of single workshops with little follow-up (Hertberg-Davis, 2009; Scot et al., 2009). However, the Mustard Seed Project (2002) demonstrated professional development could lead to positive changes for regular education teachers who teach gifted students in the classroom through qualitative observations as well as a systematic observation tool called the CIPS (Classroom Instructional Practices Scale) (Johnsen et al., 2002). The researchers found that over two years of professional development and training, all teachers made a transitive change in at least one area of instructional practices, according to a comparison of teachers' classroom practices observation results from the CIPS (Johnsen et al., 2002). This result gives support to the idea that professional development may increase STEM instructional practices, which may or may not be part of the gifted endorsement process.

This research, however, seems to indicate that there is not a statistical difference between the self-efficacy levels of science and STEM and gifted endorsement status, when reducing the effects of grade level, STEM training, and years of experience together, although this is more conjecture based on the small sample size in this study. When analyzing teachers' years of experience, out of the total number of respondents, the 14 teachers who reported they did not have a gifted endorsement had a lower mean for years of experience (*M* = 15.21, *SD* = 11.89). For the 25 teachers who reported they did have a gifted endorsement, the mean years of experience was 19.96 years (*SD* = 6.56). While this study focused on whether a teacher had a gifted endorsement while controlling for years of experience, it is interesting to note that those with endorsements had more experience. Could this mean that there is connection between years of experience and endorsement status? According to social cognitive theory (Bandura, 1986), behavior is determined by observing and learning from others' behaviors. This may mean that teachers with more experience may have more positive behaviors and thus seek out further education such as a gifted endorsement.

This leads the researcher to question how effective a gifted endorsement may be when looking at science, mathematics, and STEM self-efficacy. Post-graduate programs offering a gifted endorsement may need to analyze their certification programs to determine what training or courses would make a more effective endorsement program in Virginia for teachers of the gifted. Since the coursework in Virginia does not currently include STEM training (see appendix C), it may be a topic that endorsement programs should add into the certification process in the future.

By comparing teachers with their gifted endorsement status, this research demonstrated certification status for teachers of the gifted may not be important for teacher self-efficacy and classroom instructional practices in science, mathematics and STEM. It is possible both endorsed and nonendorsed teachers of the gifted can meet students' needs through utilizing best instructional practices for gifted students; however, "with the prevalence of gifted students in general education classrooms, all teachers will be responsible for providing appropriate programming for them" (Bangel et al., 2010). Thus, all teachers would need to be trained, which could benefit all students in the classrooms, not just gifted students. In the Higher Education Opportunity Act (2008), teacher preparation programs are required to implement research-based teaching practices in their classrooms for gifted students (Johnsen, 2012). Therefore, it is important to provide appropriate professional development so teachers develop self-efficacy and can implement appropriate programming for gifted students in STEM education.

Limitations and Future Research

There were several limitations inherent in this research study. First, there was only an overall response rate of 9% with a usable response rate of 5.5%. It is possible that those who participated were individuals who felt passionate about STEM education, which may result in data not being representative of the larger population. The low response rate could be due to mitigating factors such as the time of year (prior to state testing) and the technological issues referenced in the data analysis section. However, the total number of responses for this survey, 39, was comparable to Nadelson's (2013) study in which 32 respondents answered a Likert format survey on self-efficacy. The reporting groups also resulted in uneven groups for the data analysis. Overall, 14 of the 39 teachers reported that they did not have an endorsement. When reporting what subjects taught, for science, there were nine teachers who did not have an endorsement and 23 who did. For mathematics and for STEM, there were eight teachers who did not have an endorsement and 32 teachers that did, which resulted in uneven groups when running the ANCOVA. The sample reflects beliefs of teachers in three school divisions in Virginia. The findings may not be representative of a larger population. In addition, teachers who self-report may unconsciously report a higher level of self-efficacy.

This survey should be completed again with a larger sample size that is more equitable between endorsed and nonendorsed teachers of gifted students. Although participants were satisfied or very satisfied (90.6%) that the questions reflected their beliefs, teachers suggested other ideas in each area of mathematics, science, and integrated STEM in an open-ended question at the close of each self-efficacy section (science, mathematics, and integrated STEM). The inclusion of these ideas (see Table 13), once vetted, in future surveys may ensure a more accurate reflection of a teacher's self-efficacy.

In the data analysis, there were additional limitations that need to be addressed. First, since each teacher could select multiple grade levels, the responses had to be separated into different responses to show the various grade levels a teacher would be part of when creating the dummy variables for analysis. Next, when an ANCOVA or univariate general linear analysis was not appropriate due to the assumptions not being tenable, a modified regression model was run, which has multicollinearity concerns inherent in the way the analysis was set up. In addition, within three of the analyses (grade level in relation to STEM self-efficacy and gifted endorsement status, grade level in relation to self-reported use of STEM instructional strategies and gifted endorsement status, and grade level in relation to science self-efficacy and gifted endorsement status) there were one or two of the individual grade levels that did have a significant interaction. However, the remaining grade levels did not have a significant interaction. Therefore, the researcher chose to run both the regressions in addition to the ANCOVAS, despite the violation of the assumption for a minority of the levels for grade level. The researcher considered the benefits of running a univariate general linear model analysis and determined that this model outweighed the limitations of using a modified regression model which could have multicollinearity.

