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## Self-Efficacy of Early Childhood Teachers in Science, Technology, Engineering, and Mathematics

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Self-Efficacy of Early Childhood Teachers in Science, Technology, Engineering, and

Mathematics

A Dissertation by

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Brandman University

Irvine, California

School of Education

Submitted in partial fulfillment of the requirements for the degree of

Doctor of Education in Organizational Leadership

June 2018

Committee in charge:

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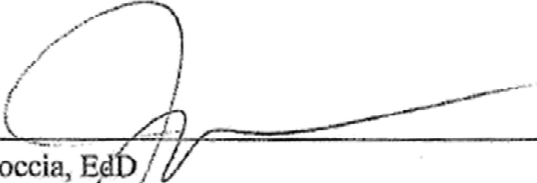
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Self-Efficacy of Early Childhood Teachers in Science, Technology, Engineering, and  
Mathematics

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## ABSTRACT

Self-Efficacy of Early Childhood Teachers in Science, Technology, Engineering, and Mathematics

by Ariella Rachel Donnelley Smith

**Purpose.** The purpose of this study was to identify the self-efficacy of early childhood teachers toward STEM subjects as measured on the Teacher Efficacy and Attitudes toward STEM Survey (T-STEM) and to explore factors that influence this confidence.

**Methodology.** A quantitative approach with two open-ended items was selected for this study, seeking to elicit both quantitative and qualitative data from participants. This approach allowed for multiple viewpoints to be expressed, with the qualitative data collected simultaneously with the quantitative data, and the former designed to illuminate reasons influencing the latter in a complimentary approach. The population for the study included teachers working at schools affiliated with the Northwest Association of Independent Schools who taught children aged three to eight years.

**Findings.** Examination of data revealed ten major findings. Three of these, a tendency toward neutrality, indications of low levels of self-efficacy of early childhood teachers in teaching STEM subjects, and a resistance to evaluation by a colleague, were identified by the survey. Three of these, a lack of experience/education/training, a lack of time/resources/materials, and the diminished value of the role of STEM were identified as barriers to feelings of self-efficacy. The final four findings, collaboration, professional development opportunities, opportunities for integration and hands-on practice across the school day, and access to curriculum and materials were identified as positive influences on self-efficacy.

**Conclusions.** Based on the data, it was concluded that teachers had low levels of self-efficacy in teaching STEM subjects and explicit instruction in STEM subjects and instructional techniques helped build confidence. The presence of supportive and collaborative colleagues, as well as high perceptions of the importance of STEM in early childhood education also supported feelings of self-efficacy.

**Recommendations.** Further research is recommended to explore the effectiveness of professional development for early childhood educators in STEM, the role of the collegial relationship, and specifically the mentor/novice relationship. Additionally, further research into the intersection of collaboration and professional development as well as the role of integrated learning in early childhood is recommended.

## TABLE OF CONTENTS

CHAPTER I: INTRODUCTION.....	1
Background.....	4
STEM Education.....	4
Early Childhood Education.....	5
Teacher Confidence .....	6
Teacher Confidence in Early Childhood Education .....	7
Teacher Confidence in STEM Education .....	8
STEM Education and Early Childhood Education .....	9
Statement of the Research Problem .....	10
Purpose Statement.....	12
Research Questions.....	12
Significance of the Problem.....	12
Definitions.....	13
Delimitations.....	14
Organization of the Study .....	14
 CHAPTER II: REVIEW OF THE LITERATURE .....	 16
STEM Education.....	16
A History of STEM Education .....	17
The Value of Education in STEM Subjects.....	18
Professional Development in STEM Subjects.....	20
Early Childhood Education.....	21
A History of Early Childhood Education.....	22
The Value of Early Childhood Education.....	24
Professional Development in Early Childhood Education .....	26
The Intersection of STEM and Early Childhood Education.....	27
Professional Development in STEM Subjects in Early Childhood Education .....	29
Professional Development for Early Childhood Teachers in Science.....	31
Professional Development for Early Childhood Teachers in Technology .....	33
Professional Development for Early Childhood Teachers in Engineering.....	36
Professional Development for Early Childhood Teachers in Mathematics.....	39
The Role of Efficacy.....	41
Self-Efficacy .....	42
Teacher Self-Efficacy .....	44
Teacher Efficacy in Early Childhood .....	48
Teacher Confidence Levels in STEM Subjects in Early Childhood Education .....	48
Conclusions.....	50
 CHAPTER III: METHODOLOGY .....	 51
Purpose Statement.....	51
Research Questions.....	52
Research Design.....	52
Method .....	54
Population .....	55



Sample.....	55
Instrumentation .....	57
Reliability and Validity.....	58
Data Collection .....	59
Data Analysis .....	61
Limitations .....	62
Summary.....	62
 CHAPTER IV: RESEARCH, DATA COLLECTION, AND FINDINGS.....	 63
Purpose Statement.....	63
Research Questions.....	63
Research Methods and Data Collection Procedures .....	64
Population .....	65
Sample.....	65
Demographics .....	65
Presentation and Analysis of Quantitative Data .....	66
Data Analysis for Research Question One.....	66
Summary Analysis for Research Question One.....	95
Presentation and Analysis of Qualitative Data .....	96
Intercoder Reliability .....	97
Data Analysis for Research Question Two.....	97
Data Analysis for Research Question Three.....	99
Collaboration.....	101
Professional Development Opportunities .....	101
Opportunities for Integration and Hands on Practice Across the School Day....	102
Access to Curriculum and Materials.....	102
Summary.....	103
 CHAPTER V: FINDINGS, CONCLUSIONS, AND RECCOMENDATIONS .....	 105
Purpose Statement.....	105
Research Questions.....	105
Methodology Review .....	106
Major Findings.....	107
Major Findings from Research Question 1 .....	107
Major Findings from Research Question 2 .....	109
Major Findings from Research Question 3 .....	110
Unexpected Findings .....	112
Conclusions.....	113
Implications for Action.....	116
Recommendations for Further Research.....	119
Concluding Remarks and Reflections.....	120
 REFERENCES .....	 122
 APPENDICES .....	 139

## LIST OF TABLES

Table 1. Statement Means in Descending Order .....	96
Table 2. Frequency of Themes for Research Question 2.....	97
Table 3. Frequency of Themes for Research Question 3.....	100

## LIST OF FIGURES

Figure 1. Project growth in STEM professions .....	17
Figure 2. Rate of return on investment in human capital.....	25
Figure 3. Inquiry theory for young children. ....	32
Figure 4. Responses to statement 1 for all teachers.....	67
Figure 5. Responses to statement 1 for teachers of 3- and 4-year-olds. ....	68
Figure 6. Responses to statement 1 for teachers of 5- and 6-year-olds. ....	68
Figure 7. Responses to statement 1 for teachers of 7- and 8-year-olds. ....	69
Figure 8. Responses to statement 2 for all teachers.....	70
Figure 9. Responses to statement 2 for teachers of 3- and 4-year-olds. ....	70
Figure 10. Responses to statement 2 for teachers of 5- and 6-year-olds. ....	71
Figure 11. Responses to statement 2 for teachers of 7- and 8-year-olds. ....	71
Figure 12. Responses to statement 3 for all teachers.....	72
Figure 13. Responses to statement 3 for teachers of 3- and 4-year-olds. ....	73
Figure 14. Responses to statement 3 for teachers of 5- and 6-year-olds. ....	73
Figure 15. Responses to statement 3 for teachers of 7- and 8-year-olds. ....	74
Figure 16. Responses to statement 4 for all teachers.....	75
Figure 17. Responses to statement 4 for teachers of 3- and 4-year-olds. ....	75
Figure 18. Responses to statement 4 for teachers of 5- and 6-year-olds. ....	76
Figure 19. Responses to statement 4 for teachers of 7- and 8-year-olds. ....	76
Figure 20. Responses to statement 5 for all teachers.....	77
Figure 21. Responses to statement 5 for teachers of 3- and 4-year-olds. ....	78
Figure 22. Responses to statement 5 for teachers of 5- and 6-year-olds. ....	78

Figure 23. Responses to statement 5 for teachers of 7- and 8-year-olds. ....	79
Figure 24. Responses to statement 6 for all teachers. ....	80
Figure 25. Responses to statement 6 for teachers of 3- and 4-year-olds. ....	80
Figure 26. Responses to statement 6 for teachers of 5- and 6-year-olds. ....	81
Figure 27. Responses to statement 6 for teachers of 7- and 8-year-olds. ....	82
Figure 28. Responses to statement 7 for all teachers. ....	82
Figure 29. Responses to statement 7 for teachers of 3- and 4-year-olds. ....	83
Figure 30. Responses to statement 7 for teachers of 5- and 6-year-olds. ....	84
Figure 31. Responses to statement 7 for teachers of 7- and 8-year-olds. ....	84
Figure 32. Responses to statement 8 for all teachers. ....	85
Figure 33. Responses to statement 8 for teachers of 3- and 4-year-olds. ....	86
Figure 34. Responses to statement 8 for teachers of 5- and 6-year-olds. ....	86
Figure 35. Responses to statement 8 for teachers of 7- and 8-year-olds. ....	87
Figure 36. Responses to statement 9 for all teachers. ....	88
Figure 37. Responses to statement 9 for teachers of 3- and 4-year-olds. ....	88
Figure 38. Responses to statement 9 for teachers of 5- and 6-year-olds. ....	89
Figure 39. Responses to statement 9 for teachers of 7- and 8-year-olds. ....	90
Figure 40. Responses to statement 10 for all teachers. ....	90
Figure 41. Responses to statement 10 for teachers of 3- and 4-year-olds. ....	91
Figure 42 Responses to statement 10 for teachers of 5- and 6-year-olds. ....	92
Figure 43. Responses to statement 10 for teachers of 8- and 9-year-olds. ....	92
Figure 44. Responses to statement 11 for all teachers. ....	93
Figure 45. Responses to statement 11 for teachers of 3- and 4-year-olds. ....	94

Figure 46. Responses to statement 11 for teachers of 5- and 6-year-olds. ....	94
Figure 47. Responses to statement 11 for teachers of 7- and 8-year-olds. ....	95
Figure 48. Summary of major findings.....	107

## CHAPTER I: INTRODUCTION

Across the United States, conversations about education abound in political, professional, and personal arenas. In January 2015, U.S. Secretary of Education Arne Duncan called for the reauthorization of 1965s Elementary and Secondary Education Act. He said in a speech to a joint session of congress that America is at an educational crossroads. stating we must celebrate “America’s real progress toward full educational opportunity” while also recognizing the need for legislation that supports the continuation of that progress (Duncan, 2015). The questions that arise from this perspective are discussed in classrooms, gathering places, and around family dinner tables with passion. The question becomes what is next for education in America and what is needed to assure that every child can access high-quality educational opportunities that support their future success.

Although education includes many complex facets, several emerged over the last decade as having a direct impact on 21<sup>st</sup> century learners. Of these, three of the most widely debated in educational and political arenas are the role of early childhood education; education in the disciplines of science, technology, engineering, and math (collectively known as STEM); and teacher preparation. Each of these areas independently contribute to a significant part of the conversation about successful education in this country, and the areas where they overlap are sorely under researched. This study addressed the intersection of all three areas and provided recommendations for supporting teacher preparation of early childhood teachers in STEM subjects.

The importance of providing a child with a strong foundation for their future educational endeavors through a robust early childhood program emerged as a vital need

in the past decade (Schweinhart, 2007). In that same speech to congress, Secretary Duncan stressed that “every single child must have a strong start in life through high-quality preschool” (Duncan, 2015). With *preschool for all* initiatives being launched by The White House (2013, 2014), a focus on early childhood programs that get all children started on the right foot is becoming more of a reality.

These initiatives included authorizing the U.S. Department of Education to allocate funds toward school districts and partner organizations that offer high-quality preschool programs to four-year old children from low- to moderate-income households (Slack, 2013; White House, 2013). It also offered incentives for districts that choose to implement full day kindergarten programs. Funding was also available to increase access to Early Head Start and home visitation programs across the country that support the health and development of young children before they enter preschool (Slack, 2013).

Education that focuses on the skills and behaviors needed to move into STEM careers emerged as a critical focus for America’s schools. STEM education, and its connection to a robust workforce in these fields, receives significant attention in educational and political arenas. A 2013 report from the Committee on STEM Education stated, “it is essential that the United States enhance U.S. students’ engagement in STEM disciplines” (p. vi). At a time when the projected workforce need for STEM careers are expected to increase significantly, the level of interest in these careers from American students is falling drastically (U.S. Department of Education, 2015b). It is the responsibility of the American educational system to respond to these needs.

How to effectively support teachers in the ongoing refinement of their practice is another important focus area in education. This can be achieved through professional

development internally within a school, externally through professional organizations and resources, and through informal experiences (Darling-Hammond & Sykes, 1999; Gomez, Kagan, & Fox, 2015). Having well-prepared teachers is an essential factor in the success of a school and has an immeasurable impact on individual students. Many factors contribute to a well-prepared teacher, including the confidence of the teacher in his or her abilities (Moore, 1952). For over half a century, the role of confidence in successful teaching has been studied. “Only teachers who are self-confident and competent can work creatively with children and youth” asserted a decades-old article on effective teaching (Moore, 1952, p. 1). More recent studies concurred that teachers who were confident in their abilities in all content areas and their knowledge of the content had increased student success (Chen, McCray, Adams, & Leow, 2014; Nadelson et al., 2013). One of the major challenges of the educational system in the United States is assuring teachers are well-prepared. An integral piece of this is having well-established, firmly rooted confidence and perceptions of their own efficacy.

STEM education, early childhood education, and teacher confidence levels are all areas ripe with opportunities for in-depth research. The spaces where they intersect are especially relevant. Teacher preparation in early childhood education and teacher preparation in STEM education are major areas of focus for those interested in adequately preparing teachers to support successful students. The role of STEM education in an early childhood classroom has only begun to be deeply explored in the last five years, as it became evident that attitudes and behaviors learned young have a lasting impact on students. This study investigated the space where all three of these



important topics intersect and sought to offer insight into the confidence levels of teachers of young children as they delve into STEM subjects.

### **Background**

Each of the topics of STEM education, early childhood education, and teacher confidence levels, as determined by their self-efficacy perceptions, provide multiple opportunities to consider diverse thoughts, emerging trends, and various pathways to understanding. The National Education Association (NEA; 2015) listed both early childhood education and STEM subjects on its list of current educational issues. Although it did not specifically name teacher confidence levels as one of these issues, three other issues on the list addressed the role of the teacher in effective education (NEA, 2015). As such, the exploration of these topics was timely, relevant, and had the potential to positively impact the field of education.

### **STEM Education**

In 2009, President Obama launched the *Educate to Innovate* initiative to provide students with the skills needed to succeed in STEM subjects (Garg, 2010). This program worked to bolster federal involvement in STEM through funding and policy decisions. The need for qualified individuals in STEM careers is growing, with the need for biomedical engineers increasing 62% between 2010 and 2020 (U.S. Department of Education, 2015b). At the same time, only 16% of high school graduates in the United States express an interest in STEM careers (U.S. Department of Education, 2015b). This gap could be addressed by a focus on STEM subjects throughout K-12 education.

STEM subjects support the development of skills, behaviors, and habits of mind necessary for success in the 21<sup>st</sup> century and beyond (Donnelly, 2008; Feder, Pearson,

Katehi, 2009; National Research Council, 2011). These include systems thinking, creativity, optimism, collaboration, communication, and attention to ethical concerns (Feder et al., 2009). As the world becomes more connected through technology and the global marketplace, preparing students in these perspectives is essential (Committee on STEM Education, 2013).

### **Early Childhood Education**

High-quality early education makes both logical sense and financial sense. The Perry Preschool Study (2007) found a 7% to 10% return on the financial investment in preschool based on increased school and career achievement. Studies of students who participated in early childhood education programs found that those children scored higher on achievement tests later in school and had higher high school graduation rates than their counterparts who began schooling later (Schweinhart, 2007; U.S. Department of Education, 2015a). Currently, fewer than 40% of four-year old children in the United States are enrolled in high-quality preschool programs, despite a significant push in government at the local, state, and national levels to address this (U.S. Department of Education, 2015a).

The contexts of early childhood education are rapidly evolving, with the complex landscape of programs challenging attempts at evaluation and standardization (*Nurturing STEM skills in Young Learners, PreK - 3*, 2013). Early childhood education centers are diverse and funded from a wide variety of sources, beginning with home day cares, Head Start programs, and privately funded child care centers in the early years and progressing to public, independent, and parochial schools as K-3 options. This complex delivery system of early childhood education includes both private and government-funded

preschool settings (*Nurturing STEM skills in Young Learners, PreK - 3*, 2013). The diversity and lack of cohesive accountability reiterates the need for clear parameters on the factors that provide a quality early childhood education (Moomaw & Davis, 2010; National Association for the Education of Young Children [NAYCE], 2005).

Even with this environment of diverse care provider systems and rapid change in the awareness and availability of care, the commitment to quality early childhood education is growing. In January 2015, U.S. Secretary of Education Arne Duncan emphasized the need for every family in America to have an opportunity for a strong start in life through attending a quality preschool. Secretary Duncan (2015) proposed a reauthorized Elementary and Secondary Education Act, which would be expanded to reflect the importance of early childhood education by including funding for its development an oversight. Non-government organizations are also working to encourage an increase in access to quality early childhood programs. In Washington State, the Bill and Melinda Gates Foundation partners with government and private enterprise to ensure high-quality early learning opportunities by funding promising early childhood programs and advocating for legislation to support expanding access to programs that help children enter elementary school ready to succeed (U.S. Department of Education, 2015b).

### **Teacher Confidence**

Teacher confidence in the subject matter they teach and their own beliefs about their efficacy are important factors in the success of their students on competency assessments (Chen et al., 2014). Chen et al. (2014) also found confidence was not entirely dependent on knowledge of subject matter, but other factors influenced its development. For example, a teacher who employed coping mechanisms, such as avoiding topics for

which they felt less effective to compensate for their lack of confidence, could negatively impact student learning (Chen et al., 2014; Ertmer & Ottenbreit-Leftwich, 2010).

Teacher confidence levels are informed by a wide variety of factors, including experience gained in their pre-service schooling, interaction between colleagues and professional organizations, and their feelings about managing student learning (Kidd, 2014). Teacher confidence in their ability to teach the subject matter is also informed by their confidence with the content in a specific area (Chen et al., 2014). In a 2001 study of fourth grade students and their teachers, Stipek, Givvin, Salmon, and MacGyvers (2001) found that teacher math self-confidence was significantly correlated with student confidence in themselves as math learners (Stipek, Givvin, Salmon, & MacGyvers, 2001). This emphasized the importance of strong subject matter confidence levels among teachers.

### **Teacher Confidence in Early Childhood Education**

Early childhood educators come from a variety of backgrounds and teach in a wide range of settings (NAEYC, 2005). Despite this, studies showed consistency in the skills, behaviors, attitudes, and beliefs that led to effective early childhood teaching in all settings (Saracho, 2012). Several regulatory bodies, including the NAEYC (2005) and the NBPTS (2012), set forth standards for the identification and support of effective early childhood teachers. These standards outline many factors that influence effective teaching, including the importance of teacher confidence in their teaching skills and content knowledge.

The role of teacher confidence levels in supporting early childhood student learning was the focus of several studies (Chen et al., 2014; Garbett, 2003; Stipek et al.,

2001). These showed teacher confidence levels had a measurable impact on student learning. In particular, when students were exposed to a teacher with low confidence in a subject area, the students demonstrated increased anxiety in that subject area (Chen et al., 2014). Although the relationship between teacher confidence and student achievement was not limited to early childhood, its impact on these young children was meaningful to their future school experiences (Nuttall, 2014).

### **Teacher Confidence in STEM Education**

As interest in STEM education grew, developing effective teacher support programs has been one major area of focus (Nadelson et al., 2013). Professional development in STEM education was especially important for early education and elementary schools teachers of children where subject-specific teaching assignments were more rare (Honardoost, 2014). Finding or developing programs to support teachers in self-contained classrooms teaching all aspects of the curriculum to become more adept at teaching STEM subjects has been challenging, but studies showed that improving subject area confidence had positive results in improving student achievement (Appleton, 1995; Beatty, 2011; Ertmer & Ottenbreit-Leftwich, 2010; Smith, Douglas, & Cox, 2009; Wimsatt, 2012).