In order to use the information garnered in this study to help the research community, there are several research avenues that need to be explored. With a lack of statistical evidence provided in this study, it is imperative to refer to the literature to look at other confounding variables that may have influenced the data. Using a personality test, such as the Myers-Briggs Personality Test, may help researchers determine what makes an exemplary teacher. Certain character traits, such as preferences for abstract themes and concepts, being open and flexible, and or valuing logical analysis, such as in Mills' research (2003), may be used to predict teachers' self-efficacy levels.

Table 13

Respondents' Ideas for Better Representation of Questions

Science	Mathematics	Integrated STEM
Background in science perhaps?	Extent of math background	I disagree with the definition of STEM where at least three components of S.T.E. or M. must occur for a lesson to qualify as a STEM lesson.
I know what to do if I don't understand a science concept.	Are you choosing to teach mathematics to gifted students? I am having to teach a level of math outside of my comfort level at this time.	Do you feel your administration is supportive in STEM education? I am lucky that mine are, but I know it is challenging for other teachers.
A question that reflects the knowledge of when I don't know how to answer a student's question I research/find out the answer to give to them.	I know what to do if I don't understand a mathematics concept.	In the early questions about STEM it asks about how much training I have had but I have provided professional development in STEM and presented at state and international conferences. So maybe asking Have you offered any STEM training?
Specific questions about types of science instruction, such as hands on, lecture, etc.	A question about finding out answers I don't know in order to help the students.	How much training have you had on STEM instruction?
		I don't think my beliefs in the value of STEM instruction and my confidence in teaching it are the same thing.

There is a large body of research calling for more training and professional development in gifted education for both preservice (Bangel et al., 2010) and in-service teacher programs (Hansen & Feldhusen, 1994; Hertberg-Davis, 2009; Nowikowski, 2011; and Marland, 1972). While there is a push to ensure teachers instruct students at an appropriate level, teachers may find this difficult when they may not know how to reach the needs of advanced students. An additional area that may influence endorsement status could be self-reflection, and thus may be noteworthy to research in conjunction with self-efficacy in the area of STEM, as referenced by Greene and Hartzell (2011), who believed that it was both endorsement status and self-reflection that made a teacher effective in the classroom. In fact, it may also be interesting to determine if self-efficacy can predict STEM instructional strategies, such as in Bandura's (1977) theory where self-efficacy can predict outcomes.

In gifted education, there is less extant research about elementary school populations compared to middle and high school populations (Karnes and Whorton, 1991). There is a slight disconnect between research and practice, with the research cited overwhelmingly representing situations that are not in a school environment, such as preservice teachers teaching a Saturday Enrichment Course (Bangel et al., 2010) or a demonstration of the Classroom Observation Scale-Revised (COS-R), which focused on characteristics of teachers of gifted students (VanTassel-Baska, 2012) in select classrooms. Therefore, more research needs to be completed using samples from elementary school teachers. In fact, even the definition of STEM requires more research. A respondent shared that they did not agree with the operational definition chosen for this study (see Table 13), which warrants clarification of the different definitions and which definition is being used in school settings.

The perceptions of endorsements and professional development are also key to this research. Swanson (2007) found through interviews that gifted education experts considered gifted education courses a positive factor in how teachers understood and teach gifted students. However, this research does not reference the content or material in the professional development. There should be more research on the type of professional development that is provided for teachers through the endorsement process. It is also apparent that more research should be conducted to determine if a gifted endorsement is effective in helping teachers feel more effective in the classroom in the area of STEM, which supports the lack of research that was found in the relationship between STEM education and gifted certification. As a former gifted research teacher, the researcher may be impacted by research positionality, or bias in reporting these results based on the identity influencing the researcher's understanding of the world. Thus, there is a need for future research to explore the relationship between gifted endorsement status and STEM education in more detail.

Conclusion

While future studies may add more research to our knowledge based on gifted endorsements, STEM education, and self-efficacy, it is noteworthy that this dissertation study references no statistical difference between endorsed and nonendorsed teachers' self-efficacy in teaching science, mathematics, and STEM. Thus, there needs to be more recognition that these areas are difficult and an advocacy for changes in training either through the gifted endorsement process or in STEM training in order to provide teachers with more self-efficacy in the areas of science, mathematics, and STEM as there is no direct correlation to these areas referenced in Virginia's endorsement process. In addition, the statistical difference found between the means of self-reported use of STEM instructional strategies used during classroom STEM sessions by endorsed and nonendorsed elementary teachers of gifted students, when controlling for STEM training, with a higher mean for nonendorsed teacher use leads to the previously noted additional questions that should be addressed through future research.

List of References

Atkinson, R. D., & Mayo, M. (2010). *Refueling the U.S. innovation economy: Fresh approaches to science, technology, engineering, and mathematics (STEM) education.* The Information Technology & Innovation Foundation.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215. http://dx.doi.org/10.1037/0033-295X.84.2.191

Bangel, N. J., Moon, S. M., & Capobianco, B. M. (2010). Preservice teachers' perceptions and experiences in a gifted education training model. *Gifted Child Quarterly, 54*(3), 209-221. doi:http://dx.doi.org.proxy.library.vcu.edu/10.1177/0016986210369257

Brophy, S., Klein. S., Portsmore, M., & Rogers, C. (2008). Advancing engineering education in P-12 classroom. *Journal of Engineering Education, 97*(3), 369-387.

Bybee, R. W. (2010). Advancing STEM education: a 2020 vision. *Technology and Engineering Teacher, 70*(1), 30-35.

Creswell, J. W. (2003). *Research design qualitative, quantitative, and mixed methods approaches.* Thousand Oaks, California: Sage Publications.

Dare, E. A., Childs, G. T., Cannaday, A. E., & Roehrig, G. H. (2014). Engineering encounters: Blasting off with engineering. *Science and Children, 52*(3), 60-64.

Ed.Gov. (n.d.). Civil rights data collection. Retrieved August 17, 2017, from https://ocrdata.ed.gov/StateNationalEstimations/Estimations_2011_12

Faul, F., Erdfelder, E., Lang, A.G. & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175-191.

Field, A. P. (2018). *Discovering statistics using IBM SPSS statistics*. Thousand Oaks, CA: Sage Publications.

Field, G.B. (2010). From quantitative results to qualitative meaning: A look at Renzulli learning through the eyes of students, teachers, and administrators at Oak Hills Elementary School and Inman Middle School. *Gifted Education International, 26*(2). 285-301.

Friday Institute for Educational Innovation (2012). *Teacher Efficacy and Attitudes Toward STEM Survey-Elementary Teachers,* Raleigh, NC: Author.

Gavin, M. K., & Adelson, J. L. (2008). Mathematics, elementary. In *Critical issues and practices in gifted education: what the research says* (pp. 367-394). Waco, TX: Prufrock Press.

Gonzalez, H. B., & Kuenzi, J. J. (2012). Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer. CSR Report for Congress.

Grimes, D. & Warschauer, M. (2008). Learning with laptops: A multi-method case study. *Journal of Educational Computing Research, 38,* 305-332.

Hansen, J. B., & Feldhusen, J. F. (1994). Comparison of trained and untrained teachers of gifted students. *Gifted Child Quarterly, 38*(3), 115-121. doi: http://dx.doi.org.proxy.library.vcu.edu/10.1177/001698629403800304

Harris, P.A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., Conde, J.G. (2009). Research electronic data capture (REDCap) – a metadata-driven methodology and workflow process for providing translational research informatics support. *J. Biomed Inform, 42*(2), 377-381.

Harris, P.A., Taylor, R., Minor, B.L., Elliott, V., Fernandez, M., O'Neal, L. McLeod, L., Delacqua, G., Delacqua, F., Kirby, J., Duda, S.N. (2019). The REDCap consortium: Building an international community of software partners. *J. Biomed Inform.* doi: 10.1016/j.jbi.2019.103208.

Hertberg-Davis, H. (2009). Myth 7: Differentiation in the regular classroom is equivalent to gifted programs and is sufficient--classroom teachers have the time, the skill, and the will to differentiate adequately. *Gifted Child Quarterly, 53*(4), 251-253.

Heslin, P. A., & Klehe, U. C. (2006). Self-efficacy. In S.G. Rogelberg (Ed.), *Encyclopedia of Industrial/Organizational Psychology (2*), 705-708. Thousand Oaks, CA: Sage.

Hong, E., Greene, M., & Hartzell, S. (2011). Cognitive and motivational characteristics of elementary teachers in general education classrooms and in gifted programs. *Gifted Child Quarterly, 55*(4), 250-264.

Johnsen, S. K. (2012). Standards in gifted education and their effects on professional competence. *Gifted Child Today, 35*(1), 49-57.

Karademir, E. (2016). Investigation the scientific creativity of gifted students through project-based activities. *International Journal of Research in Education and Science, 2*(2), 416-427.

Karnes, F. A., & Marquardt, R. G. (1995). Gifted education and the courts: Teacher certification and employment decisions. *Roeper Review, 17*(4), 229-231.

Karnes, F. A., & Whorton, J. E. (1996). Teacher certification and endorsement in gifted education: A critical need. *Roeper Review, 19*(1), 54-56.

Kelble, E. S., Howard, R. E., & Tapp, J. B. (1994). Enhancing physical science instruction for gifted elementary school students: Developing teacher confidence and skills. *Roeper Review, 16*(3), 162-166. doi:10.1080/02783199409553565.

Lea, K. (2010). *Talented & gifted: Working with high achievers.* Virtual Education Software, Inc.

Lockwood, A. T. (2005) *An agenda for the future: Closing the achievement gap for underrepresented groups in gifted and talented education.* Portland, Oregon: Northwest Regional Educational Laboratory.

Maher, P. A. Bailey, J. M., Etheridge, D. A., & Warby, D. B. (2013). Working with STEM faculty mentors: An exploratory study. *Teacher Education and Practice, 26*(2), 266-284.

Marland, P. S. (1971). *Education of the gifted and talented - volume 1: Report to the congress of the united states by the U. S. commissioner of education*.

Mathews, N. F., & Burns, J. M. (1992). A parent evaluation of a public preschool gifted program. *Roeper Review, 15*(2), 69-72.

McMillan, J. H. (2008). *Educational research: fundamentals for the consumer*. Boston: Pearson.