Teacher confidence in STEM education could be influenced in two major areas, content knowledge and pedagogy. As teacher comfort levels with the information they were attempting to convey to students increased, their confidence in their own content knowledge grew, which positively impacted student learning (Stipek et al., 2001; Wimsatt, 2012). Low confidence in content knowledge could be addressed through effective pre-service teaching training programs by offering STEM courses aimed at

teachers, and by promoting a collegial environment where a lack of knowledge was freely discussed (Feder et al., 2009; Munck, 2007; Stipek et al., 2001).

The second area where teacher confidence in STEM education could be effectively influenced was in their STEM teaching methods. These methods include project-based learning, experiential opportunities, and learning experiences that promote collaboration and communication among students. Even teachers with high levels of confidence in their content knowledge could have low levels of STEM pedagogical confidence due to a lack of comfort with STEM teaching methods (Harlen & Holroyd, 1997; Honardoost, 2014). Increasing professional development in delivery methods such as project-based learning and inquiry teaching practices could help teachers develop confidence in this area of STEM education (Smith et al., 2009).

### **STEM Education and Early Childhood Education**

Young children are avid and eager STEM learners. They are inquisitive, curious, and naturally explore the world around them through hands-on activities (Brownrigg, Carey, & Fredericks, 2013). Since they are less focused on appearances and peer relationships, they often take more cognitive risks than their pre-adolescent and adolescent counterparts. They also bring less pre-conceived notions to their explorations. Young children are able to truly play with new knowledge and experiences, which was considered key to developing the habits of mind essential to successful STEM learning (Brownrigg et al., 2013; Katz, 2010; Moomaw & Davis, 2010; *Nurturing STEM skills in Young Learners, PreK - 3*, 2013) .

The acquisition of STEM skills by young children may look different. Thematic or project-based learning activities are used more often with young children, leading to

greater integration of distinct subject area topics (Brenneman, Stevenson-Boyd, & Frede, 2009; Garbett, 2003; Ricks, 2012). Play was considered an important venue for STEM learning in early education. “Tomorrow’s engineers are building bridges in the block corner today. Tomorrow’s scientists are doing ‘field work’ at recess, inspecting the structure of a fallen leaf” (*Nurturing STEM skills in Young Learners, PreK - 3*, 2013). The level of dialogue promoted in the classrooms of young children also provides an ideal environment for STEM learning (Brownrigg et al., 2013). The sense of inquiry and wonder that young children bring to each day can be nurtured to help them retain curiosity and explore new stimuli safely using all of their senses (Moomaw & Davis, 2010). Teachers of young children are an essential component to providing appropriate environments for effective STEM learning.

### **Statement of the Research Problem**

In recent years, the role of early education in a child’s development received a great deal of attention by the government and media. Current research on brain development supports the value of high-quality early childhood education programs (Brownrigg et al., 2013; Rushton & Juola-Rushton, 2011). Concurrently, the role of STEM subjects has become a political focus for educational policymakers. According to the United States Department of Education (n.d.), President Obama made STEM education a priority, including over \$300 million dollars toward initiatives to advance it in the 2015 fiscal year budget.

Increased success in early childhood education and STEM education both have the potential to impact the field of education for the next generation (U.S. Department of Education, 2015b; NAEYC, 2005; STEM Education Coalition, 2015). Independently,

early childhood education research and STEM education research are both areas of increasing importance and relevance. Research in the intersection of the two is in its infancy, but vital. “Ensuring every child has a high-quality early STEM education is one of the best investments our country can make” (*Nurturing STEM skills in Young Learners, PreK - 3*, 2013, p. 4). Although several researchers looked at what constitutes a developmentally appropriate STEM curriculum for young children (Brownrigg et al., 2013; Katz, 2010; Moomaw & Davis, 2010; *Nurturing STEM skills in Young Learners, PreK - 3*, 2013), little has been done to assess the needs of classroom teachers in providing quality early childhood STEM education.

For some time it has been accepted that low teacher confidence can have a negative impact on student learning (Harlen & Holroyd, 1997). Due in part to inconsistency in teacher preparation programs for early childhood educators, teachers of young children may be especially susceptible to low confidence in STEM education (*Nurturing STEM skills in Young Learners, PreK - 3*, 2013). Additionally, teacher attitude was a key factor in effective learning and confidence levels had a direct impact on developing attitudes toward subject matter (Munck, 2007).

STEM education in early childhood classrooms developed over the last five years into a relevant and well-researched topic (Katz, 2010; Moomaw & Davis, 2010; *Nurturing STEM skills in Young Learners, PreK - 3*, 2013; Ricks, 2012). Additionally, a growing movement aims to support K-12 educators in more effective STEM teaching by researching their attitudes toward it and how to influence those attitudes (Beatty, 2011; Nadelson et al., 2013; National Research Council, 2011; Smith et al., 2009; Teo & Ke, 2014). A gap in the research exists where these topics intersect, as research could not be



found that specifically focused on identifying and examining early childhood teachers' attitudes toward their teaching of STEM subjects.

### **Purpose Statement**

The purpose of this study was to identify the self-efficacy of early childhood teachers toward STEM subjects as measured on the Teacher Efficacy and Attitudes toward STEM Survey (T-STEM; Friday Institute for Education Innovation [FIEI], 2012) and to explore factors that influence confidence in teaching STEM.

### **Research Questions**

This study sought to address the following research questions:

1. What is the degree of self-efficacy of early childhood teachers in STEM subjects as measured by the T-STEM (FIEI, 2012)?
2. What factors do early childhood teachers identify as barriers to increased confidence in teaching STEM subjects?
3. What factors do early childhood teachers identify as positively influencing their confidence in teaching STEM subjects?

### **Significance of the Problem**

This study sought to identify early childhood educators' level of confidence in teaching STEM subjects and to explore the factors that contribute to confidence levels. By identifying trends that lead to increased teacher confidence, this study added to the growing body of research guiding professional development in STEM subjects. Specifically targeting early childhood educators, this study aimed at exploring the intersection of early childhood and STEM education, providing specific feedback on effective strategies for supporting this demographic of early childhood teachers.

The results of this study could be used to develop more effective professional development for early childhood educators in STEM, a need identified by several researchers (Brenneman et al., 2009; Katz, 2010; Moomaw & Davis, 2010; Nadelson et al., 2013). The results could also support the identification and evaluation of existing professional development offerings for early childhood teachers. Additionally, the results could be used in a more general sense to support the growing body of research aimed at understanding the role of teacher confidence in effective teaching. Increased research in this area was recommended to examine the factors that influence quality teaching (Appleton, 1995; Ertmer & Ottenbreit-Leftwich, 2010; Harlen & Holroyd, 1997). Another possible application of the results of this study could be to compare the results to similar research into the attitudes of teachers of older children toward STEM subjects to identify potential trends. These trends may be helpful in developing comprehensive perspectives and standards for STEM teachers aligned from early childhood through post-secondary education.

This study delved into the intersection of early childhood education, STEM education, and the role of teacher confidence in classrooms. Research into each of these areas independently yielded significant and meaningful results with a direct impact on many facets of education (U.S. Department of Education, 2015b). By exploring the area where these three important areas overlap, this study produced more targeted information that could enhance each area independently and collectively.

### **Definitions**

**Early Childhood Educator.** A teacher whose students are between three and eight years old.

**Level of Confidence.** A measure of self-efficacy as reported on the T-STEM.

**National Association of Independent Schools (NAIS).** A nonprofit membership association that provides services to more than 1,800 schools and associations of schools in the United States and abroad, including more than 1,500 independent private K-12 schools in the U.S. ("NAIS - National Association of Independent Schools," 2015).

**Northwest Association of Independent Schools (NWAIS).** A division of NAIS comprised of schools in Alaska, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming ("Northwest Association of Independent Schools," 2015).

**Personal STEM Teaching Efficacy Belief Scale.** A measure consisting of Likert-scale questions that about confidence in teaching skills in the areas of STEM education (FIEI, 2012).

**STEM Education.** Teaching and learning in the fields of science, technology, engineering, and mathematics (Gonzalez & Kuenzi, 2012).

### **Delimitations**

This study examined the confidence levels of early childhood teachers in the teaching of STEM subjects. It was delimited to individuals who anonymously responded to a survey offered to classroom teachers of children aged three to eight years old in schools affiliated with NWAIS for the 2016-17 school year.

### **Organization of the Study**

Chapter I presented an overview and the significance of this study. Chapter II reviews the relevant existing literature on early childhood education, STEM education, and teacher confidence levels. It also presents literature exploring areas of intersection for these topics. Chapter III describes the research methods undertaken in this study,

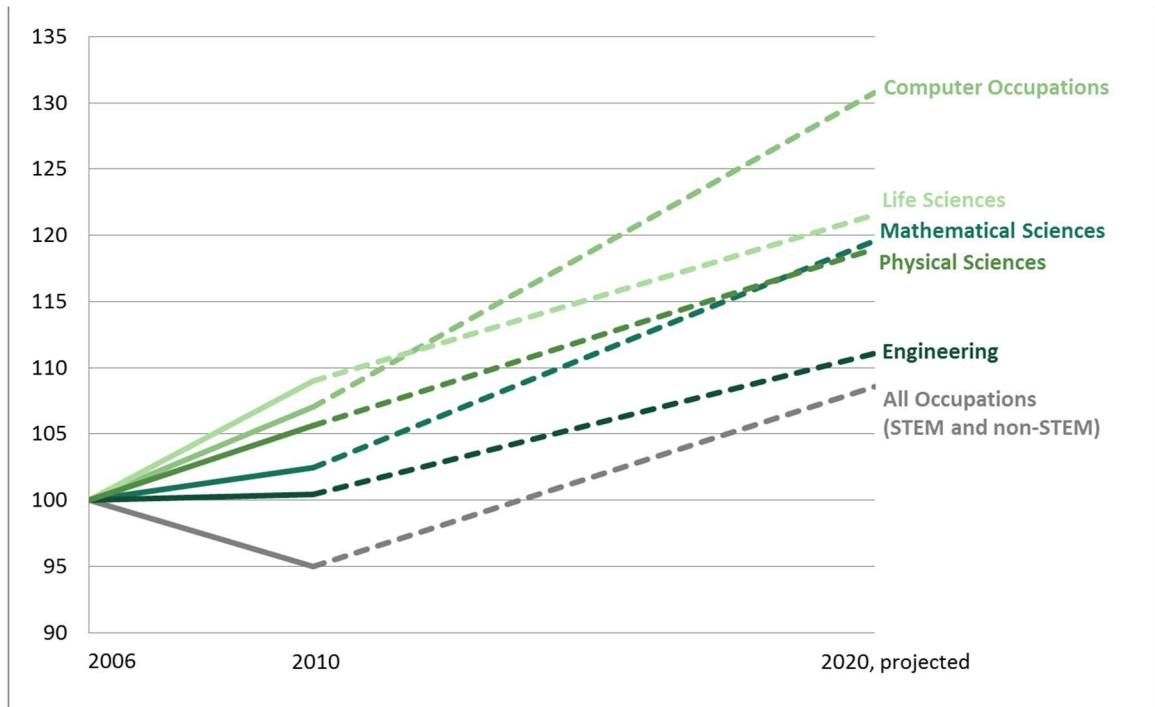
including the population, sample, data collection procedures, instrument, study methodology, and data analysis methods. Chapter IV reports the findings of the study, including the responses to the survey given to participants, and summarizes the study's findings. Chapter V connects the findings of the study with the current literature and includes conclusions, implications for action, and recommendations for further research.

## CHAPTER II: REVIEW OF THE LITERATURE

Questions regarding early childhood teacher confidence levels in teaching science, technology, engineering, and mathematics (STEM) subjects sit within a conceptual framework fashioned from the research of many scholars. To establish this framework and build an understanding of why the research questions were worthy of intensive scrutiny, this chapter explores that research. It reviews relevant studies based on establishing the landscape of STEM education, early childhood education, and their intersection. The relevance to this study is thoroughly grounded in the review of research literature influencing this study.

### **STEM Education**

The importance of a foundational education in STEM for all students is also a central premise of this study. It is believed these subjects form the core of every growing capacity for progress and change. Without them, student capacity for success in an ever-changing global economy would be diminished and students would be less inclined to nurture inquiry, innovation, and experimentation. STEM subjects offer students the opportunity to practice 21<sup>st</sup> century skills in an integrated and meaningful way (Hilton, 2010). They also present the most likely areas of projected job growth into the next decade (Bybee, 2010). As evidenced by Figure 1, job growth is projected to grow across all STEM professions, with some STEM careers experiencing growth at twice the rate of other professions (Bybee, 2010).



*Figure 1.* Project growth in STEM professions. Source: Bureau of Labor Statistics (2006), as cite by Bybee (2010).

### **A History of STEM Education**

With the Soviet Union’s launch of the Sputnik space craft in 1957 and the associated “Space Race” between the USSR and United States, a great deal of focus was placed on math and science education in the American school system. This was backed by funding from President Eisenhower with the 1958 National Defense Education Act, designed to boost spending in math and science education (Donnelly, 2008). In the decades that followed, the focus of education reform shifted from these topics to other worthy endeavors (Bybee, 2010). STEM education did not take the spotlight again until the turn of the century. The term STEM originated from the National Science Foundation in the 1990s and was used to generically refer to any event, policy, program, or practice

involving one or more of the disciplines of science, technology, engineering, or math (Bybee, 2010).

The 2001 passage of the No Child Left Behind Act focused on improving test scores in reading, writing, and mathematics. However, without an assessment for scientific aptitude, many felt it lack in its attentiveness to STEM topics (Donnelly, 2008). A breakthrough in policy and funding for STEM education came in 2006, when in President George W. Bush's State of the Union address, he announced the American Competitiveness Initiative, which set a goal of recruiting more college and university students to study STEM subjects.

This shift in policy to support STEM education continued in 2007 with the passage of the America Competes act by Congress (Gonzalez & Kuenzi, 2012). This piece of legislation included \$43.3 billion for STEM education between 2008 and 2010. It was reauthorized in 2010 to give two additional years of government funding to organizations supporting STEM learning endeavors (Gonzalez & Kuenzi, 2012). With this support in place, the years since 2007 were a time of transformational change for STEM education in early childhood through post-doctoral studies. Most recently, the Every Student Succeeds Act signed by President Obama in December 2015 contained STEM-specific language including required math and science standards, professional development for STEM educators, and funding specified for STEM learning (STEM Education Coalition, 2015).

### **The Value of Education in STEM Subjects**

The *STEM Education Strategic Plan* (U.S. Department of Education, 2013) answered the question, "Why does STEM education matter?" in this way:

Numerous advances, from mapping the human genome to discovering water on Mars to developing the Internet, would not have been possible without a skilled and creative STEM workforce. New technologies and STEM knowledge lie at the core of our ability to manufacture better, smarter products, improve health care, preserve the environment, and safeguard national security. Individuals prepared with the skills and knowledge to invent, build, install, and operate those new technologies are essential. In addition, a basic understanding of STEM topics and concepts is necessary beyond the workplace for citizens to make informed decisions on issues that are increasingly at the center of local and national political debates, such as environmental regulation. STEM literacy is also critical when it comes to making sound personal consumer choices, from health-care decisions to purchases at the grocery store. (para. 17)

This passage illuminated the widespread impact of education in STEM topics, both for individuals and society. STEM education goes beyond subject area topics and content knowledge, serving as a place where core 21<sup>st</sup> century skills can develop and thrive (Bybee, 2010). These skills, which focus more on habits of thinking and communicating such as innovation and collaboration, can be applied to a quickly changing world (Binkley et al., 2012). In STEM classrooms, value is placed on participation and the student engaging deeply with the content, wrestling with ideas and forming conclusions not necessarily predetermined by the instructor (Yager, 2015).

Teaching that supports the development of these patterns of thought requires a different set of skills and presents a unique set of challenges (Smith et al., 2009; Teo &



Ke, 2014). Opening students up to divergent thinking, making space and time for creativity in the classroom, and expecting effective teamwork as students work together are all patterns not often found in traditional classroom settings where conformity, order, and individuality are often prized. Yet, these approaches, where classrooms become labs for innovation and collaboration, are exactly often lead to successful STEM environments (National Research Council, 2011).

### **Professional Development in STEM Subjects**

An association between a teacher's preparation to teach STEM subjects and student achievement in STEM subjects was found, but often teachers were hampered by their constrained background knowledge, confidence, and sense of efficacy in STEM subjects (Nadelson et al., 2013). Professional development programs for teachers was determined to be an effective way of addressing these concerns and had a positive impact on increasing student achievement (Nadelson et al., 2013).

One of the challenges facing designers of professional development programs for STEM teachers is the diversity of material across STEM subject areas (Hanson & Carlson, 2005; Rockland et al., 2010). Although concepts and practices unify disciplines of STEM, each has distinct skill sets teachers need to develop. The need to attend to the intersection of disciplines led to a focus on STEM education and the distinctive nature of each discipline in isolation, assuring developing effective professional development in these areas will be a complex process (Hanson & Carlson, 2005; Rockland et al., 2010).

In the quest to provide relevant, high-quality professional development for teachers in STEM subjects, a wide range of modalities were employed. These ranged from traditional professional development delivery models such as workshops and

lectures, to other opportunities that immersed teachers in STEM experiences, such as video game-based training and hands-on design experiences. Several peer-to-peer professional development movements, including synchronous chats on platforms such as Google Hangouts or Twitter, were also aimed at raising student achievement by increasing teacher's knowledge and skills in STEM subjects (Hayden, Ouyang, Scinski, Olszewski, & Bielefeldt, 2011; Patton, Parker, & Tannehill, 2015; Penuel, Fishman, Yamaguchi, & Gallagher, 2007).

In 2014, the National Science Teachers Association explored the pathways to effective professional development in their publication *Models and Approaches to STEM Professional Development* (Wojnowski & Pea, 2014). This guide explored the importance of professional development to support teachers of all experience levels and with students of all grade levels to effectively gain and refine the necessary skills to teach STEM subjects. Most of the articles, however, focused on STEM subject teaching in and professional development for teachers of upper elementary, middle, and high school. Professional development for early childhood teachers in STEM subjects was woefully underrepresented in the literature, reinforcing the need for studies to establish the importance of work in this area.

### **Early Childhood Education**

Early childhood education refers to the teaching of children three to eight years of age in formal settings such as child development centers, preschools, and elementary schools (NBPTS, 2012). During this critical time in a child's life, their understanding of and relationship to schooling is formed, often by the teachers leading them. The United States is in a process of great change and transition in its cultural understanding of the

value of effective education during these pivotal years (Ritblatt, Garrity, Longstreth, Hokoda, & Potter, 2013). More emphasis is being placed on quality early learning experiences for all children. Early childhood education professionals are charged with facilitating the transition from the world of home and family to the complex world of the educational system.

### **A History of Early Childhood Education**

The history of early childhood education can be traced back to ancient times, with societies predating the Greeks and Romans demonstrating value in children and preparing them for adulthood (Lascarides & Hinitz, 2013; Nutbrown & Clough, 2014). Throughout this timeline from ancient to modern history, the value placed on the education of young children ebbed and flowed, often coinciding with the perceived success of society at that time. For example, the period known as the Dark Ages was particularly high in instances of infanticide, child labor, and an overall lack of education (Lascarides & Hinitz, 2013; Nutbrown & Clough, 2014).

In America, the earliest examples of early childhood education were found in colonial times (Nutbrown & Clough, 2014). They focused on early reading using the bible and several primers brought from the English educational system on writing and arithmetic. European ideals, such as using materials modeled after practical life implements, were also be found in early colonial classrooms (Nutbrown & Clough, 2014).

With the birth of the nation came the understanding that its democratic ideals must be taught and a well-educated voting population would be essential to its success (Kaufman, Kaufman, & Nelson, 2015). Forefathers such as Benjamin Franklin and

Thomas Jefferson weighed in on the best process for educating America's youth. Each of these men sought to support access to education for common men, not just the aristocracy, and supported public education starting for children as young as seven, well below the common age of formal education preceding this time (Kaufman et al., 2015).