Mills, C. J. (2003). Characteristics of effective teachers of gifted students: Teacher background and personality styles of students. *Gifted Child Quarterly, 47*(4), 272-281. doi:http://dx.doi.org.proxy.library.vcu.edu/10.1177/001698620304700404

Nadelson, L.S., Callahan, J., Pyke, P., Hay, A., Dance, M., & Pfiester, J. (2013). Teacher STEM perception and preparation: Inquiry-based STEM professional development for elementary teachers. *The Journal of Educational Research, 106*(2), 157-168.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. 2007. *Rising above the gathering storm: Energizing and employing America for a* *brighter economic future*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11463

National Association for Gifted Children (NAGC). (2013). NAGC-CEC teacher preparation standards in gifted education. Retrieved from http://www.nagc.org/resources-publications/resources /national-standards-gifted-and-talented-education/nagc-cec-teacher

National Association for Gifted Children (NAGC). (2015). State of the states in gifted education policy and practice data. Retrieved from https://www.nagc.org/sites/default/files/key%20reports/2014-2015%20State%20of%20the%20States%20(final).pdf

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

NGSS Lead States. (2013). *Next generation science standards: For states, by states.* Washington, DC: National Academies Press. Retrieved from http://www.nextgenscience.org/next-generation-science-standards.

Nowikowski, S. H. (May 2011). *A study of the perceptions of pre-service and in-service educators on best practices for gifted students.* (Unpublished Doctor of Education). Indiana University of Pennsylvania, UMI Dissertation Publishing.

Periathiruvadi, S. & Rinn, A. N. (2012) Technology in gifted education: A review of best practices and empirical research. *Journal of Research on Technology in Education, 45*(2), 153-169.

Pierce, R. L., Cassady, J. C., Adams, C. M., Speirs Neumeister, K. L., Dixon, F. A., Cross, T. L. (2011). The effects of clustering and curriculum on the development of gifted learners' math achievement. *Journal for the Education of the Gifted, 34*(4), 569-594.

Polzella, L. (1997). Gifted students suggest reforms for education: Listening to gifted students' ideas. *Gifted Child Today, 20*(4), 30-35.

Reeves, C. G., Fostvedt, L., Laugerman, M., Baenziger, J., & Shelley, M. (2013). Structural equation modeling of knowledge content improvement using inquiry based instruction. *Society for Research on Educational Effectiveness Conference Abstract.*

Reis, S. M., Gentry, M., & Maxfield, L. R. (1998). The application of enrichment clusters to teachers' classroom practices. *Journal for the Education of the Gifted, 21*(3), 310-334.

Renzulli, J. S, & Reis, S. M. (2007). A technology based program that matches enrichment resources with student strengths. *International Journal of Emerging Technologies in Learning, 2*(3), 1-8.

Rittmayer, A. D. & Beier, M. E. (2008). *Overview: Self-efficacy in STEM.* SWE-AWE CASEE Overviews. Retrieved from http://AWEonline.org

Roberts, A. (2012). A justification for STEM education. *Technology and Engineering Teacher,* 1-5.

Root-Bernstein, R. (2015). Arts and crafts as adjuncts to STEM education to foster creativity in gifted and talented students. *Asia Pacific Education Review, 16*, 203-212. doi:10.1007/s12564-015-9362-0

Rubenstein, L. D., Gilson, C. M., Bruce-Davis, M., & Gubbins, E. J. (2015). Teachers' reactions to pre-differentiated and enriched mathematics curricula. *Journal for the Education of the Gifted, 38*(2), 141-168. doi:10.1177/0162353215578280

Sanders, M. (2009). STEM, STEM Education, STEMmania. *Technology Teacher, 68*(4), 20-26.

Schultz, C. B. (1991). *The effects of curriculum compacting upon student achievement in fourth grade mathematics.* Unpublished master's thesis, University of Northern Iowa, Cedar Falls.

Scot, T. P., Callahan, C. M., & Urquhart, J. (2009). Paint-by-number teachers and cookie-cutter students: The unintended effects of high-stakes testing on the education of gifted students. *Roeper Review, 31*(1), 40-52.

Shaklee, B. D. (1997). Gifted-child education in the new millennium. *Educational Forum, 61*(3), 212-219.

Shaunessy, E. (2007). Attitudes toward information technology of teachers of the gifted. *Gifted Child Quarterly, 51*(2), 119-135.

Snyder, T. D., & Dillow, S. A. (2013). *Digest of education statistics, 2012. NCES 2014-2015*. Jessup, MD: National Center for Education Statistics.

Swanson, J. D. (2006). Breaking through assumptions about low-income, minority gifted students. *Gifted Child Quarterly, 50*(1), 11-25. doi:10.1177/001698620605000103.

Swanson, J. D. (2007). Policy and practice: A case study of gifted education policy implementation. *Journal for the Education of the Gifted, 31*(2), 131-164.

Tassell, J., Maxwell, M., & Stobaugh, R. (2013). CReaTE excellence: Using a teacher framework to maximize STEM learning with your child. *Parenting for High Potential 3*(2), 10-13.

Tilgner, P. J. (1990). Avoiding science in the elementary school. *Science Education, 74*(4), 421-431.

Tomlinson, C. A., & Callahan, C. M. (1992). Contributions of gifted education to general education in a time of change. *Gifted Child Quarterly, 36*(4), 183-189.