In the mid-1800s, dancing, music, and gymnastics were added into the daily experiences of many American children attending school. By the end of that century, the progressive influences of John Dewey, William Kilpatrick, and Maria Montessori began to shape education (Lascarides & Hinitz, 2013). These reforms brought to light the role of the child as an active participant in his or her education. The value of the child in society was again at the forefront and schools needed to be places that sought to meet children's needs and prepare them for adulthood.

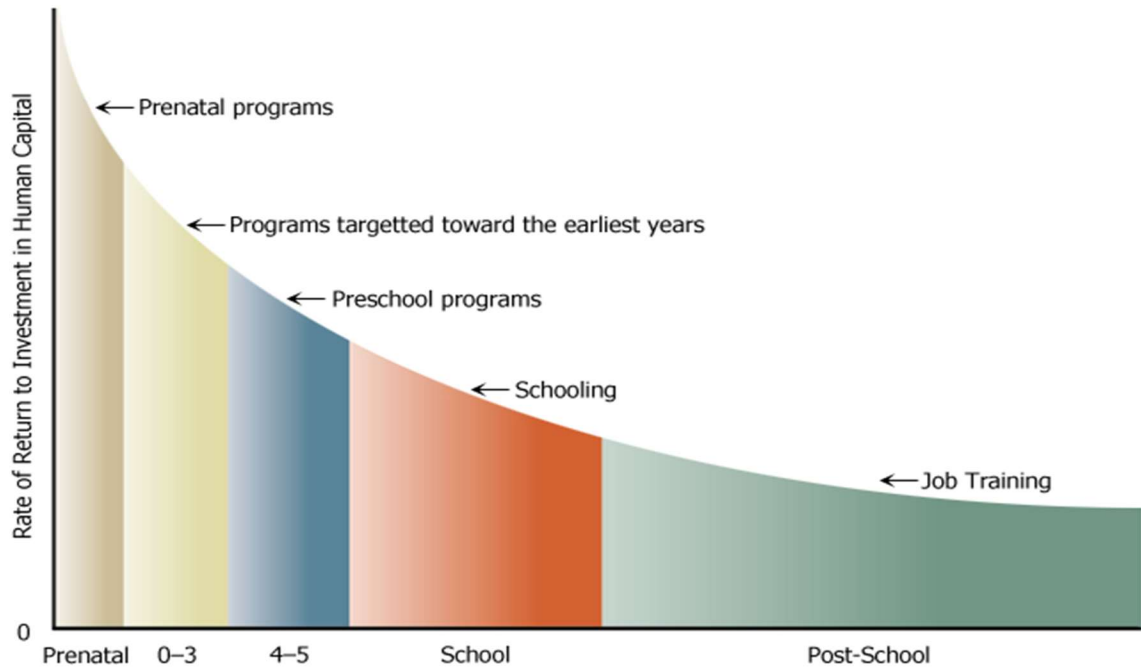
Throughout the 1900s and into the current century, two main paths for early childhood education began to emerge (Kaufman et al., 2015). The first, often called a *traditional* or *authoritarian* approach, focused on preparing children for adulthood. It often referenced standards and learning outcomes, supported by the idea early exposure to patterns of thinking support later success in core content areas such as literacy and math. The second, often called a *progressive* or *constructivist* approach, focused on the behaviors and attitudes children bring to school each day. It often referenced materials for children to explore and was supported by the idea that a child's innate curiosity led him or her to the knowledge needed for later success (Kaufman et al., 2015).

Since 2000, much work was done to find middle ground between these two stances and early childhood education that prepares children for their futures while honoring their developmental stages emerged. The NAEYC (2005) standards promoted

high-quality early childhood education programs that were standards based, developmentally appropriate, and inclusive of a child's family. These program standards served as the basis for governmental support of expanding high-quality early childhood programs to all children.

### **The Value of Early Childhood Education**

Throughout his presidency, Barak Obama focused the nation on the need for high-quality preschool experiences for young people. The current early learning initiative invested more than one billion dollars in government and philanthropic funds into early learning programs across the country. This focused plan was based on what is now becoming common knowledge, high-quality early childhood education leads to greater success in life (U.S. Department of Education, 2015a; Slack, 2013). James Heckman, a professor at the University of Chicago's Center for the Economics of Human Development, concluded the return rate of a dollar invested in a child zero to five-years-old was surpassed only by investments made in prenatal care (Figure 2). He stated, "an abundance of evidence has shown that investing in early childhood development is both economically efficient and fair, especially when compared to other attempts to 'level the playing field.' Later remediation is costly and frequently ineffective" (Heckman, 2008, p. 21).



*Figure 2.* Rate of return on investment in human capital. Source: Heckman (2008).

Research since the 1960s showed attending early childhood education programs lowered delinquency rates, the need for special education programs, arrest rates, and the number of people on welfare in a community (Essa, 2013). Data reinforced the economic benefits of investing in early childhood education (Kaufman et al., 2015). The value of early childhood education is widely accepted by American society, but questions linger about what constitutes a quality program and how to assure programs remain relevant for the quickly changing needs of a future workforce.

In recent years, the political and social landscape reflected this value by expanding programs, giving access to early childhood education, specifically prekindergarten, to wider swaths of society. These are commonly known as Universal PreK initiatives that provide government-funded access to school for children as young as four. These initiatives are being adopted in more states and being lauded as positively

impacting both student early reading success and maternal employment (Deutschlander, 2016). Several studies conducted late in the last decade confirmed the effectiveness of early schooling, prompting political intervention to establish programs throughout the country (Fitzpatrick, 2008; Howes et al., 2008; Wong, Cook, Barnett, & Jung, 2008).

As the long-term impacts of such programs are still undetermined, attention to the possibilities is growing. President Obama produced a plan for early education for all Americans in 2012, bringing the issue onto a national stage. Although access still varies greatly across states, there is a trend toward more young children being enrolled in preschool and prekindergarten programs overall (U.S. Department of Education, 2015a).

### **Professional Development in Early Childhood Education**

To meet the goal of providing high-quality early learning experiences for young children, their teachers and caregivers should participate in facilitated teaching and learning experiences designed to enhance knowledge, skills, and dispositions toward their work (Snyder et al., 2012). The availability, accessibility, and effectiveness of professional development for early childhood professionals can be problematic, however. The diversity in program offerings, including home care settings, daycare settings, and schools provides unique challenges in developing appropriate support systems. In most states, care of children from birth-kindergarten is regulated by a separate agency than the one regulating the school years, often considered kindergarten-12<sup>th</sup> grade. This offers challenges in many areas, including professional development opportunities for teachers of children aged three to eight (Weber-Mayrer, Piasta, & Yeager Pelatti, 2015).

Overall, the qualifications of the typical early childhood education workforce are regarded as quite low. This was attributed to a “fragmented landscape of policies and

uneven investment” by regulating bodies, especially in the years prior to kindergarten (Gomez et al., 2015, p. 174). Although substantive changes in societal and cultural values regarding early childhood education would be one path to increasing the quality of providers, a more accessible path is the cultivation, delivery, and oversight of relevant, responsive professional development (Weber-Mayrer et al., 2015).

Currently, professional development opportunities for early childhood educators focus on meeting regulatory requirements regarding child health and safety, or on a prescribed set of topics. More and more often, studies of effective professional development find it must be responsive to the needs of the recipient, addressing needed specific skills and developing knowledge, dispositions, and confidence (Epstein & Willhite, 2015; Gomez et al., 2015; Linder, Rembert, Simpson, & Ramey, 2016; Lumpe, Vaughn, Henrikson, & Bishop, 2014). This was particularly true for early childhood educators, given the often-lower standards of pre-service training required for their positions. To fully attend to the needs of the youngest learners, their teachers must be offered opportunities to grow as practitioners in ways reflecting their needs and needs of their students (Linder, Rembert et al., 2016).

### **The Intersection of STEM and Early Childhood Education**

Both the National Council of Teachers of Mathematics and the National Science Teachers Association clearly articulate in their guidelines for STEM programing for young children an emphasis on the importance of integration of the disciplines, with a main goal for students to develop understanding of the places where STEM overlap and where their connections to other disciplines lie (Moomaw & Davis, 2010). One of the major pathways toward teaching young children with an approach integrating traditional



learning values such as standardized outcomes with progressive approaches focused on child development is the use of project-based learning experiences (Katz, 2010). These experiences constructed an authentic learning experience for young children, providing context for STEM concepts within an environment where their own natural curiosity, inquisitiveness, perseverance, and experimentation develop (Essa, 2013; Kaufman et al., 2015).

In an early childhood classroom, an example of this kind of learning would be exploration of balls. Children would look at and play with balls used for a variety of purposes including a ping pong ball, golf ball, bowling ball, basketball, soccer ball, and so forth. They authentically experience these materials, engaging in purposeful play that characterizes learning in young children (Torres-Crespo, Kraatz, & Pallansch, 2014). As the NBPTS (2012) stated in their guidelines for accomplished teachers of young children, they emphasized understanding young children “construct knowledge through playful exploration, then become ready to focus their attention on specific dimensions of material” (p. 22). Thus, in the ball example children would freely explore the variety of balls before being guided by the teacher with questions such as which ball will bounce the highest or roll the fastest. These questions spur children’s thinking across the discipline of mathematics (three dimensional objects, measurement of height and speed, variance in size), science (hypothesizing, experimentation, physics), and engineering (travel across a ramp, design features of each ball, purpose of each ball) in a way promoting engagement and critical thinking on a developmentally appropriate level (Brownrigg et al., 2013; Katz, 2010).

Guiding children through this discourse-rich process of exposure, interaction, observation, experimentation, and conclusion requires a skilled teacher. Foundational learning in STEM subjects requires more than content knowledge; in fact, with the rate of progress in STEM disciplines, it is likely the content knowledge will be outdated before these children become adults (Yager, 2015). Children need to develop the habits of mind, or intellectual dispositions, that support continued learning in STEM subjects. These abilities include reasoning, hypothesizing, predicting, seeking understanding, and puzzling, as well as the development, analysis, and communication of ideas (Katz, 2010; Rushton & Juola-Rushton, 2011). Developing these dispositions does not happen through direct instruction, rather through careful building of intellectually stimulating experiences and the teacher's implementation of sound instructional practices to guide children through them to provide the foundational STEM learning to effectively prepare children for their future (Brownrigg et al., 2013; Moomaw & Davis, 2010).

### **Professional Development in STEM Subjects in Early Childhood Education**

Early childhood educators often received less formal schooling than their counterparts in upper elementary through postsecondary education. The Department for Professional Employees (2015), a division of the AFL/CIO union, published a study on the teaching profession. This overview included a look into the educational experience of teachers at all developmental levels. The younger the student taught, the less formal postsecondary education the teacher had (Department for Professional Employees, 2015). Additionally, the distribution of formal training varied widely within the diverse kinds of early childhood facilities (Schweingruber, Woods, & Cross, 2009). Almost half of teachers in family care centers (FCC) achieved an education of high school or less. Even

in center-based or Head Start preschool programs, a majority of teachers had not completed a bachelor's degree (Schweingruber et al., 2009). This emphasized the importance on ongoing, relevant professional development experiences for all early childhood professionals.

Providing teacher development programs and ongoing education for those working with children is a construct of the last 100 years (Darling-Hammond & Sykes, 1999; Wei et al., 2009). Ongoing professional development focused on early childhood educators is even more recent. Professional development programs focused on STEM subjects are difficult to find for early childhood educators, so much so that a review of relevant research on it must be broken down into each STEM component area (*Nurturing STEM skills in Young Learners, PreK - 3*, 2013).

Content specific training for teachers of young children is a more recent approach to build their skill level and positively impact student achievement. Early exposure to high-quality, developmentally appropriate engagement in academic subjects had a positive impact on school success into elementary school and beyond (Epstein & Willhite, 2015; Essa, 2013; Gomez et al., 2015; Kaufman et al., 2015; Nuttall, 2014). Building the content knowledge of teachers was one way to positively impact student outcomes. It should be cautioned, however, it was not the singular factor in this endeavor. A teacher's knowledge of developmental norms and instructional practices, as well as factors such as classroom management and differentiation skills also played a significant part in aspects of student success influenced by the teacher (Ball, 2002; Bechtel & O'Sullivan, 2006; Borko, 2004; Hill, Beisiegel, & Jacob, 2013; Patton et al., 2015).

## **Professional Development for Early Childhood Teachers in Science**

Early childhood teachers rarely self-identify as scientists. In interviews, much of their conversation about science focused on descriptions of experiences and experiments, with little language devoted to scientific concepts or constructs (Harlen & Holroyd, 1997). Although early childhood teachers were eager to share stories about their students planting seeds and observing their growth, or flying kites in the wind, they balked when encouraged to identify scientific skills and concepts associated with these activities (Harlen & Holroyd, 1997). Building early childhood teacher content knowledge across the domains of science supported their application of these concepts and constructs in their classrooms. As these teachers became more capable and confident scientists, they engaged their students more deeply in connecting to the scientific process and understandings embedded in the experiments and experiences they brought to their classrooms (Garbett, 2003; Munck, 2007; Wimsatt, 2012).

Building the relevant skills for successful science teaching beyond content knowledge was also challenging (Andersson & Gullberg, 2014). Researchers studying preschool science teaching identified four concrete professional skills that strongly influenced early childhood student success with scientific content: paying attention to and using children's previous experiences; capturing unexpected things that happen at the moment they occur; asking questions that challenge the children and stimulate further investigation; and creating a situated presence, that is, remaining in the situation and listening to the children and their explanations (Andersson & Gullberg, 2014).

A main goal of science teaching in early childhood is to stimulate an inquiry cycle that becomes internalized so the child can access it beyond the classroom walls. In

developing one such inquiry model, Karen Worth (2010) said, “Children need guidance and structure to turn their natural curiosity and activity into something more scientific. They need to practice science—to engage in rich scientific inquiry” (p. 4). The model she developed with her colleagues, Figure 3, demonstrates both the complexity of the scientific process in early childhood classrooms and its iterative nature.

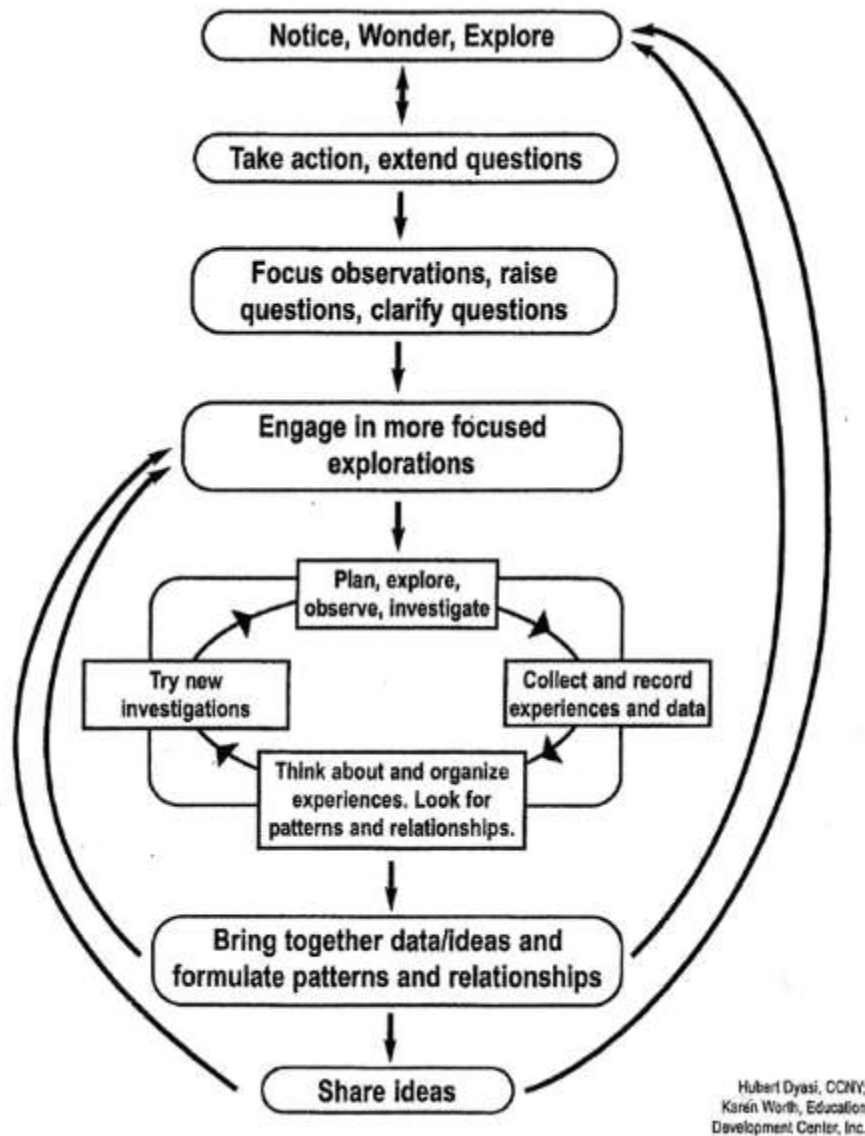


Figure 3. Inquiry theory for young children. Source: Worth, 2010.

Evaluation instruments are being developed to assess effective science teaching in the early childhood years. With the expanding adoption of the Next Generation Science Standards across the nation, a standard for science teaching in K-12 environments is being set (National Research Council, 2013). Much of the content and concepts emphasized in the early grades is rooted in early childhood education learning experiences. As these standards are implemented with young children, specific teaching practices to support them can be developed. These practices can then be measured and evaluated to improve early childhood teacher skill and efficacy in science (Kaderavek et al., 2015).

### **Professional Development for Early Childhood Teachers in Technology**

The role of technology in early childhood classes is bi-directional. It needs to be addressed both in the role of direct technological interaction from students (when they utilize devices and applications in service of their own learning) and in the role of direct technological interaction from teachers (when they utilize devices and applications to further their professional goals). Both these roles could make a positive impact in the classroom and on student learning (Blackwell, Lauricella, Wartella, Robb, & Schomburg, 2013; Briseno, 2015). When appropriately monitored and effectively guided, children as young as three can benefit from practicing skills through digital gaming or accessing audio books independently (Spodek & Saracho, 2007). Technology use by early childhood professionals can increase their personal engagement in lesson planning, better support family/classroom connections, and facilitate the documentation of student progress (Ertmer & Ottenbreit-Leftwich, 2010).

For these technological applications to be effective, teachers must engage in ongoing professional development (Ching-Ting, Ming-Chaun, & Chin-Chung, 2014; Daugherty, Dossani, Johnson, Wright, & Education, 2014; Dietze & Kashin, 2013; Lux & Lux, 2015). Technology, perhaps more than any other discipline, requires ongoing attention to emerging innovations and evolving resources. New opportunities for children to directly interact, including learning focused apps, play-based technologies, and accessibility supports, are released daily. It is impossible to remain abreast of all of these resources (Daugherty et al., 2014).

Connections through social media and professional associations can also support teaching learning. Social media outlets provide networking opportunities that connect teachers in ways not possible in previous decades (Lux & Lux, 2015). These networks form a cornerstone of effective technology use among early childhood educators. Many sources provide this, including personally managed blogs offering insight into classrooms around the world, digital pin board systems allowing for idea sharing, and communication platforms connecting educators with each other and new ideas. These sources changed the face of professional development (Hayden et al., 2011). For example, if a teacher was unable to travel across the country to attend an early learning conference, they could follow the conference hashtag across social media outlets and get multiple perspectives on the insights shared. This system makes teachers the agents of their own learning, giving access to expansive ideas on their time and in their way. This was a highly effective model of professional development at all ages of instruction (Ertmer & Ottenbreit-Leftwich, 2010; Lux & Lux, 2015).