U.S. Department of Education. (1983). A nation at risk: The imperative for educational reform. Washington, DC: The National Commission on Excellence in Education.

U.S. Department of Education. (2010, June 25). Higher education opportunity act - 2008. Retrieved from www2.ed.gov/policy/highered/leg/hea08/index.html

U.S. Department of Education. (2011, May 26). ESEA reauthorization: A blueprint for reform. Retrieved from www2.ed.gov/policy/elsec/leg/blueprint/index.html

U.S. Department of Education. (2013). Jacob K. Javits gifted and talented students education program. Retrieved October 27, 2013, from http://www2.ed.gov/programs/javits/index.html

VanTassel-Baska, J. (2012). Analyzing differentiation in the classroom: Using the COS-R. *Gifted Child Today, 35*(1), 42-48.

VanTassel-Baska, J. Bass, G., Ries, R., Poland, D., & Avery, L. (1998). A national study of science curriculum effectiveness with high ability students. *Gifted Child Quarterly 12*(4), 200-211.

Vidergor, H. E. (2012). Culturally responsible research, teacher certification and gifted education services: A response to Persson's target article. *Gifted and Talented International, 27*(1), 77-82.

Virginia Department of Education. (2012). *Gifted education: Frequently asked questions.* Retrieved December 8. 2014, from http://www.doe.virginia.gov/instruction/gifted_ed/faq.shtml

Virginia Department of Education. (2020). *Licensure regulations for school personnel*. Retrieved November 9, 2020, from https://law.lis.virginia.gov/admincode/title8/agency20/chapter23/section370/

Whitlock, M. S. &. DuCette, J.P. (1989). Outstanding and average teachers of the gifted: A comparative study. *Gifted Child Quarterly, 33*(1), 15-21. doi:http://dx.doi.org.proxy.library.vcu.edu/10.1177/001698628903300103

Yoo, J. H. (2016). The effect of professional development on teacher efficacy and teachers' self-analysis of their efficacy change. *Journal of Teacher Education for Sustainability*, *18*(1), 84-94.

Ysseldyke, J., Tardew, S., Betts, J., Thill, T., & Hannigan E. (2004). Use of an instructional management system to enhance math instruction of gifted and talented students. *Journal for the Education of the Gifted, 27*(4), 293-319.

Zimlich, S. L. (2015). Using technology in gifted and talented education classrooms: The teachers' perspective. *Journal of Informational Technology Education: Innovations in Practice, 14,* 101-124.

Appendix A

Survey

Self-efficacy of endorsed and nonendorsed elementary teachers of gifted students in STEM education

Welcome to the research survey entitled "Self-efficacy of endorsed and nonendorsed elementary teachers of gifted students in STEM education". Your participation is voluntary. You may decide to not participate in this study. If you do participate, you may withdraw from the study at any time. Your decision not to take part or to withdraw will involve no penalty. Continuing with the survey is giving consent to participate in this survey. Participation in the survey is also considered consent for using your responses as part of the study.

Do you or have you taught gifted students in a classroom setting in any capacity, such as classroom mainstreaming, pull-out services, collaborative services, etc. within the past three years?

○ Yes
○ No

When teaching gifted students, did you teach students in grades kindergarten through fifth grade?

○ Yes
○ No

Please enter the email address this survey was sent to in order to avoid duplicate answers. This email will be used in the drawing for the raffle but will be separated from any data collected.

____

What grade(s) did you teach gifted students?

☐ Kindergarten
☐ 1st Grade
☐ 2nd Grade
☐ 3rd Grade
☐ 4th Grade
☐ 5th Grade

How many years have you been teaching?

____

Do you have a gifted endorsement granted to you by the Virginia Department of Education?

○ Yes
○ No

Have you received any training in STEM* instruction in the last year?
*STEM is the integrative approach to curriculum and instruction merging science, technology, engineering, and mathematics. An example may be a lesson within the classroom that incorporates science and engineering to solve a real world problem or a mathematics lesson in which you purposely utilize technology to make global connections.

○ Yes
○ No

What is the approximate number of training hours completed at the:

	0	1-10	11-20	20-30	30-40	40-50	50-60	61+
School level	○	○	○	○	○	○	○	○
District/Division level	○	○	○	○	○	○	○	○
State level	○	○	○	○	○	○	○	○
University or college level	○	○	○	○	○	○	○	○

Science Teaching Self-efficacy

For each of the following statements, please indicate the degree to which you agree or disagree.

Even though some statements are very similar, please answer each statement. There are no "right" or "wrong" answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help make your choice.

Directions: Please respond to these questions regarding your feelings about your own teaching.

Have you taught science to gifted students within the past three years?
- ◯ Yes
- ◯ No

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I am continually improving my science teaching practice.	◯	◯	◯	◯	◯
I know the steps necessary to teach science effectively.	◯	◯	◯	◯	◯
I am confident that I can explain to students why science experiments work.	◯	◯	◯	◯	◯
I am confident that I can teach science effectively.	◯	◯	◯	◯	◯
I wonder if I have the necessary skills to teach science.	◯	◯	◯	◯	◯
I understand science concepts well enough to be effective in teaching science.	◯	◯	◯	◯	◯
Given a choice, I would invite a colleague to evaluate my science teaching.	◯	◯	◯	◯	◯
I am confident that I can answer students' science questions.	◯	◯	◯	◯	◯
When a student has difficulty understanding a science concept, I am confident that I know how to help the student understand it better.	◯	◯	◯	◯	◯
When teaching science, I am confident enough to welcome student questions.	◯	◯	◯	◯	◯
I know what to do to increase student interest in science.	◯	◯	◯	◯	◯

	Very satisfied	Satisfied	Unsatisfied	Very unsatisfied
To what degree are you satisfied this survey captured your beliefs about science instruction?	○	○	○	○

What question should be included in order to better represent your beliefs toward science instruction?

____

Mathematics Teaching Self-efficacy

For each of the following statements, please indicate the degree to which you agree or disagree.

Even though some statements are very similar, please answer each statement. There are no "right" or "wrong" answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help make your choice.

Directions: Please respond to these questions regarding your feelings about your own teaching.

Have you taught mathematics to gifted students within the past three years? ◯ Yes ◯ No

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I am continually improving my mathematics teaching practice.	◯	◯	◯	◯	◯
I know the steps necessary to teach mathematics effectively.	◯	◯	◯	◯	◯
I am confident that I can explain to students how mathematics work.	◯	◯	◯	◯	◯
I am confident that I can teach mathematics effectively.	◯	◯	◯	◯	◯
I wonder if I have the necessary skills to teach mathematics.	◯	◯	◯	◯	◯
I understand mathematics concepts well enough to be effective in teaching mathematics.	◯	◯	◯	◯	◯
Given a choice, I would invite a colleague to evaluate my mathematics teaching.	◯	◯	◯	◯	◯
I am confident that I can answer students' mathematics questions.	◯	◯	◯	◯	◯
When a student has difficulty understanding a mathematics concept, I am confident that I know how to help the student understand it better.	◯	◯	◯	◯	◯
When teaching mathematics, I am confident enough to welcome student questions.	◯	◯	◯	◯	◯
I know what to do to increase student interest in mathematics.	◯	◯	◯	◯	◯

	Very satisfied	Satisfied	Unsatisfied	Very unsatisfied
To what degree are you satisfied this survey captured your beliefs about math instruction?	○	○	○	○

What question should be included in order to better represent your beliefs toward math instruction?

____

STEM Teaching Self-efficacy

For each of the following statements, please indicate the degree to which you agree or disagree.

Even though some statements are very similar, please answer each statement. There are no "right" or "wrong" answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help make your choice.

Directions: Please respond to these questions regarding your feelings about your own teaching.

Have you taught STEM* to gifted students within the past three years?
◯ Yes
◯ No

*STEM is the integrative approach to curriculum and instruction merging science, technology, engineering, and mathematics. An example may be a lesson within the classroom that incorporates science and engineering to solve a real world problem or a mathematics lesson in which you purposely utilize technology to make global connections.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I am continually improving my STEM teaching practice.	◯	◯	◯	◯	◯
I know the steps necessary to teach STEM effectively.	◯	◯	◯	◯	◯
I am confident that I can explain to students how STEM works.	◯	◯	◯	◯	◯
I am confident that I can teach STEM effectively.	◯	◯	◯	◯	◯
I wonder if I have the necessary skills to teach STEM.	◯	◯	◯	◯	◯
I understand STEM concepts well enough to be effective in teaching STEM.	◯	◯	◯	◯	◯
Given a choice, I would invite a colleague to evaluate my STEM teaching.	◯	◯	◯	◯	◯
I am confident that I can answer students' STEM questions.	◯	◯	◯	◯	◯
When a student has difficulty understanding a STEM concept, I am confident that I know how to help the student understand it better.	◯	◯	◯	◯	◯

When teaching STEM, I am confident enough to welcome student questions.	○	○	○	○	○
I know what to do to increase student interest in STEM.	○	○	○	○	○

	Very satisfied	Satisfied	Unsatisfied	Very unsatisfied
To what degree are you satisfied this survey captured your beliefs about STEM instruction?	○	○	○	○

What question should be included in order to better represent your beliefs toward STEM instruction?

____

Elementary STEM Instruction

Directions: Please answer the following questions about how often students engage in the following tasks during elementary STEM* instructional time.

Elementary STEM* Instruction

***STEM is the integrative approach to curriculum and instruction merging science, technology, engineering, and mathematics. An example may be a lesson within the classroom that incorporates science and engineering to solve a real world problem or a mathematics lesson in which you purposely utilize technology to make global connections.**

	Never	Occasionally	About half the time	Usually	Every time
Develop problem-solving skills through investigations (e.g. scientific, design or theoretical investigations.)	○	○	○	○	○
Work in small groups.	○	○	○	○	○
Make predictions that can be tested.	○	○	○	○	○
Make careful observations or measurements.	○	○	○	○	○
Use tools to gather data (e.g. calculators, computers, computer programs, scales, rulers, compasses, etc.)	○	○	○	○	○
Recognize patterns in data.	○	○	○	○	○
Create reasonable explanations of results of an experiment or investigation.	○	○	○	○	○
Choose the most appropriate methods to express results (e.g. drawings, models, charts, graphs, technical language, etc.)	○	○	○	○	○
Complete activities with a real-world context.	○	○	○	○	○
Engage in content-driven dialogue.	○	○	○	○	○
Reason abstractly.	○	○	○	○	○
Reason quantitatively.	○	○	○	○	○
Critique the reasoning of others.	○	○	○	○	○

Learn about careers related to the instructional content.	○	○	○	○	○

Do you feel as if the questions in this survey are representative of your mathematics, science, and/or STEM instruction and beliefs?