For many, however, learning to navigate these opportunities could be daunting. Although classes and mentorships are available, the most effective way to access professional development in technology is through a concept central to early childhood education – play (Dietze & Kashin, 2013). By exploring options for their own learning and that of their students through direct interaction with technologies themselves, teachers deepen their own understanding of the offerings and their uses. Support in effectively using technology was essential to success with it, in both the student and teacher roles. In the words of one research team’s findings,

Support specifically targeting teachers’ understanding of how to use technology to aid children’s learning is an essential component to helping them use technology in their classrooms. Support also had an indirect effect on technology use via confidence and attitudes, suggesting that the effect of support is mediated by these two variables. (Blackwell, Lauricella, & Wartella, 2014, p. 6)

These findings reinforced the importance of a teacher’s self-efficacy as a contributing factor to success as well.

In any discussion of technology use, it is important to raise questions of equity and access to materials and content. The financial burden of many technological programs restricted their use, even when other factors supporting them existed (Linder, Emerson, Hefron, Shevlin, & Vest, 2016). These fiscal implications existed across both technological roles, inhibiting effective student use and effective teacher implications. Strides toward greater accessibility were encumbered by the relentless pace of new releases, rendering many systems obsolete in just a few years. Schools and educators



implementing technological systems must be aware of this struggle and develop strategies for mitigating it (Ertmer & Ottenbreit-Leftwich, 2010).

### **Professional Development for Early Childhood Teachers in Engineering**

Engineering and early childhood were not historically placed side-by-side in education. With the adoption of the Next Generation Science Standards and widespread attention to the integration of STEM, these topics were considered in partnership much more often (Katz, 2010). Engineering in the early years primarily focused on developing mindsets for curiosity, problem-solving, and prototyping. The Next Generation Science Standards presented engineering practices for kindergarten through second grade focused on questioning, exploring, and analyzing (National Research Council, 2013). To prepare young students for success in these areas upon their entry to kindergarten, it is essential the building blocks of this work are laid in preschool programs emphasizing similar concepts (Briseno, 2015).

Katz (2010) differentiated between academic and intellectual goals in learning. She said in academic goals “the items learned and practiced require correct answers, rely heavily on memorization, on the application of formulae versus the search for understanding, and consist largely of giving the teacher the correct answers that the children know she awaits” (Katz, 2010, p. 2). This was especially important when understanding engineering in the early years. Early childhood educators did not set out to impart discreet information to young children; rather, they provided experiences allowing children to meet intellectual goals and build dispositions toward engineering behaviors (Bagiati & Evangelou, 2016; Briseno, 2015).

Many researchers agreed play was a key component to this important work (Bagiati & Evangelou, 2016; Ricks, 2012; Torres-Crespo et al., 2014). Play allows children to think creatively, engage with materials in new ways, and problem-solve in authentic scenarios, building their skills across engineering perspectives. Open-ended and project-driven play may be most effective in cultivating the perspectives essential to future engineering success (Bagiati & Evangelou, 2016; Torres-Crespo et al., 2014).

Authentic projects, such as the one featured in *Hamsters, Picture Books, and Engineering Design* (Tank, Pettis, Moore, & Fehr, 2013) where kindergarten through second grade students design animal habitats using found materials, asked students to solve real-world problems. This provided young students the opportunity to think creatively, respond to needs, and participate in a prototyping process requiring revision of thought – all essential engineering practices (Tank et al., 2013). In preschool classes, the presence of a wide array of materials to build and interact with had a similar impact. Open-ended materials such as unit blocks, interlocking blocks, and geometric shapes encouraged young students to adapt the purpose of the tool based on its use (Bagiati & Evangelou, 2016; Pantoya, Aguirre-Munoz, & Hunt, 2015). This represented fundamental thinking in engineering practices and was one of the elements most often named as a struggle for adult engineers (Briseno, 2015).

Questions remained about how teachers learned to support these skills, what professional development was needed to help teachers, and what teacher dispositions were necessary to support children. These questions lack easy answers and continue to be grappled with, but some indicators of what supports success are emerging. Prevailing all these is an emphasis on hands-on experiences (Bagiati & Evangelou, 2016; Dietze &

Kashin, 2013; Ricks, 2012; Torres-Crespo et al., 2014). Teachers themselves must play with the content and materials, and participate in the problem contexts to develop their own capacity for intellectual goal setting. A central characteristic of engineering tasks is the presence of more than one correct answer. Educators benefited from engagement in the process of trial and revision to find their path through experiences, then relate this to their students' learning (Beatty, 2011; Fairweather, 2008; Ricks, 2012; Thomas, 2014; Torres-Crespo et al., 2014; Webb, 2015).

Embedded in this, for both students and teachers, was a fundamental emphasis on communication and collaboration (Fairweather, 2008; Nadelson et al., 2013). Students of engineering, even in early childhood settings, endeavored to articulate their ideas and the rationale behind them while also listening carefully to the ideas of others. This remains true in effective professional development in engineering. Collaborative groups that share experiences, reflect on them together, and continue to collaborate over time were identified as an important part of effective professional development in engineering (Bagiati & Evangelou, 2015, 2016; Pantoya et al., 2015; Ricks, 2012; Thomas, 2014).

At its core, professional development in engineering for early childhood teachers must be collaborative, hands-on, open-ended, and ongoing (Webb, 2015). This was a far cry from so many professional development experiences focused on imparting knowledge from a single individual to a group gathered one time. To truly engage as engineers, some early childhood educators banded together in professional learning communities dedicated to engineering the experiences of their students (Honardoost, 2014). These groups of educators explored ways to present authentic projects to their classes, helped each other engage with materials in new and different ways, and continuously reflected

upon and revised their thinking (Honardoost, 2014). Although this method of professional development was difficult to organize and sustain, it gave teachers experience living the dispositions of engineering while supporting student experiences.

### **Professional Development for Early Childhood Teachers in Mathematics**

Educators and researchers agree young children should learn mathematics. The specifics of this agreement changed over time, although fundamentals like choral counting and pattern recognition remain at the core. Teachers of mathematics at the elementary level relied heavily on numeracy, the strands of mathematics dealing with quantities each assigned a numeral (Chen et al., 2014). With almost nationwide adoption of the Common Core State Standards in mathematics, a shift to the intentional inclusion of strands such as algebraic thinking and geometry occurred. These formed the habits of mind and mathematical dispositions kindergarten through twelfth grade teachers want their students to develop, which begins in early childhood classes (Common Core State Standards, 2011).

It can be difficult to consider algebraic and geometric applications with elementary aged children as a three-year-old child cannot reason abstractly and think quantitatively. In mathematics, a focus on productive play provided a pathway to navigating these complex ideas with young children (Brenneman et al., 2009; Clements, Copple, & Hyson, 2002; Stipek et al., 2001; Woods, Hyson, & Ginsburg, 2014). When playing house and doling out a single cookie to each family member, then giving the leftovers to the dog, the preschooler is reasoning abstractly and quantitatively. When they fill buckets in the sandbox and decide with a friend they only need three more scoops of sand until the bucket overflows, they are reasoning abstractly and quantitatively. The

challenge for early childhood professionals is to provide provocative materials so these moments arise, notice them, and respond in a way that pushes the child's thinking (Brendefur, Strother, Thiede, Lane, & Surges-Prokop, 2013; Linder, Emerson et al., 2016). Thoughtful questioning turns playful moments into mathematical experiences.

A significant component of developing facility in this provocation, observation, inquiry, feedback, and revision cycle is high-quality professional development. NAEYC (2005) author a position paper on mathematics in early childhood environments, in which they outlined the following components of an effective mathematics professional development program for teachers of young children:

To support children's mathematical proficiency, every early childhood teacher's professional preparation should include these connected components: (1) knowledge of the mathematical content and concepts most relevant for young children—including in-depth understanding of what children are learning now and how today's learning points toward the horizons of later learning; (2) knowledge of young children's learning and development in all areas—including but not limited to cognitive development—and knowledge of the issues and topics that may engage children at different points in their development; (3) knowledge of effective ways of teaching mathematics to all young learners; (4) knowledge and skill in observing and documenting young children's mathematical activities and understanding; and (5) knowledge of resources and tools that promote mathematical competence and enjoyment. Essential

as this knowledge is, it can be brought to life only when teachers themselves have positive attitudes about mathematics.

Once again, professional development for teachers beyond specific content area knowledge was considered essential. Skills in child development, effective teaching practices, observation and documentation, and awareness of resources were all essential for effective teaching of mathematics, as well as any content area in the early childhood curriculum. These skills on their own were not enough, however. Positive attitudes accompanying high levels of self-confidence and self-efficacy bring the concepts to life (Ball, 2002; Brendefur et al., 2013; Brenneman et al., 2009; Clements et al., 2002; Schweingruber et al., 2009; Stipek et al., 2001; Woods et al., 2014).

### **The Role of Efficacy**

Efficacy is the power of something to produce a desired outcome, or its capacity to do what it says it can do (Gibson & Earley, 2007). Often, efficacy is used as a synonym for effectiveness. Although appropriate in many settings, including studies in education, it is important to acknowledge in medical and clinical trial settings, measures of efficacy are the results achieved in controlled settings, whereas effectiveness refers to results achieved in real life applications. Measurements of efficacy are essential in a variety of contexts. A pharmaceutical's initial value is highly connected to its efficacy as determined in clinical trials (although its effectiveness has more impact on its long-term value). Project managers in a corporate workplace must have some ways of determining the efficacy of their team, and the individuals who comprise it, to make measured and intentional adjustments for greater results. Shareholders and board members evaluate the efficacy of a company based on several factors, both quantitative and qualitative, to

maximize their profits and move closer to their defined successes. Evaluation is an ongoing and pervasive process throughout the human experience and one of the key factors used in evaluation is determining efficacy (Gibson & Earley, 2007).

### **Self-Efficacy**

Self-efficacy was defined as “beliefs in one’s capabilities to organize and execute the courses of action required to manage prospective situations” (Bandura, 1995, p. 2). More simply put, self-efficacy is what an individual believes he or she can accomplish using his or her skills under certain circumstances (Lunenburg, 2011). Evaluation of one’s self is ongoing and had profound effects on behavior and attitudes. Albert Bandura first illuminated the role of self-efficacy in the lives of individuals in the late 1970s through a series of articles in psychological journals. In the ensuing decades, Bandura’s research remained at the forefront of this thinking, although studies of self-efficacy and its impacts expanded across the fields of psychology, education, sociology, and beyond (Bandura, 1977, 1994, 1995; Epstein & Willhite, 2015; Gibson & Earley, 2007; Goodson, Slater, & Zubovic, 2015; Lunenburg, 2011; Riggs & Enochs, 1989; Webb, 2015).

A basic idea behind self-efficacy psychological theory was people’s motivation toward and performance on a task was determined, in part, by how effective they believed they could be completing the task (Bandura, 1995; Redmond, 2010; van der Bijl & Shortridge-Baggett, 2001). Bandura (1995) suggested these judgements of self-efficacy were formed through performance outcomes, vicarious experiences, verbal feedback, and physiological feedback.

Performance outcomes referred to the previous experiences an individual had with a specific task and his or her past effectiveness, or lack thereof. It was considered the

most important source of self-efficacy with the strongest measurable impact on both motivation and performance (Bandura, 1994; Goodson et al., 2015; Lunenburg, 2011).

“Mastery experiences are the most influential source of efficacy information because they provide the most authentic evidence of whether one can muster whatever it takes to succeed” (Bandura, 1977, p. 80).

Self-efficacy can also be formed through vicarious experiences. Through watching another person’s performance on a task and determining commonalities with that person, an individual assesses his or her likelihood of success. If people saw someone similar succeed, it increased their self-efficacy. However, the opposite was also true; seeing someone similar fail lowered self-efficacy (Bandura, 1995; Lumpe et al., 2014; van der Bijl & Shortridge-Baggett, 2001). The strength of this path to determining self-efficacy depended on the strength and nature of the relationship one had with the individual they compared themselves to for the task (Redmond, 2010).

Another factor identified as influencing feelings of self-efficacy was verbal persuasion. This referred to spoken encouragement or discouragement pertaining to an individual’s performance or ability to perform (Redmond, 2010). The impact of others’ words as an expression of their belief in one’s capabilities was significant, with positive expressions raising an individual’s feelings of self-efficacy and negative expressions lowering them (Bandura, 1994; Lunenburg, 2011; van der Bijl & Shortridge-Baggett, 2001). Once again, the relationship between the individuals was a key factor in the magnitude of the impact, where more credibility had a greater influence, either positive or negative (Lunenburg, 2011).



The final factor influencing self-efficacy was physiological feedback. This referred to the physiological manifestations of an individual's emotional arousal. The sensations experienced by the body, including agitation, high heartrate, sweaty palms, and rapid breathing, sent a psychological signal indicating danger or apprehension. Conversely, physiological sensations of calmness and low stimulation could indicate confidence (Bandura, 1977; Redmond, 2010; van der Bijl & Shortridge-Baggett, 2001). This was often the least influential of the four named factors influencing self-efficacy. It was also the most easily impacted through conscious thought. This was why individuals were coached to take deep breaths or put their shoulders back and stand tall when feeling nervous. These physiological cues tricked the brain into raising self-efficacy levels (Lunenburg, 2011; Redmond, 2010). The more at ease an individual felt with the task at hand, as demonstrated by physiological cues, the higher the self-efficacy levels.

### **Teacher Self-Efficacy**

Efficacy, as related to education and specifically teachers' evaluations of their self-efficacy, was studied for decades (Tschannen-Moran, Hoy, & Hoy, 1998). Teacher self-efficacy, its role in and application to student learning, and challenges in assessing it were written about from many disciplines and perspectives (Ashton & Webb, 1986; Baxter, Ruzicka, Beghetto, & Livelybrooks, 2014; Edwards, 1996; Epstein & Willhite, 2015; Nuttall, 2014; Webb, 2015; Wimsatt, 2012). In 1976, RAND Corporation conducted a large study of teachers in Los Angeles Unified School District. The last two questions added to their questionnaire were "When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his or her home environment," and "If I really try hard, I can get through to even the most

difficult or unmotivated students” (Armor, 1976). These were seen as the first attempt to quantify teacher-specific self-efficacy (Klassen & Tze, 2014; Lumpe et al., 2014; Tschannen-Moran & Hoy, 2001; Tschannen-Moran et al., 1998).

The challenge of defining, quantifying, and calibrating teacher self-efficacy measures remains significant. In fact, a large amount of inconsistency exists in the literature, with some studies indicating self-efficacy rates increased over time and others indicating a progressive decrease over time. In one study, the researchers illuminated a series of questions plaguing any study of the topic:

Is teacher efficacy a trait that can be captured by a teacher efficacy instrument or is it specific to given contexts? Are the traditional assessments of teacher efficacy adequate to the task? Does the concept need to be refined or expanded to capture more aspects of teachers’ self-efficacy? What contributes to the development of strong, positive teacher efficacy? How malleable is a sense of efficacy once it is established? Does the stability of efficacy change over career stages or across contexts? In what ways does a teacher’s sense of efficacy influence teaching behavior? How do teachers’ efficacy beliefs influence student beliefs and achievement? (Tschannen-Moran et al., 1998, p. 203)

Although these questions were articulated almost two decades ago, no clear answers emerged and researchers continue to study them to more fully understand teacher efficacy and self-efficacy measures (Baxter et al., 2014; Epstein & Willhite, 2015; Goddard & Goddard, 2001; Goddard, Hoy, & Hoy, 2000; Kidd, 2014; Klassen & Tze, 2014; Lumpe et al., 2014; Tschannen-Moran & Hoy, 2001).

The first question posed looks to establish the viability of measuring efficacy in teaching, acknowledging it as a difficult to define trait and the unknown influence of contextual factors. The second question built on this inquiry by wondering about the effectiveness of existing measures. Over time, it was established contextual factors including job longevity and collegial relationships influenced measures of self-efficacy, but measures could be crafted with reliability and validity independent of those contexts (Baxter et al., 2014; Goddard & Goddard, 2001; Goddard et al., 2000). The quest to establish these scales is ongoing, and although quite a few were developed since these questions were posed in 1998, only a few are well regarded and widely used (Goodson et al., 2015; Kidd, 2014; Lumpe et al., 2014; Webb, 2015).

The next question brought into focus the definition of self-efficacy and its application to the teaching profession. Multiple studies sought to address this and the outcomes overwhelmingly held the relationship between measures of self-efficacy and teaching performance, as measured both by student achievement and teacher performance reviews, was significant (Klassen & Tze, 2014; Lumpe et al., 2014; Riggs & Enochs, 1989). Most consistently, high levels of self-efficacy correlated to lower stress levels, higher job satisfaction, greater flexibility, and more willing to take risks. Not surprisingly, teachers with higher self-efficacy ratings reported more long term plans to remain in the profession (Edwards, 1996; Klassen & Tze, 2014).

Factors that contributed to increased levels of self-efficacy, as addressed in the next question, were less researched and remain somewhat elusive. Although strong collegial relationships and consistent professional development experiences were mentioned in some research, these terms were not fully defined and the quality of the

relationship or experience was not quantified (Goddard & Goddard, 2001; Goddard et al., 2000; Klassen & Tze, 2014; Lumpe et al., 2014). More research could benefit the growth of understanding in this area.

The next two questions posed wonderings about efficacy over time and across contexts. It was often postulated higher levels of efficacy attributed to more experience with the same material in the same teaching environment. This could be due to a buildup of positive performance outcomes, as emphasized in the research regarding building efficacy (Baxter et al., 2014; Coladarci, 1992; Gibson & Earley, 2007; Lumpe et al., 2014; Tschannen-Moran & Hoy, 2001). Research indicated this did not account for a complete picture of efficacy, although there was a correlation to increased self-efficacy scores and longevity in a consistent context. In some cases, these scores diminished over time or grew with a change of context. Other factors influencing these measures, and their impact across contexts, are still being explored (Tschannen-Moran & Hoy, 2001).

The last two questions from these researchers focused on the impact of self-efficacy on behaviors of the teacher and student performance. Recent research indicated the impact of self-efficacy scores on behavior was quite high, with teachers who had similar self-efficacy scores engaging in similar behaviors, even across contexts, such as time spent on student feedback and time spent seeking new professional learning experiences (Kidd, 2014; Klassen & Tze, 2014; Lumpe et al., 2014; Webb, 2015). The link to student performance, although not as strong, remained consistent and teachers with higher levels of self-efficacy also had higher scores on measures of their students' performance (Klassen & Tze, 2014).

## **Teacher Efficacy in Early Childhood**

Little research was conducted on teacher self-efficacy measures specific to early childhood, and what existed focused exclusively on early childhood teacher efficacy measures in teacher preparation programs. Recent publications indicated early childhood teacher's self-efficacy levels were strongest in areas addressing student engagement and management. Areas of weaker self-efficacy included supporting families of atypically developing children and content instruction connected to standards (Epstein & Willhite, 2015; Nuttall, 2014). Also of note, in research of early childhood preparation programs, strong feedback helped develop a better sense of self-efficacy, which was a key component to effective teacher development (Nuttall, 2014).

## **Teacher Confidence Levels in STEM Subjects in Early Childhood Education**

Although many teachers were aware of their role as facilitators of STEM learning, few received adequate training to develop skills in this area (*Nurturing STEM skills in Young Learners, PreK - 3*, 2013). The development of these necessary skills went beyond increasing content knowledge, in part because the specific content knowledge shifted so rapidly (Appleton, 1995). Professional development programs designed to increase teacher skills in STEM areas must also address increasing confidence levels in being able to push student thinking in intellectual dispositions. It was not enough for a teacher to impart rote content; rather, young children needed to develop flexible thinking skills necessary for STEM explorations. Especially in early childhood education, when the focus of STEM learning is on nurturing and developing habits of mind, teachers must confidently adapt instruction to the divergent thinking of students in cross disciplinary

experiences rather than rely on formulaic curricular plans or content-specific goals (Baxter et al., 2014; Fairweather, 2008; Torres-Crespo et al., 2014).

A key element in developing high levels of teacher confidence in any area is adequate pre-service preparation and on-going professional development. However, early childhood teachers were often underserved in these areas. This was particularly true of teachers of children under five who were rarely served by the public schooling system. Early childhood teachers also often had less formal education, less non-child contact time in their work schedules, and less compensation, including paid professional development, than their K-12 counterparts, further complicating the issue of access to necessary support (Bagiati & Evangelou, 2015; Ball, 2002; Blackwell et al., 2014; Brendefur et al., 2013; Chen et al., 2014).