○ Yes
○ No

Describe why the questions do not match your science, mathematics, and/or STEM instruction or beliefs.

____

Appendix B

VDOE Regulations Governing Educational Services for Gifted Students

8VAC20-542-310. Gifted education (add-on endorsement).

The program in gifted education shall ensure that the candidate has demonstrated the following competencies:

1. Understanding of principles of the integration of gifted education and general education, including:

a. Strategies to encourage the interaction of gifted students with students of similar and differing abilities; and

b. Development of activities to encourage parental and community involvement in the education of the gifted, including the establishment and maintenance of an effective advisory committee.

2. Understanding of the characteristics of gifted students, including:

a. Varied expressions of advanced aptitudes, skills, creativity, and conceptual understandings;

b. Methodologies that respond to the affective (social-emotional) needs of gifted students; and

c. Gifted behaviors in special populations (i.e., those who are culturally diverse, economically disadvantaged, or physically disabled).

3. Understanding of specific techniques to identify gifted students using diagnostic and prescriptive approaches to assessment, including:

a. The selection, use, and evaluation of multiple assessment instruments and identification strategies;

b. The use of both subjective and objective measures to provide relevant information regarding the aptitude/ability or achievement of potentially gifted students;

c. The use of authentic assessment tools such as portfolios to determine performance, motivation/interest and other characteristics of potentially gifted students;

d. The development, use, and reliability of rating scales, checklists, and questionnaires by parents, teachers and others;

e. The evaluation of data collected from student records such as grades, honors, and awards;

f. The use of case study reports providing information concerning exceptional conditions; and

g. The structure, training, and procedures used by the identification and placement committee.

4. Understanding and application of a variety of educational models, teaching methods, and strategies for selecting materials and resources that ensure:

a. Academic rigor through the development of high-level proficiency in all core academic areas utilizing the Virginia Standards of Learning as a baseline;

b. The acquisition of knowledge and development of products that demonstrate creative and critical thinking as applied to learning both in and out of the classroom; and

c. The development of learning environments that guide students to become self-directed, independent learners.

5. Understanding and application of theories and principles of differentiating curriculum designed to match the distinct characteristics of gifted learners to the programs and curriculum offered to gifted students, including:

a. The integration of multiple disciplines into an area of study;

b. Emphasis on in-depth learning, independent and self-directed study skills and metacognitive skills;

c. The development of analytical, organizational, critical, and creative thinking skills;

d. The development of sophisticated products using varied modes of expression;

e. The evaluation of student learning through appropriate and specific criteria; and

f. The development of advanced technological skills to enhance student performance.

6. Understanding of contemporary issues and research in gifted education, including:

a. The systematic gathering, analyzing, and reporting of formative and summative data; and

b. Current local, state, and national issues and concerns.

7. Understanding of and proficiency in grammar, usage, and mechanics and their integration in writing.

8. The program shall include a practicum that shall include a minimum of 45 instructional hours of successful teaching experiences with gifted students in a heterogeneously grouped (mixed ability) classroom and a homogeneously grouped (single ability) classroom.

Statutory Authority

§ 22.1-298.2 of the Code of Virginia.

Historical Notes

Derived from Virginia Register Volume 23, Issue 25, eff. September 21, 2007.

Appendix C

VDOE Licensure Regulations for a Gifted Endorsement

8VAC20-23-370. Gifted Education (Add-On Endorsement).
Endorsement requirements. The candidate shall have:

1. Earned a baccalaureate degree from a regionally accredited college or university and hold a license issued by the Virginia Board of Education with a teaching endorsement in a teaching area;

2. Earned a baccalaureate degree from a regionally accredited college or university and completed an approved teacher preparation program in gifted education; or

3. Completed the following requirements:

a. Earned a baccalaureate degree from a regionally accredited college or university and hold a license issued by the Virginia Board of Education with a teaching endorsement in a teaching area; and

b. Completed 12 semester hours of graduate-level coursework in gifted education distributed in the following areas:

(1) Introduction and identification of giftedness: 3 semester hours;

(2) Social and emotional development and guidance of gifted learners: 3 semester hours;

(3) Curriculum and instructional strategies for gifted learners: 3 semester hours; and

(4) Advanced course work in one of the following areas: 3 semester hours:

(a) Advanced curriculum, instruction, and assessment design;

(b) Advanced program development and evaluation; or

(c) Advanced study in underrepresented populations; and

c. Completed a practicum of at least 45 instructional hours. This practicum shall include a minimum of 45 instructional hours of successful teaching experiences with gifted students in a public or an accredited nonpublic school. In lieu of the practicum, one year of successful, full-time teaching experience with gifted students in a public or an accredited nonpublic school may be accepted, provided the teacher is assigned a mentor holding a valid license with an endorsement in gifted education.

Statutory Authority

§§ 22.1-298.1 and 22.1-299 of the Code of Virginia.