This was particularly problematic in the STEM subject areas. Kimberlee Kiehl, Executive Director of the Smithsonian Early Enrichment Center (as cited in *Nurturing STEM skills in Young Learners, PreK - 3*, 2013), said, “When you talk about the PreK world, teachers often come into the job having had no coursework in STEM at all. They’re not prepared for it, and there is very little professional development out there for them” (p. 4). With student-teacher relationships and teacher enthusiastic engagement in STEM activities with young students emerging as important predictors of STEM achievement in elementary school, it is essential to expand support for teachers of young children (Ricks, 2012).

Although teacher confidence levels began to be more widely accepted as an important indicator of student success, little research exists regarding how to evaluate and positively impact them (Goodson et al., 2015; Lumpe et al., 2014). Teachers with high

levels of confidence in both the STEM content and inquiry-based approaches to support student learning of intellectual dispositions in STEM areas developed more successful students. However, the systems of assessing early childhood student knowledge in STEM areas, beyond rote content, is also woefully underdeveloped (Chen et al., 2014). Greater understanding is needed of the impact of early childhood teacher confidence levels in STEM subjects on their teaching practices and of the factors that impact the development of high levels of confidence in these areas.

### **Conclusions**

The issues of effective STEM education and effective early childhood education sit at the core of the current dialogue regarding education in America (U.S. Department of Education, 2015b). These are timely and relevant issues, and research into their intersection is woefully sparse. Much can be learned about increasing access to effective STEM education in the early years of life for all children. One major contributor to effectiveness is the teaching professionals on the front lines with those children. They provide the provocations, push the thinking, and elicit interactions from students. They must do this with confidence and skill. As Schweingruber et al. (2009) highlighted, “Any effort to change educators classroom practices must include consideration of how those teachers view their roles, the children they teach, and the purpose of the setting in which their interactions take place” (p. 295). This study sought to illuminate a process for measuring early childhood teacher’s confidence levels in STEM subjects and begin to identify factors that impact the development of that confidence.

## CHAPTER III: METHODOLOGY

Chapter I introduced this study and the background of relevant research. The chapter set forth the questions to be researched, the significance of the problem, relevant definitions, and the organization of the study. In Chapter II a review of literature focused on influential research completed in the areas of early childhood education and education in science, technology, engineering, and math (STEM), and research aimed at understanding the role of teacher confidence levels. The chapter also addressed research aimed at understanding the intersection of these areas and their collective impact on the educational landscape.

Chapter III explains the procedures used to collect and interpret data for this study. The research questions guided all aspects of the study, with the goal of shedding light on the complex topic of early childhood teacher confidence levels in STEM subjects. This chapter restates the purpose statement and research questions, and expands upon details of the research methodology, population and sample, instrumentation, data collection, analysis, and limitations of the study.

### **Purpose Statement**

The purpose of this study was to identify the self-efficacy of early childhood teachers toward STEM subjects as measured on the Teacher Efficacy and Attitudes toward STEM Survey (T-STEM; FIEI, 2012) and to explore factors that influence confidence in teaching STEM.



## Research Questions

The study sought to answer the following research questions:

1. What is the degree of self-efficacy of early childhood teachers in STEM subjects as measured by the T-STEM (FIEL, 2012)?
2. What factors do early childhood teachers identify as barriers to increased confidence in teaching STEM subjects?
3. What factors do early childhood teachers identify as positively influencing their confidence in teaching STEM subjects?

## Research Design

This study sought to identify self-efficacy toward STEM subjects among teachers of children aged three to eight. It also sought to explore and describe trends in factors that influence their self-efficacy scores.

A quantitative approach, in isolation, would address the levels of teacher confidence, but provide no insights into how those levels were attained or what factors influenced them. A purely qualitative approach would not accurately measure a teacher's level of confidence, thereby removing the impartial method of comparison. By collecting both types of data in tandem, the strengths of each are incorporated while the limitations of each method are addressed (McMillan & Schumacher, 2010).

Qualitative and quantitative approaches in the same study complement each other and can provide results with greater breadth and depth (Roberts, 2010). The quantitative focus on *what* combines with the qualitative focus on *why* to tell a story about the data that can be more illustrative than either in isolation (Creswell, 2008, 2013). The use of both quantitative and qualitative methodologies in this study was driven by the research

questions and the complexity of the concepts considered. Specific quantitative data on early childhood teacher self-efficacy in STEM subjects would illuminate only the extent to which teachers felt effective in their STEM instruction. Conversely, the qualitative research questions in isolation would illuminate factors influencing teacher's self-efficacy, but not provide any measure of that efficacy. Together, these methods offered data on both the level of self-efficacy and the factors influencing that level, providing a nuanced and informative perspective.

When implementing mixed-methods research methodologies, it is important to consider several models of design and determine the appropriate match for the study (Airasian & Gay, 2003). One such model is the QUAL-Quan model, where the qualitative data are collected first and weighted more heavily than the quantitative data. This model was considered for this study, then discounted due to its need for data to be collected twice. Teachers' lives are extremely busy and the impact of being asked for even one survey to be completed is significant and two would be inappropriately burdensome and unnecessary. It was also not chosen because of its unequal weighting of the data sets. The second model considered, the QUAN-Qual model, collects quantitative data first and weights it more heavily than qualitative data. This method was also not chosen for this study for the same reasons of the frequency of data collection and unequal weighting. The final model considered, and chosen, was the QUAL-QUAN model which equally weights both kinds of data and collects them simultaneously. This was determined to be the best model for this study because it allowed for a single instance of data collection and weighted the data equally. The self-efficacy scores of early childhood teachers in STEM subjects cannot be clearly interpreted without understanding the factors

influencing them, and the converse is also true. By collecting the data together, and interpreting it in tandem, a more complex and relevant understanding can be developed.

To appropriately address the quantitative research questions, a search for survey questions was undertaken. Measurements of teacher efficacy are somewhat recent, so few tools exist to quantify them in a valid and reliable way. This was even more true when specifically targeting teacher efficacy in STEM subjects. The Teacher Efficacy and Attitudes Toward STEM (T-STEM) survey, developed by the Friday Institute for Education Innovation (FIEI, 2012) at North Carolina State University, is considered the seminal tool in this area of research. It is also the only survey aimed at teachers of elementary school children. As such, it was an ideal option for this study as early childhood teachers include teachers of young elementary students. The first scale of the battery, the Personal STEM Teaching Efficacy Belief Scale (PSTEBS), was chosen as the basis for the quantitative research in this study because it provides perceptive data from teachers, asking them to quantify their own perceptions or beliefs. This scale for rating self-efficacy in STEM subjects looks at how confident teachers are in teaching science, technology, engineering, and math topics (FIEF, 2012). It is designed to measure precisely what this study sought to uniquely apply to early childhood educators, and was found to be a valid and reliable tool for collecting this information (FIEI, 2012; Riggs & Enochs, 1989).

## **Method**

A qualitative approach with open-ended questions was selected for this study, seeking to elicit both quantitative and qualitative data from the participants. This approach allowed for multiple viewpoints to be expressed, with the qualitative data

collected simultaneously with the quantitative data, and the former designed to illuminate reasons influencing the latter in a complimentary approach (Tashakkori & Teddlie, 1998; Terrell, 2012).

### **Population**

One definition of population for the purpose of scholarly research offered by (McMillan & Schumacher, 2010) was “a group of elements or cases, whether individuals, objects, or events, that conform to a specific criteria and to which we intend to generalize the results of the research” (p. 129). Exploring the confidence levels in teaching STEM subjects for all general education teachers with students aged three to eight was the purpose of this study. Currently, over one million individuals meet this description in the United States (U.S. Department of Education, 2015b).

A target population is often used in studies where the identified population is vast. It is a group of individuals, or sometimes organizations or objects, who fit the characteristics of the overall population, but can be separated out by a single defining characteristic (Creswell, 2008). For the purposes of this study, only teachers whose schools were members of the Northwest Association of Independent Schools (NWAIS) qualified as members of the target population. This represented approximately 1,500 teachers during the 2017-18 school year, with an estimated 210 teaching children aged three to eight (NWAIS, 2015).

### **Sample**

Sampling is defined as identifying a group of subjects or participants from whom the data are collected (McMillan & Schumacher, 2010). To compile a sample for this study, the researcher used a convenience sampling technique. This method of

nonprobability sampling does not include random assignment of subjects, rather potential participants are those readily available to the researcher (Creswell, 2008; McMillan & Schumacher, 2010; Terrell, 2012). By choosing to send the survey to teachers whose schools are members of NWAIS, the researcher utilized convenience sampling. The researcher has been a member of the association for over a decade and has reliable access to its members. Convenience sampling is widely used in both qualitative and quantitative studies to successfully address issues with efficiency and accountability ( McMillan & Schumacher, 2010). Additionally, all NWAIS schools are expected to engage in a continuous process of research, reflection, and improvement rooted in professional development ("Northwest Association of Independent Schools," 2015). Teachers in these schools, including those in early childhood classes, have access to professional development opportunities on a regular basis. All 210 individuals listed in the NWAIS directory as early childhood teachers were e-mailed the survey. Initial questions confirmed each respondent's membership in the target population, as well as their current teaching assignment with children aged three to eight. Only affirmative responses were permitted to proceed to the survey questions. This assured that all who completed the survey meet the study criteria. All completed surveys were used when compiling both quantitative and qualitative data.

Approximately 210 teachers of children aged three to eight were listed in the NWAIS directory, which encompasses Alaska, Oregon, Nevada, Idaho, Montana, Utah, Washington, Wyoming, and British Columbia. The research study was designed to return a confidence level of 95%, meaning that an individual in the general population would be 95% likely to return the same response as one in the sample. It was also designed to reach

a confidence interval of 15, meaning that if 50% of sample respondents say that they strongly agree with one of the quantitative statements, this would also be true for 35-65% of the general population (McMillan & Schumacher, 2010). To obtain this confidence level of 95% and the confidence interval of 15, the survey would need to be completed by 38 respondents, which would represent a return rate of just over 18% on the survey.

Convenience sampling was the most appropriate form of participant selection for this study because it allowed teachers to self-select their participation. The NWAIS network of teachers provides a representative and diverse group of early childhood educators., so convenience sampling assured a large enough group of qualified individuals able to participate. However, nonprobability samples, such as convenience sampling, limit the generalizability of the results from the sample to the population as a whole (Creswell, 2008; McMillan & Schumacher, 2010).

### **Instrumentation**

The primary instrument for this study was an adaptation of the T-STEM survey developed by the FIEI (2012). This instrument was chosen because it was the only survey available that specifically measures elementary teacher self-efficacy levels in STEM subjects. Other available surveys of teacher self-efficacy did not focus on STEM subjects or were designed to be given to teachers of older children and adults. The researcher received permission to use and modify this instrument (Appendix D). The portions of this survey instrument used in this study were the elementary teacher sections on Science Efficacy and Beliefs and Mathematics Efficacy and Beliefs (FIEI, 2012). The primary adaptations included limiting the instrument to the Efficacy and Beliefs sections, the expansions of those sections to encompass all STEM area subjects, and the

administration of the instrument to teachers of children as young as three. All these modifications fell within the guidelines provided by the instrument's creators.

The modifications were field tested before the full distribution of the survey. To avoid bias, current and former colleagues of the researcher who otherwise met the requirements for study participation were excluded from the target population and asked to field test the survey. The survey was field tested with 10 individuals. It was determined that 10 individual field test responses would provide appropriate validation for the modifications made to the survey instruments, given the expected size of the survey sample. The field test offered an opportunity to determine time needed for survey completion, test the survey content and delivery system, and begin identification of possible coding categories for the qualitative data.

To field test the survey, 10 individuals who meet all the criteria for the target population (current teachers of children ages 3-8 in NWAIS accredited independent schools) and are current or former colleagues of the researcher were provided the online survey in its entirety. Additional questions asking the participant to reflect on survey clarity and usability were also included for the field test. The field test version of the survey is provided in Appendix B. Field test participants were given seven days to respond. At the conclusion of this time, the researcher compiled their responses, evaluating them for relevancy of feedback on research design. Any warranted adjustments were made before distribution of the survey to the target population.

### **Reliability and Validity**

Validity refers to the degree to which the instrument measures what it set out to measure (Roberts, 2010). Reliability refers to the degree to which the instruments

measurement is consistent, its ability to return the same results time and time again in similar circumstances (Roberts, 2010). The reliability and validity of the T-STEM survey were initially established by the developer and reinforced through numerous studies (FIEI, 2012). The reliability of the original survey was established by the developers, with Cronbach Alpha's ranging between .81 and .95 (FIEI, 2012).

The reliability and validity of the qualitative research questions were addressed in two ways. First, the qualitative survey questions were developed with input from a panel of four experts in early childhood education and educational research. Second, the qualitative data were triangulated with the data collected from the quantitative survey. Triangulation is often used to support reliability and validity in qualitative studies (McMillan & Schumacher, 2010).

### **Data Collection**

All teachers of children aged three to eight in schools accredited by the NWAIS were potential participants in the sample. They self-selected their participation, yielding a sample of 80-120 teacher participants. Using the NWAIS directory, individuals were sent a personalized email inviting them to participate in the study. The purpose of the study was briefly explained and a link to the online survey was provided. Potential participants were invited to respond to the researcher with questions or to seek more information about the study. Guidelines required by the Brandman University Institutional Review Board (BUIRB), including withdrawal options and confidentiality were followed with fidelity. The first three questions of the survey were to accept the participation terms outlined by the BUIRB and confirm their membership in the target population before continuing. Individuals whose responses to these initial questions excluded them from the



target population were unable to continue to the remainder of the survey questions. This assured the convenience sample was comprised of qualified individuals.

Data for this study were obtained exclusively from a survey, delivered in an online format using Survey Monkey. The first three questions assured the respondent met the qualifications to participate in the study. The next 11 questions were a modified version of the elementary portion of the T-STEM survey designed to produce quantitative data using a Likert scale (FIEI, 2012). These questions were modified from the original survey to more comprehensively address STEM as an integrated discipline, and streamlined to focus on the determination of teacher self-efficacy levels. The final two questions asked respondents to answer open-ended questions about the factors influencing their confidence in STEM subjects, resulting in qualitative data. The data gathered were then analyzed to support the formulation of conclusions.

Teachers of children aged three to eight in NWAIS accredited schools were sent an individual email as indicated above. Those clicking the link were taken directly to the Survey Monkey site. A statement regarding consent opened the survey and required agreement from the participant to continue to the survey. The next set of questions confirmed eligibility in the population. Survey questions were delivered one at a time and each question needed to be answered before moving to the next one. Finally, participants were prompted to answer the two open-ended questions regarding factors that influence their feelings of efficacy. All data were stored in Survey Monkey and downloaded by the researcher for analysis.

Participants were asked to select the age range of their students, choosing either three to four years old, five to six years old, or seven to eight years old as part of the set

of questions assuring the eligibility. These selections grouped teachers into smaller cohorts which were used for the statistical analysis. Data collected, both quantitative and qualitative, were aggregated based on these groups to inform the interpretation of possible trends based on age of child taught.

The T-STEM questions were answered using single button responses ranked on a Likert scale. The open-ended questions regarding factors that influence feelings of efficacy were answered in an unrestricted text box. Respondents were unlimited in the length of their responses and could use text features including bullet points and hyperlinks. However, all questions on the survey had to be answered and blank responses received an error message.

### **Data Analysis**

Data analysis measures designed to describe trends in responses to both the quantitative and qualitative questions were performed on the data collected. Measures of central tendency provide a numerical index of the typical score of a distribution (James H. McMillan & Sally Schumacher, 2010). Specifically, the mean and the percentage of responses to each question provided the basis that described the confidence levels of early childhood teachers. These statistical measures were chosen to support the description of trends within the data. Subgroups of teachers disaggregated by student age level (3-4, 5-6, and 7-8) was also analyzed. Comparisons between age of students taught and level of confidence were described using measures of central tendency. The questions in the quantitative T-STEM survey were individually scored based on responses given on the Likert scale. The percentage of responses at each age level of student was calculated and descriptions were based on the number of responses.

Qualitatively, responses to the final two open-ended questions of the survey were coded and analyzed for trends in the data. To assure reliability of the coding, the researcher completed all the coding, then an independent consultant with a doctorate and experience in qualitative research double-coded 10% to check for consistency and accuracy. Any discrepancies were noted in the final analysis and used in the description of results. Data analysis software was used to organize and code the responses. Each response was read for influencing factors that fit identified codes. Analysis of the frequency and diversity of codes was performed. This provided valuable insight into describing factors that influence early childhood teacher confidence in STEM subjects.

### **Limitations**

Every study has limitations, particular features of the circumstances that can be predicted to negatively affect the results of the study or the ability of those results to be generalized to the population (Roberts, 2010). Limitations are the multitude of factors that cannot be controlled, which may influence the outcome of the study. In this research, some potential limitations included too few respondents, unsuccessful survey completion, time constraints, technological errors, and the detail in which individuals responded to the open-ended questions.

### **Summary**

The methodology of this study was designed to elicit data to support productive investigations into early childhood teacher confidence levels in teaching STEM subjects, as well as possible factors that influence that confidence. By deepening the understanding of how teachers think and feel about these relevant, timely topics, a greater body of evidence in support of effective teacher support can be built.

## CHAPTER IV: RESEARCH, DATA COLLECTION, AND FINDINGS

This chapter describes the findings regarding self-efficacy of early childhood teachers in STEM subjects. It summarizes the data collected from 44 surveys distributed to teachers of children aged three to eight years old who teach in schools affiliated with the Northwest Association of Independent Schools. This chapter begins by reviewing the purpose of the study, the research questions, and the research methodology. Next, it reviews the themes and patterns that emerged from the quantitative data collected using the Teacher Efficacy and Attitudes Toward STEM (T-STEM) survey developed by the Friday Institute for Education Innovation (FIEI, 2012) at North Carolina State University. Finally, the themes and patterns that emerged from the qualitative questions included on the survey and designed to identify both positive and negative influencing factors on early childhood teacher confidence are examined.

### **Purpose Statement**

The purpose of this study was to identify the self-efficacy of early childhood teachers toward STEM subjects as measured on the T-STEM survey (FIEI, 2012) and to explore factors that influence confidence in teaching STEM.

### **Research Questions**

This study sought to address the following research questions:

1. What is the degree of self-efficacy of early childhood teachers in STEM subjects as measured by the T-STEM (FIEI, 2012)?
2. What factors do early childhood teachers identify as barriers to increased confidence in teaching STEM subjects?

3. What factors do early childhood teachers identify as positively influencing their confidence in teaching STEM subjects?

### **Research Methods and Data Collection Procedures**

This study sought to identify self-efficacy toward STEM subjects among teachers of children aged three to eight. It also sought to explore and describe trends in factors that influence self-efficacy. The primary instrument for this study was an adaptation of the T-STEM survey developed by FIEI (2012). This quantitative measure was supplemented with two open-ended items designed to identify positive and negative factors influencing T-STEM scores.

Data collection for this study began with a field test. Current and former colleagues of the researcher who otherwise meet the requirements for study participation were asked to field test the survey. The survey was field tested with 10 individuals. The field test version included questions to determine eligibility, the quantitative T-STEM questions, the qualitative questions to determine influence, and a follow-up question seeking feedback on the clarity and usability of the study (Appendix C). Of the 10 individuals who responded to the field test, nine gave feedback on the survey design. The majority of these were complementary and no revisions to the survey were indicated.

The survey was distributed to 210 potential respondents via a group email with an embedded link to an on-line survey. of the 210 potential respondents, 44 individuals completed the survey, 43 of whom met the study criteria and completed all the questions. This number of respondents met the minimum number to obtain the desired confidence level of 95% and a confidence interval of 15.

## **Population**

The population of teachers who teach children aged three to eight in the United States numbers over one million. Given this vast population, a target population was chosen for this study. A target population is the group of individuals who fit the characteristics of the overall population, but can be separated out by a single defining characteristic (Creswell, 2008). For this study, the target population was teachers whose schools were members of the Northwest Association of Independent Schools (NWAIS). This represented approximately 1,500 teachers during the 2017-18 school year, with an estimated 210 teaching children aged three to eight (NWAIS, 2015).

## **Sample**

To compile a sample for this study, the researcher used a convenience sampling technique. This method of nonprobability sampling does not include random assignment of subjects; rather, potential participants are those readily available to the researcher (Creswell, 2008; McMillan & Schumacher, 2010; Terrell, 2012). The researcher was a member of NWAIS for over a decade with reliable access to its members. All 210 individuals listed in the NWAIS directory as early childhood teachers were e-mailed the survey. Of those, 44 responded with 43 completed surveys.

## **Demographics**

Anonymity was an important aspect to achieving candid feedback from respondents, so little demographic data were collected. Demographic data were used to assure membership in the target population, including employment in an NWAIS affiliated school and current teaching assignment with students aged three to eight. Specifically, survey respondents were asked to identify the age group they taught as 3-4,

5-6, or 7-8-year-old children. Nineteen respondents taught 3- and 4-year-olds, 14 taught 5- and 6-year-olds, and 10 taught 7- and 8-year-olds. This demographic breakdown was used to lend further insight to the quantitative study question.

### **Presentation and Analysis of Quantitative Data**

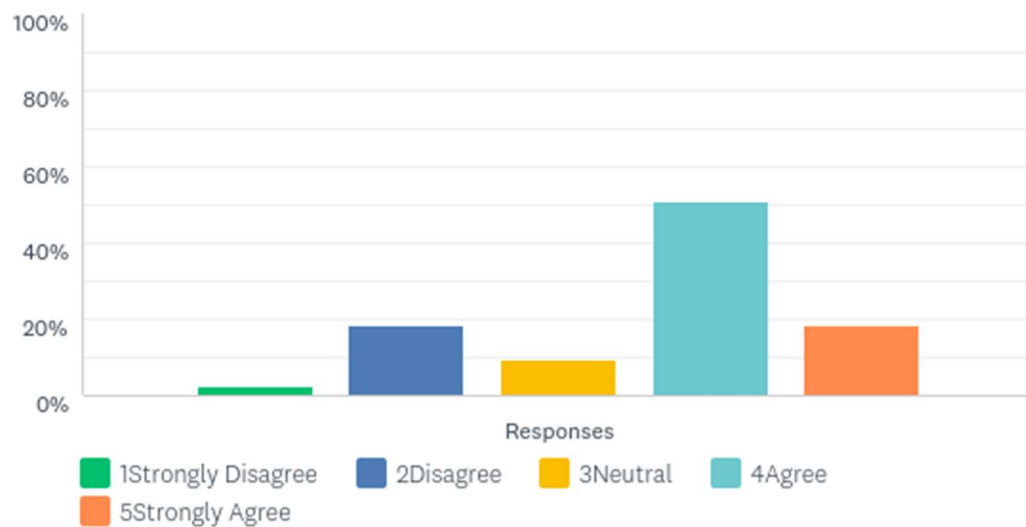
Quantitative data collected via the T-STEM survey and two open-ended items were used to answer the study's three research questions. This section presents the quantitative data and its analysis as it directly pertains to answering the study's research questions. These quantitative data were exclusively retrieved from the 43 complete responses to the electronic survey provided to the target population. Questions 4-14 of the survey were designed to elicit quantitative responses of 1-5 based on a Likert scale where 1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree*, and 5 = *Strongly Agree*.

#### **Data Analysis for Research Question One**

This section provides an analysis of the quantitative data directed at answering research question one, *What is the degree of self-efficacy of early childhood teachers in STEM subjects as measured by the T-STEM (FIEI, 2012)?* Data for this section were collected using a modified version of the elementary portion of the T-STEM survey designed to produce quantitative data using a Likert scale (FIEI, 2012). These questions were modified from the original survey to more comprehensively address STEM as an integrated discipline and streamlined to focus on the determination of teacher self-efficacy levels. To organize this section, each of the 11 questions is individually analyzed, beginning the aggregated data from all 43 respondents followed by disaggregated data by age of student taught.

**Statement 1: I am continually improving my STEM subjects teaching**

**practice.** With a mean of 3.65 on the 5-point scale, it indicated early childhood teachers slightly agreed they continually improved their STEM teaching practice. The most common response from this group (51.4%) was a 4, indicating a response of *agree*. When the responses of *agree* and *strongly agree* were combined, 30 out of 43 respondents, or 69.8% provided affirmative responses. This contrasted with 9 of 43 (20.9%) who marked *disagree* or *strongly disagree*. Only 4 respondents (9.3%) marked *neutral* (Figure 4).



*Figure 4.* Responses to statement one for all teachers.

When looking exclusively at teachers of children aged 3-4, the distribution was similar. For this group, the mean response was 3.53. The most common response was *agree* with 9 of 19 (47.4%) respondents. Combined affirmative responses accounted for 11 of 19 respondents (63.2%). Combined responses indicating disagreement accounted for 4 of 19 respondents (20.1%). Only 3 respondents marked *neutral*, accounting for 15.8% responses (Figure 5).



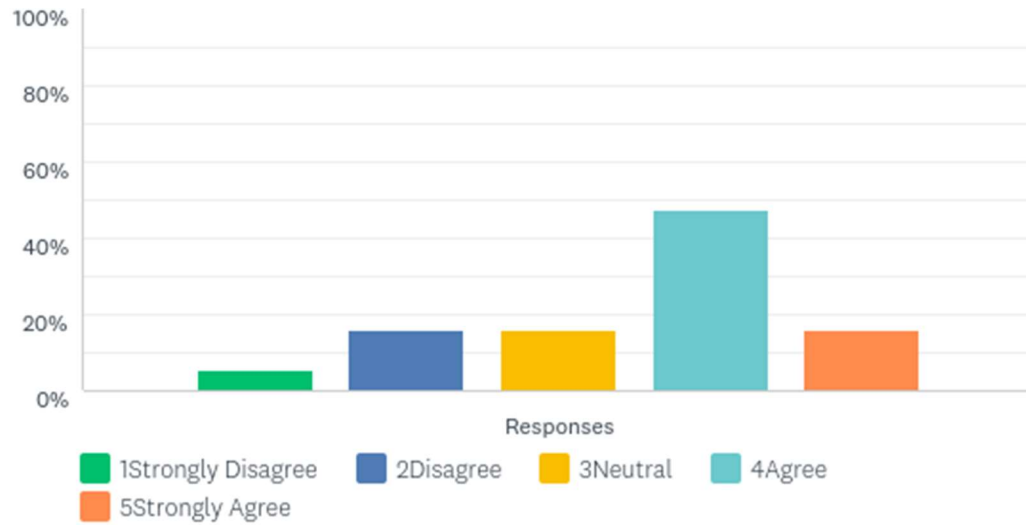


Figure 5. Responses to statement 1 for teachers of 3- and 4-year-olds.

No teachers of children aged 5-6 marked *strongly disagree* and only 3 of 14 (21.4%) marked *disagree*. Respondents indicating *neutral* accounted for 7.1%. Again, the most common response was *agree* with 7 of 14 (50.0%) respondents. These combined with the 3 respondents indicating *strongly agree* accounted for 71.4% of responses (Figure 6). The mean for this set of respondents was 3.71.

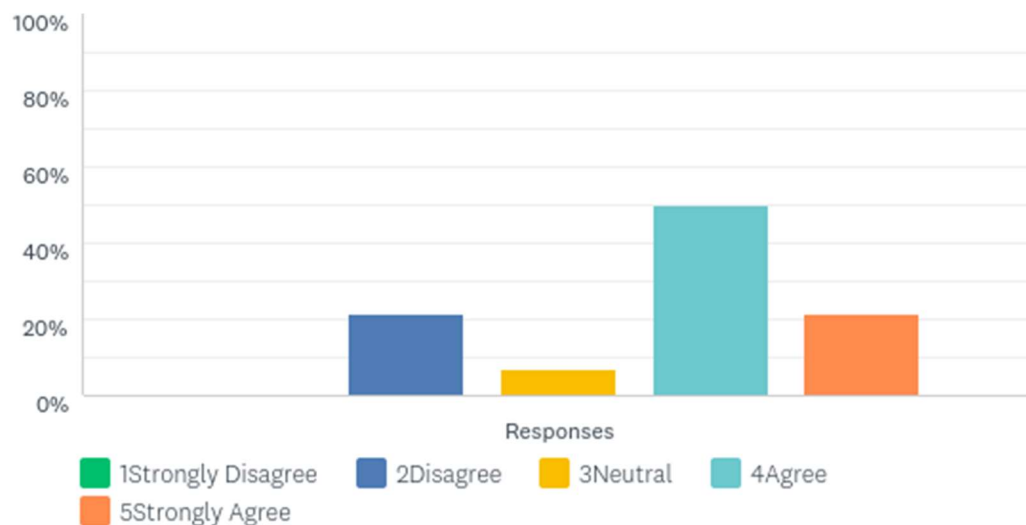


Figure 6. Responses to statement 1 for teachers of 5- and 6-year-olds.

No teachers of children aged 7-8 strongly disagreed, nor did any of these teachers remain neutral. Of the 10 respondents in this category, 2 (20%) indicated disagreement with the statement. Six respondents indicated agreement and an additional 2 indicated strong agreement (Figure 7). This resulted in combined 80% affirmative responses with a mean of 3.80 for this group.

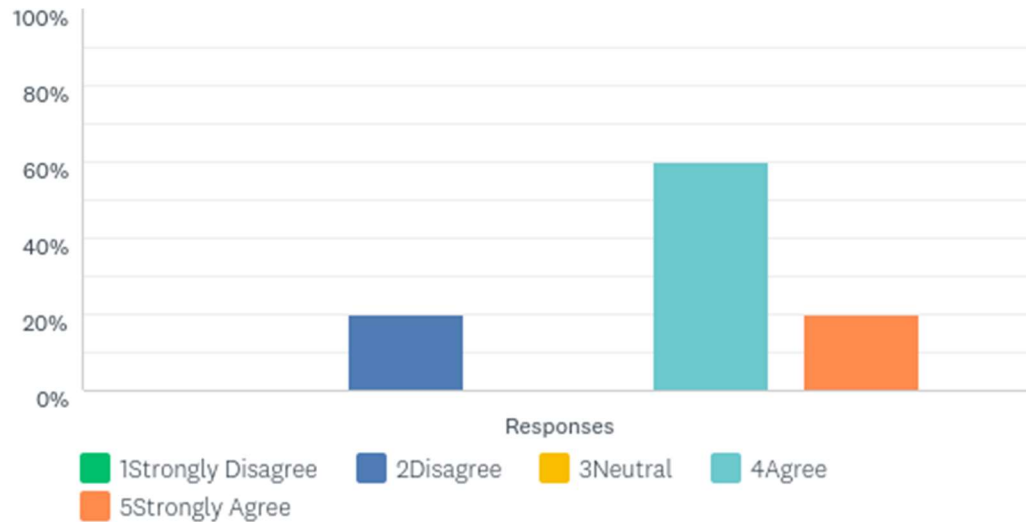


Figure 7. Responses to statement 1 for teachers of 7- and 8-year-olds.

**Statement 2: I know the steps necessary to teach STEM subjects effectively.**

In response to this statement, no individual indicated strong agreement and only 12 marked *agree*, for a total 27.9% combined affirmative responses. Four respondents (9.3%) indicated *neutral* whereas 25 individuals marked *disagree* and 2 marked *strongly disagree*. Together, 62.8% disagreed with the statement (Figure 8). Although the mean response was 2.60, indicating an overall trend toward neutrality, it is important to note most individuals responded to this statement with disagreement, indicating they did not feel confident they know the steps necessary to teach STEM subjects effectively.

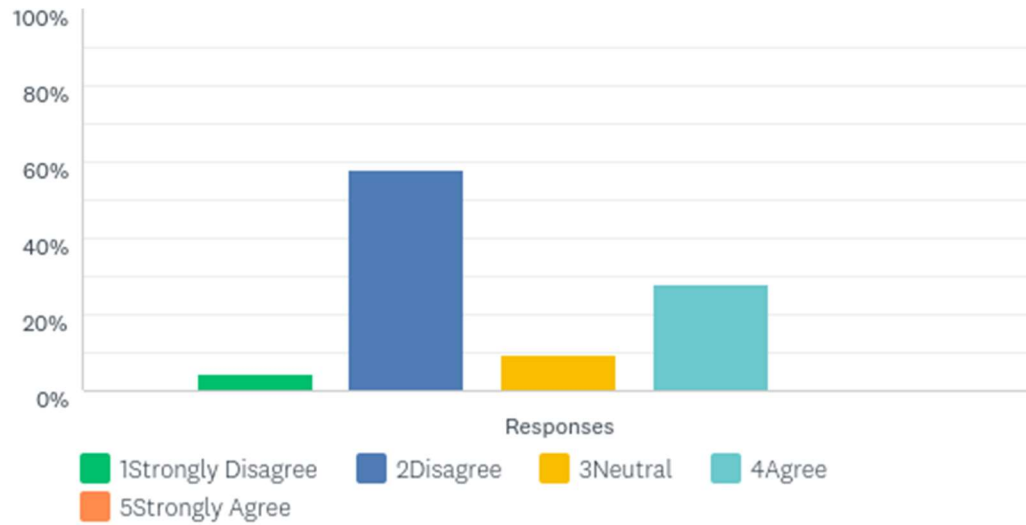


Figure 8. Responses to statement 2 for all teachers.

When separating teachers of children aged 3-4, 14 of the 19 respondents disagreed and two more strongly disagreed, representing 73.7%. Two respondents (10.5%) indicated *neutral* and 3 (15.8%) marked *agree* (Figure 9). The mean for this segment of the sample was 2.32.

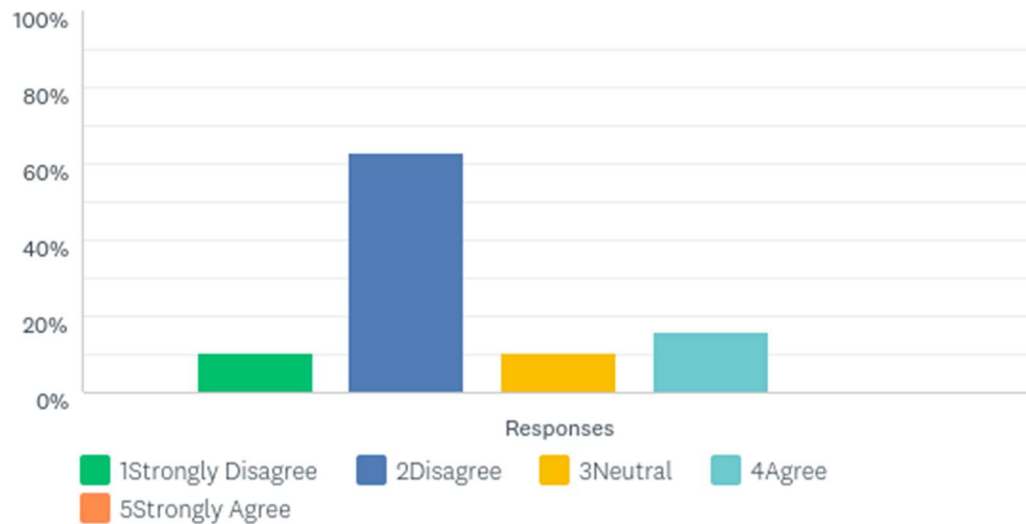


Figure 9. Responses to statement 2 for teachers of 3- and 4-year-olds.

None of the teachers of 5- and 6-year-olds indicated *strongly agree* or *strongly disagree* with the statement, leading to a mean of 2.93. As shown in Figure 10, one

teacher (7.1%) responded *neutral* whereas seven (50%) indicated disagreement and six (42.9%) indicated agreement.

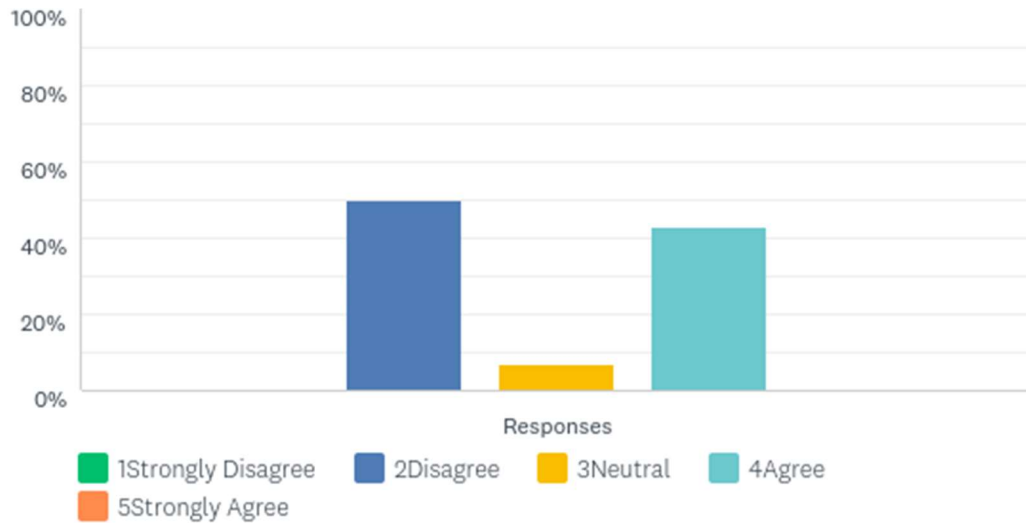


Figure 10. Responses to statement 2 for teachers of 5- and 6-year-olds.

Among the 10 respondents teaching 7- and 8-year-olds, none responded *strongly agree* or *strongly disagree*. One marked *neutral*, representing 10% of this sub-sample. Six (60%) indicated disagreement and 3 (30%) indicated agreement. The mean for this group was 2.70.

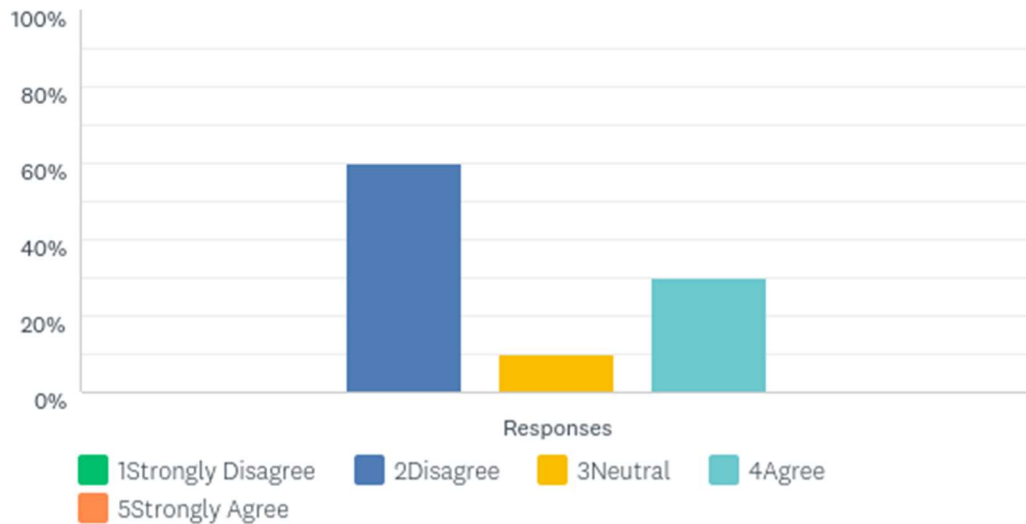


Figure 11. Responses to statement 2 for teachers of 7- and 8-year-olds.

**Statement 3: I am confident I can explain to students why experiments in STEM subjects work.** From the sample of 43 teachers, none strongly agreed with this statement and only one (2.3%) strongly disagreed. Rather, 17 individuals (39.5%) marked *agree*, 21 (48.8%) marked *disagree*, and 4 (9.3%) marked *neutral* (Figure 12). This led to a sample mean of 2.90. While this sample mean indicates overall neutrality, it is important to note the dichotomy presented by the 17 individuals who agreed and the 21 individuals who disagreed. This distribution around the mean indicates specific feelings of agreement or disagreement with the statement by individuals that is lost when looking at the collective.