Appendix D

Email Letter for Survey

Dear Virginia educator,

I am a doctoral student at Virginia Commonwealth University as well as a current elementary teacher of gifted students, and I am conducting a research study as part of my doctoral degree requirements. I am reaching out to Virginia elementary educators who teach gifted children in order to collect information about current instructional practices and self-efficacy or gifted teachers regarding STEM education.

My survey is entitled *Self-efficacy of endorsed and nonendorsed elementary teachers of gifted students in STEM education.* The survey will take approximately 20-30 minutes to complete and should be completed outside of the school day. As a thank you for your participation in this study, you can choose to be entered into a raffle for one of two Amazon $25 gift certificates. At the conclusion of the survey, you will be prompted to enter an email address if you wish to participate in the raffle. All email addresses entered will be kept separate from the survey data and will only be used as a raffle entry and for raffle notification purposes. Within two weeks of the survey's conclusion, raffle winners will be notified and an electronic gift certificate will be delivered via email to the winner's address.

Participating in this study is voluntary. You are free to decide not to participate at any time without penalty. You may also choose not to answer particular questions that are asked in the study.

By agreeing to participate in the study, you will be giving your consent for the researcher to include your responses in the data analysis. Data is being collected only for research purposes. No identifying information, such as your name, school, or school district, will be collected. Information regarding your grade level, years of experience, endorsement status, and recent STEM experience will be collected.

If you decide to participate in the study after reading this letter, you can begin the survey by clicking on this link: <insert link to survey>. Participation in the survey is considered consent for using your responses as part of my study. An informational letter regarding consent will appear on the first screen of the survey.

Thank you for taking the time to assist me with my doctoral research. The data collected will provide useful information regarding current instructional practices and self-efficacy regarding STEM in elementary classrooms.

If you have any questions or concerns about the research, please contact: Lianna Moss-Everhart at mossll@vcu.edu or my dissertation chair, Dr. Joan A. Rhodes, at jarhodes2@vcu.edu.

If you have any general questions about your rights as a participant in this or any other research, you may contact:

Office of Research
Virginia Commonwealth University
800 East Leigh Street, Suite 3000
Box 980568
Richmond, VA 23298
Telephone: (804) 827-2157

Thank you for your time and assistance.

Sincerely,
Lianna Moss-Everhart

Appendix E

Email Reminder Letter for Survey

Dear Virginia educator,

I am reaching out to you again in the hopes that you will consider completing the survey entitled *Self-efficacy of endorsed and nonendorsed elementary teachers of gifted students in STEM education.* If you have already participated, please disregard this email.

As a reminder, I am a doctoral student at Virginia Commonwealth University as well as a current elementary teacher of gifted students, and I am conducting a research study as part of my doctoral degree requirements. I am reaching out to Virginia elementary educators who teach gifted children in order to collect information about current instructional practices and self-efficacy or gifted teachers regarding STEM education.

The survey will take approximately 20-30 minutes to complete and should be completed outside of the school day. As a thank you for your participation in this study, you can choose to be entered into a raffle for one of two Amazon $25 gift certificates. At the conclusion of the survey, you will be prompted to enter an email address if you wish to participate in the raffle. All email addresses entered will be kept separate from the survey data and will only be used as a raffle entry and for raffle notification purposes. Within two weeks of the survey's conclusion, raffle winners will be notified and an electronic gift certificate will be delivered via email to the winner's address.

Participating in this study is voluntary. You are free to decide not to participate at any time without penalty. You may also choose not to answer particular questions that are asked in the study.

By agreeing to participate in the study, you will be giving your consent for the researcher to include your responses in the data analysis. Data is being collected only for research purposes. No identifying information, such as your name, school, or school district, will be collected. Information regarding your grade level, years of experience, endorsement status, and recent STEM experience will be collected.

If you decide to participate in the study after reading this letter, you can begin the survey by clicking on this link: <insert link to survey>. Participation in the survey is considered consent for using your responses as part of my study. An informational letter regarding consent will appear on the first screen of the survey.

Thank you for taking the time to assist me with my doctoral research. The data collected will provide useful information regarding current instructional practices and self-efficacy regarding STEM in elementary classrooms.

If you have any questions or concerns about the research, please contact: Lianna Moss-Everhart at mossll@vcu.edu or my dissertation chair, Dr. Joan A. Rhodes, at jarhodes2@vcu.edu.

If you have any general questions about your rights as a participant in this or any other research, you may contact:

Office of Research
Virginia Commonwealth University
800 East Leigh Street, Suite 3000
Box 980568
Richmond, VA 23298
Telephone: (804) 827-2157

Thank you for your time and assistance.

Sincerely,
Lianna Moss-Everhart

Vita

Lianna Lynn Moss-Everhart was born on August 26, 1982 in Goshen, New York and relocated to Virginia in 1990. She graduated from Culpeper County High School in 2000 and received her Bachelor of Arts in Sociology from the University of Virginia in 2004. In 2005, she received her Master of Teaching from the University of Virginia. She completed her gifted endorsement in 2010 and her administration and supervision endorsement in 2016. She taught in Hanover County Public Schools from 2005-2018 as an elementary school classroom teacher and Gifted Resource teacher. She entered Henrico County Public Schools in 2018 and served as a Resource Teacher and Associate Principal.