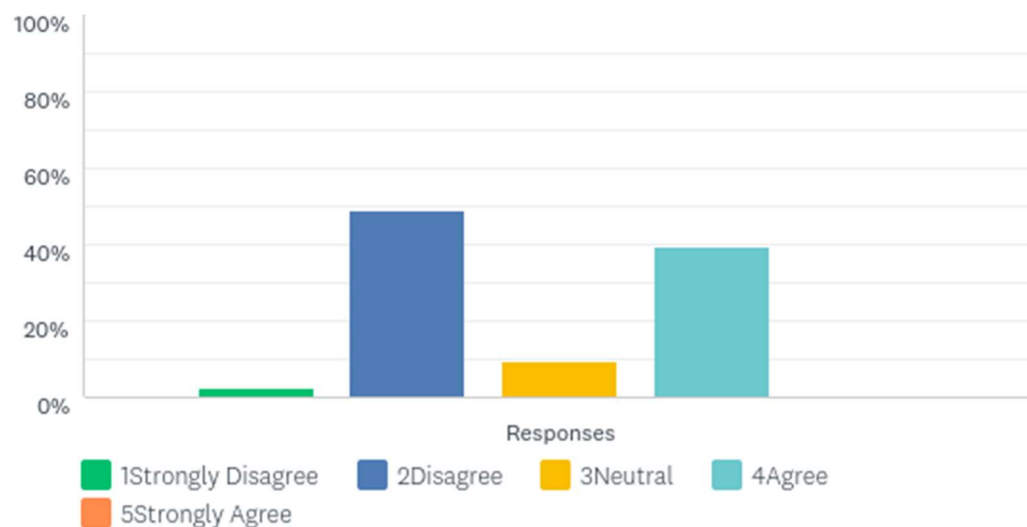


Figure 12. Responses to statement 3 for all teachers.

When isolating the results from the 19 teachers of children aged 3-4, a similar mean of 2.84 was found. Three (15.8%) teachers were neutral. Eight marked *disagree* and one marked *strongly disagree*, for a total of 47.4% who disagreed with the statement. No teachers strongly agreed with the statement and seven (36.8%) agreed (Figure 13).

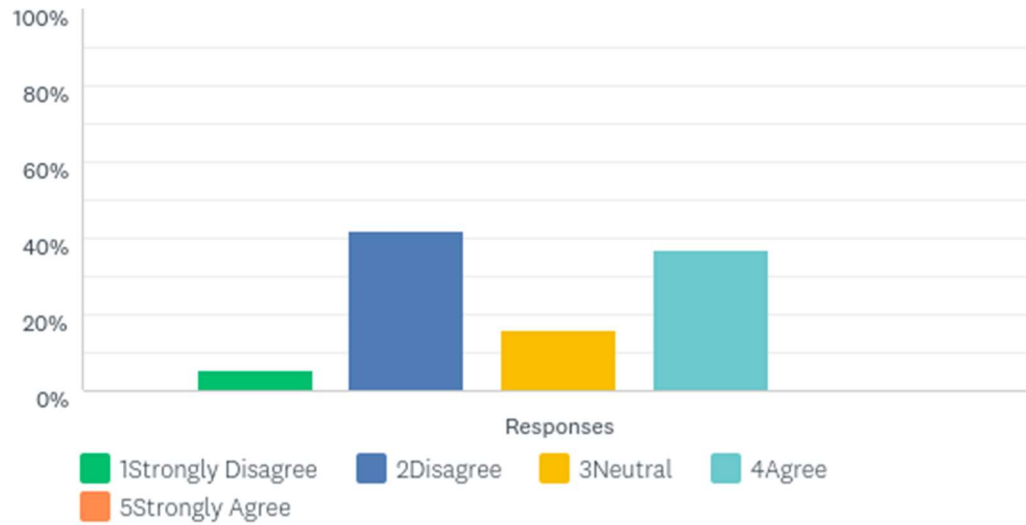


Figure 13. Responses to statement 3 for teachers of 3- and 4-year-olds.

Among teachers of children aged 5-6, the mean was 3.07. One of 14 (7.14%) respondents marked *neutral*, 6 (42.86%) marked *disagree*, and 7 (50%) indicated *agree* (Figure 14).

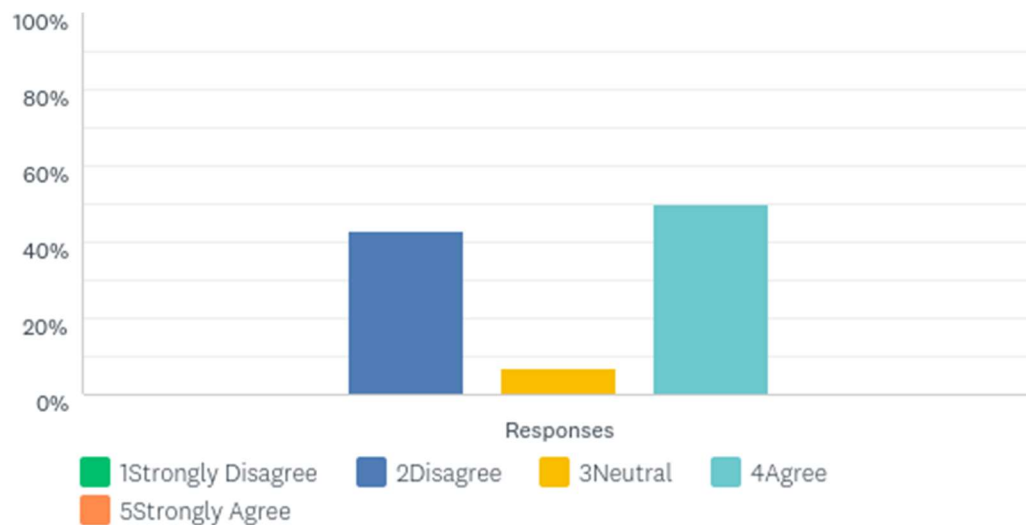


Figure 14. Responses to statement 3 for teachers of 5- and 6-year-olds.

None of the teachers working with students aged 7-8 indicated strong agreement, neutrality, or strong disagreement with the statement. Seven teachers (70%) disagreed whereas 3 (30%) agreed (Figure 15). The mean for this sub-sample was 2.60.

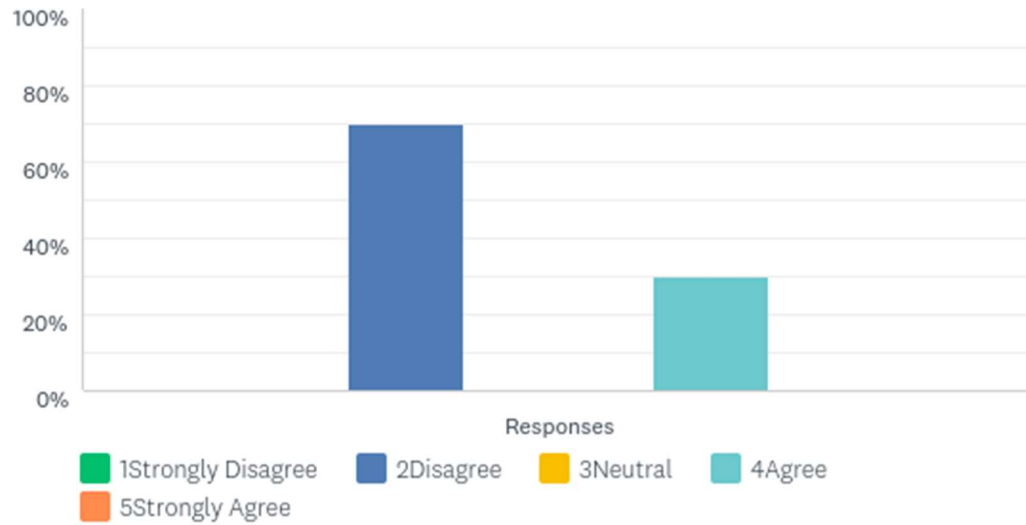


Figure 15. Responses to statement 3 for teachers of 7- and 8-year-olds.

**Statement 4: I am confident I can teach STEM subjects effectively.**

Responses from the 43 teachers had a mean of 2.86. One respondent marked *strongly disagree* and 18 marked *disagree*, indicating nearly half (44.2%) disagreed to some extent. Additionally, 11 (25.6%) marked *neutral* for the statement. Twelve respondents indicated agreement, with an additional individual indicating strong agreement, representing 30.2% of the sample (Figure 16). The responses to this statement cluster around the mean, but most individuals indicated specific agreement or disagreement.

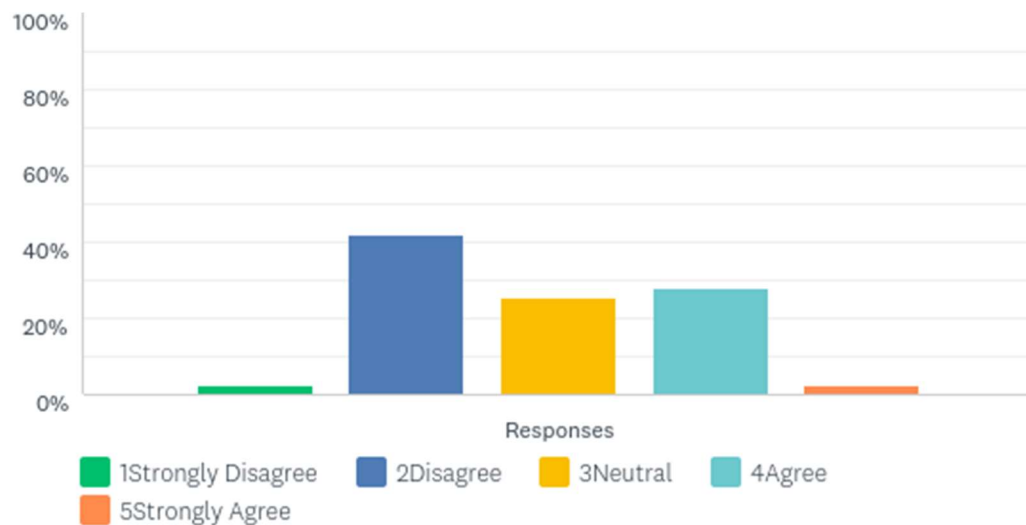


Figure 16. Responses to statement 4 for all teachers.

Responses to this statement from teachers of 3- and 4-year-old students had a mean of 2.58. Six (31.6%) indicated neutrality toward the statement. No respondents strongly agreed with the statement and only 3 (15.8%) agreed. The remaining 10 respondents disagreed, with 1 indicating strong disagreement, indicating 52.6% of respondents were not confident they could teach STEM subjects effectively (Figure 17).

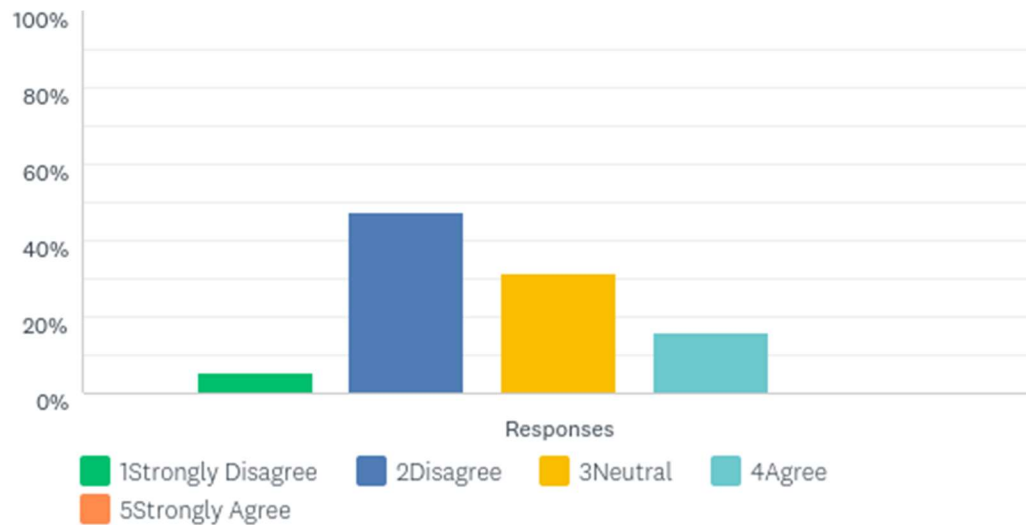


Figure 17. Responses to statement 4 for teachers of 3- and 4-year-olds.

When responses were isolated for the 14 individuals teaching children aged 5-6, the mean was 3.21, which was the highest of any subgroup. Among these, one (7.14%) marked *strongly agree* and six (42.9%) marked *agree*. Only two (14.3%) expressed neutrality. In contrast, five (35.7%) disagreed with the statement and none strongly disagreed with this statement (Figure 18).



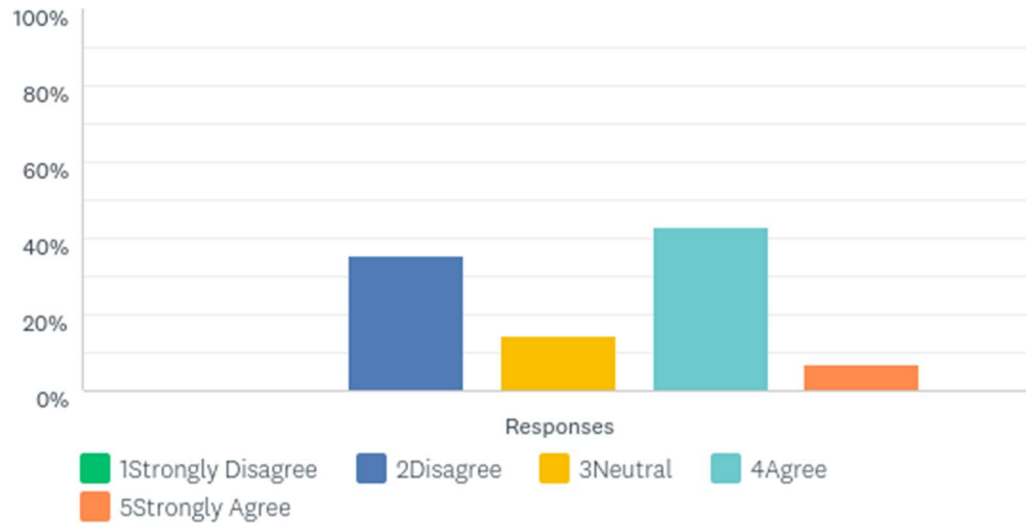


Figure 18. Responses to statement 4 for teachers of 5- and 6-year-olds.

Teachers of children aged 7-8 had a mean of 2.90. Of the 10 individuals in this demographic, none strongly agreed or disagreed with the statement. Three (30%) teachers marked *neutral*, three (30%) marked *agree*, and four (40%) marked *disagree* (Figure 19).

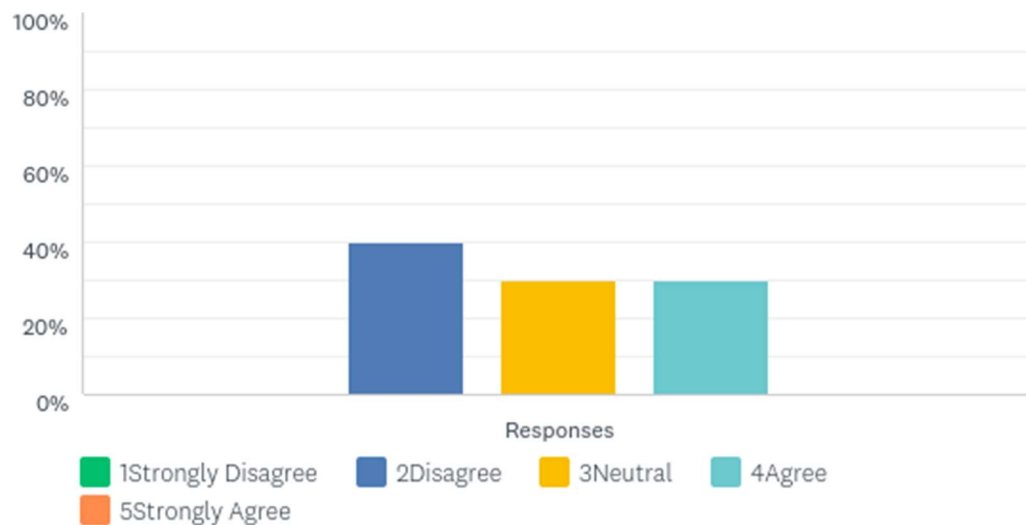


Figure 19. Responses to statement 4 for teachers of 7- and 8-year-olds.

**Statement 5: I wonder if I have the necessary skills to teach STEM subjects.**

The mean from all 43 participants was 3.53. *Agree* was chosen more than 3 times as often as any other response with 32 individuals selected this option. Two additional individuals

marked *strongly agree*, meaning 74.4% affirmed they wondered if they had the necessary skills to teach STEM subjects. Only one (2.3%) expressed neutrality and 10 (23.3%) expressed disagreement (Figure 20). Although the mean responses to this statement only falls at 3.53, indicating neutrality trending toward agreement, the large number of individual statements of agreements indicate that overall teachers do wonder if they have the necessary skills to teach STEM subjects. This indicates low feelings of self-efficacy.

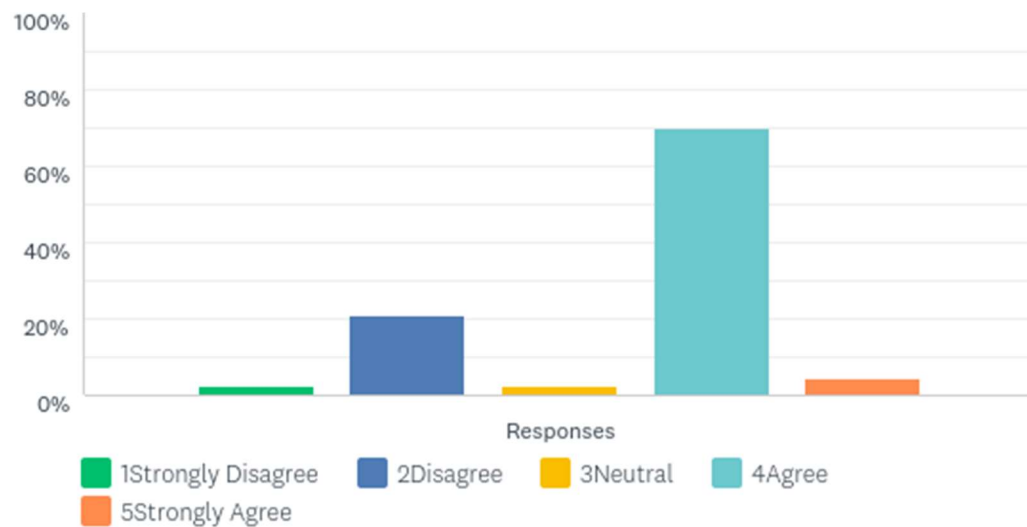


Figure 20. Responses to statement 5 for all teachers.

When disaggregated by teachers of 3- and 4-year-olds, the mean was 3.53, the same as the mean of the sample. Thirteen (68.42%) agreed with the statement, with an additional individual (5.26%) expressing strong agreement. Another single individual (5.26%) expressed neutrality toward the statement. Disagreement toward the statement was indicated by four individuals, with three (15.79%) responding *disagree* and one (5.26%) responding *strongly disagree* (Figure 21).

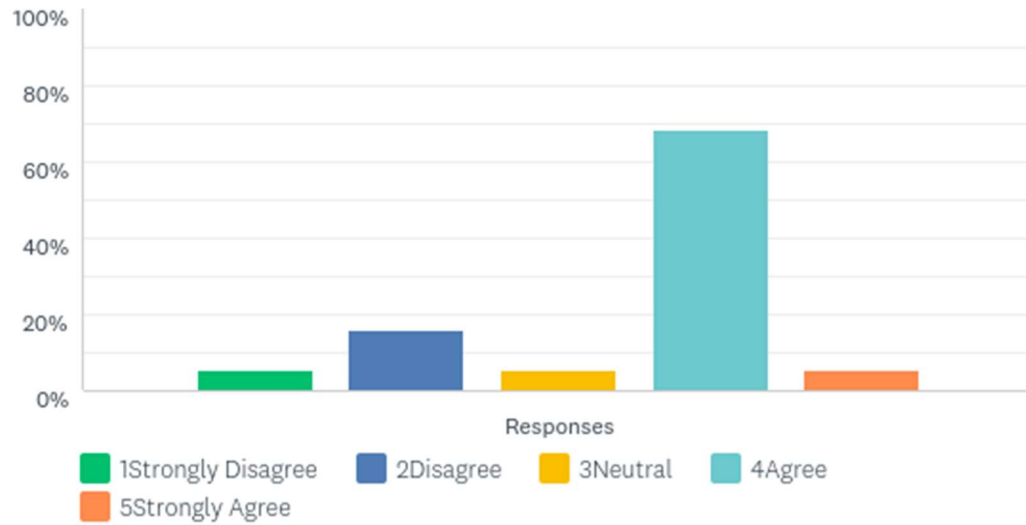


Figure 21. Responses to statement 5 for teachers of 3- and 4-year-olds.

The mean for teachers of 5- and 6-year-olds was 3.50. None of the 14 respondents strongly disagreed with the statement, but four (28.6%) disagreed. None of the individuals expressed neutrality toward the statement, but nine (64.3%) agreed and an additional individual (7.14%) strongly agreed (Figure 22).

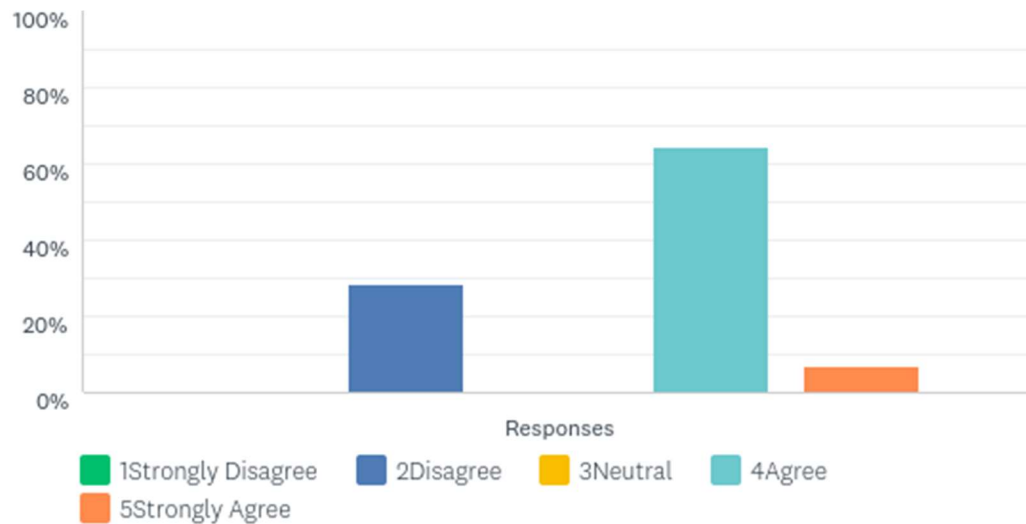


Figure 22. Responses to statement 5 for teachers of 5- and 6-year-olds.

Among respondents teaching children aged 7-8, the mean was 3.60. Responses from the 10 individuals fell into only two areas: two (20%) disagreed and eight (80%) agreed (Figure 23).

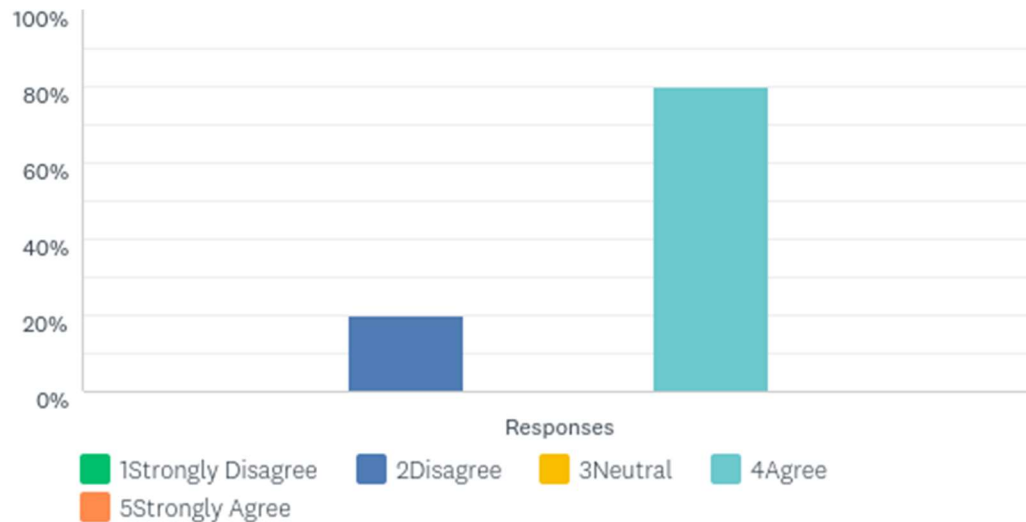


Figure 23. Responses to statement 5 for teachers of 7- and 8-year-olds.

**Statement 6: I understand STEM concepts enough to be effective in teaching STEM subjects.** Of the 43 responses to this statement, 2 individuals strongly disagreed and 19 individuals disagreed. Together, these 21 individuals expressing some level of disagreement accounted for 48.8% of the sample. Neutrality toward the statement was expressed by 10 individuals (23.3%). Eleven respondents expressed agreement, with an additional individual expressing strong agreement, accounting for 27.9% of the sample. The mean value of responses to this statement was 2.77. The responses to this statement cluster around the mean, but most individuals indicated specific agreement or disagreement.

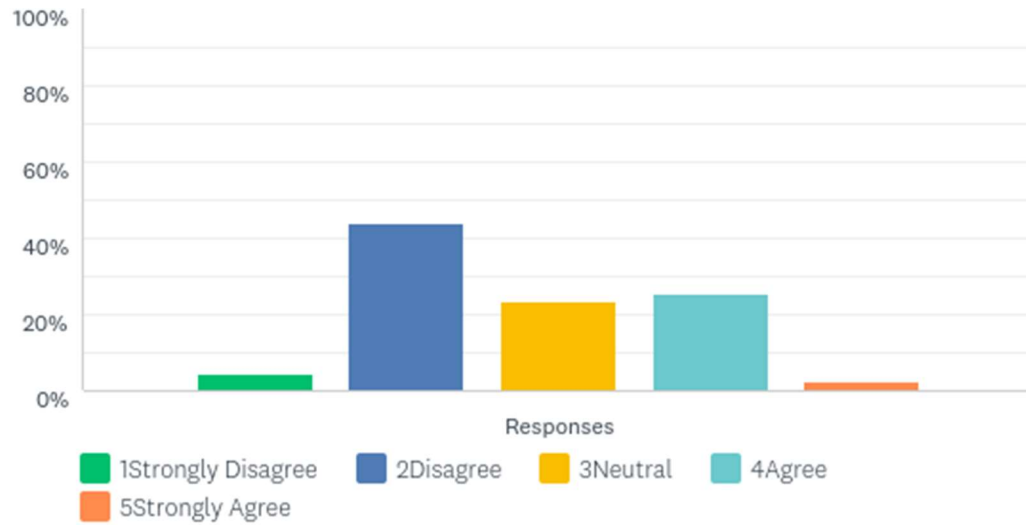


Figure 24. Responses to statement 6 for all teachers.

When isolating the responses of teachers of 3- and 4-year-olds, the mean was 2.53. Of the 19 individuals in this category, none strongly agreed with the statement and only four (21.1%) expressed agreement. Neutrality toward the statement was expressed by four (21.1%). Some extent of disagreement was expressed by 11 individuals (57.9%), with 2 noting strong disagreement (Figure 25).

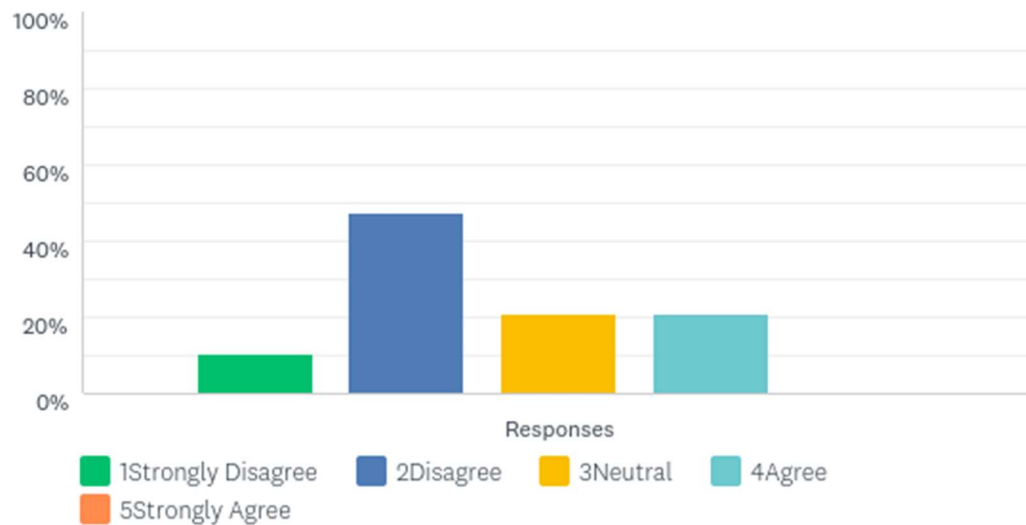
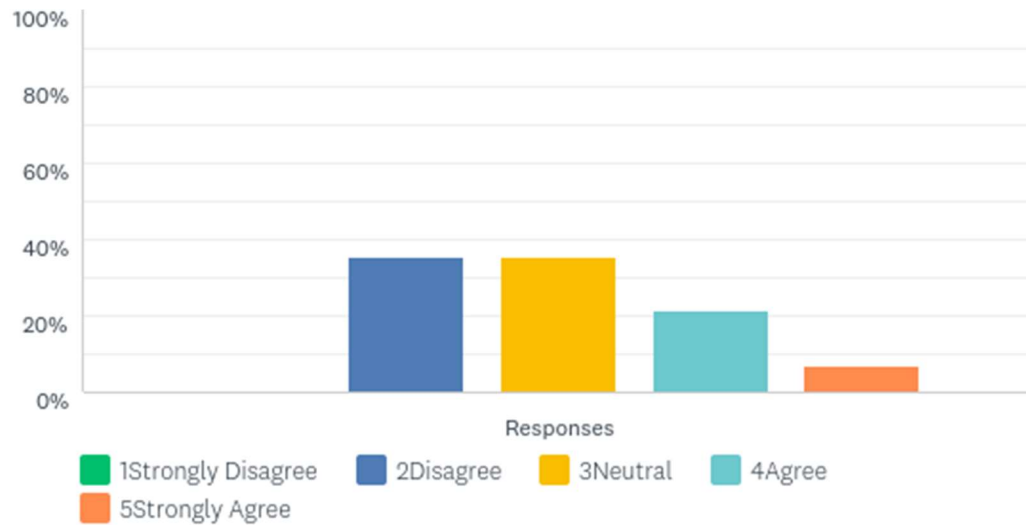


Figure 25. Responses to statement 6 for teachers of 3- and 4-year-olds.

Teachers of 5- and 6-year-olds had a mean of 3.00. Of these 14 teachers, none strongly disagreed with the statement and five (35.7%) disagreed. Another five (35.7%) stated neutrality toward the statement. Agreement was expressed by four (28.6%) teachers, with one of these expressing strong agreement (Figure 26).



*Figure 26.* Responses to statement 6 for teachers of 5- and 6-year-olds.

Isolating the responses of teachers of 7- and 8-year-olds to this statement yielded a mean of 2.90. None expressed strong agreement or strong disagreement, and only one (10%) expressed neutrality toward the statement. Five (50%) disagreed and four individuals (40%) agreed with the statement (Figure 27).

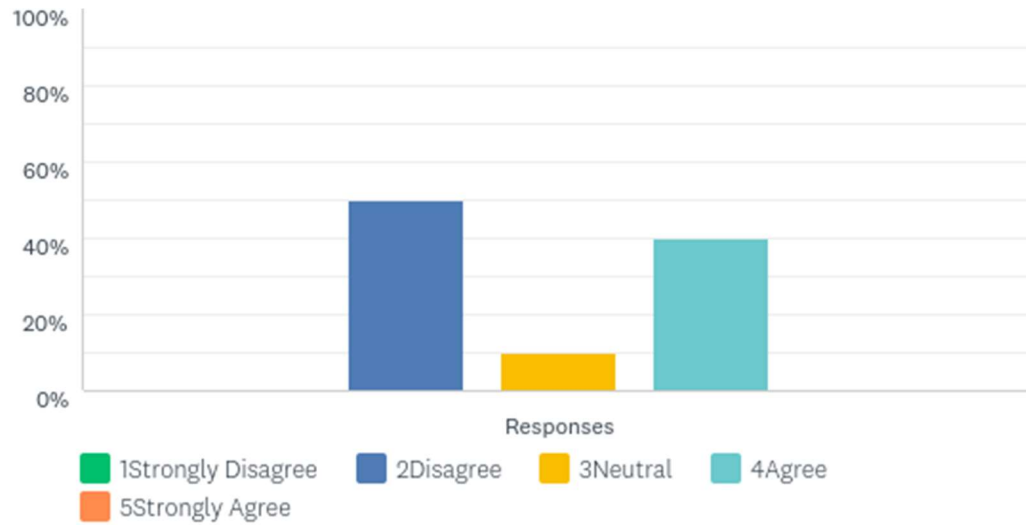


Figure 27. Responses to statement 6 for teachers of 7- and 8-year-olds.

**Statement 7: Given a choice, I would invite a colleague to evaluate my teaching of STEM subjects.** Of the 43 respondents in the sample, 69.8% (30 individuals) disagreed with this statement, with half strongly disagreeing. Four teachers (9.3%) reported being neutral toward the statement, nine (20.9%) agreed with the statement, and none strongly agreed (Figure 28). The mean for this statement was 2.16.

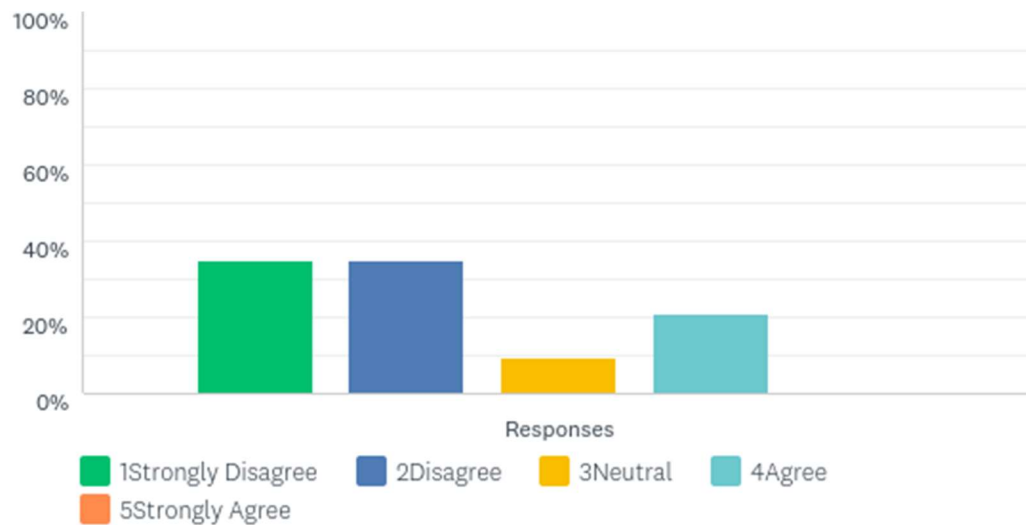


Figure 28. Responses to statement 7 for all teachers.

Responses to this statement from teachers of children aged 3-4 yielded a mean of 2.05. None of these 14 teachers strongly agreed with the statement and four (21.1%) expressed agreement. Neutrality toward the statement was expressed by one individual (5.3%). Disagreement was indicated by six individuals (31.6%), with an additional eight individuals (42.1%) marking *strongly disagree* (Figure 29).

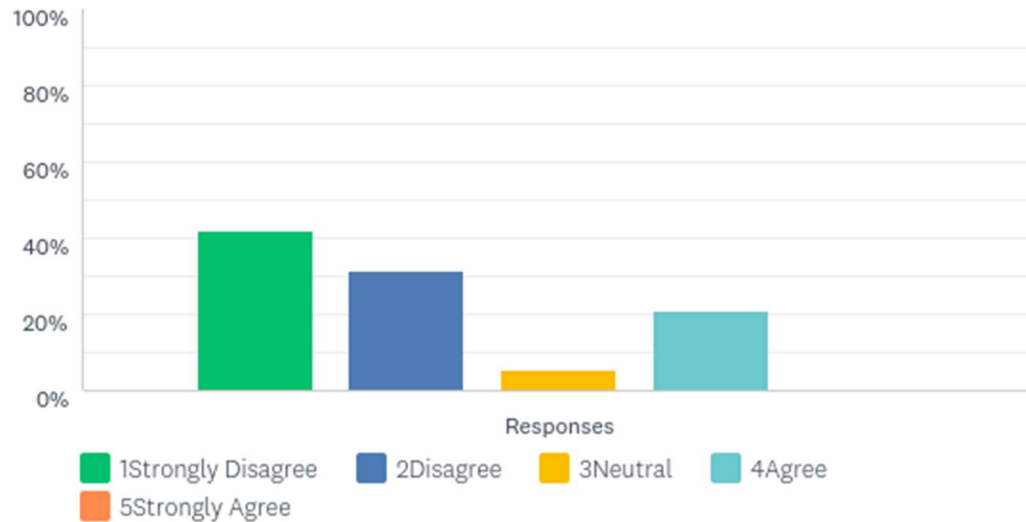


Figure 29. Responses to statement 7 for teachers of 3- and 4-year-olds.

The mean for the 14 teachers working with 5- and 6-year-olds was 2.43. More than half (57.1%) disagreed with this statement, with half of those expressing strong disagreement. Two teachers (14.3%) expressed neutrality and four (28.6%) agreed with the statement (Figure 30).



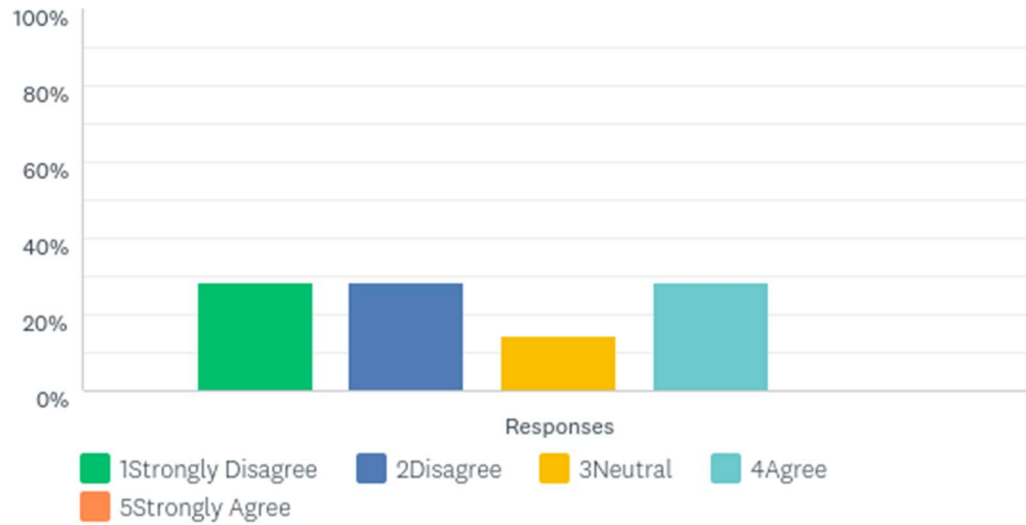


Figure 30. Responses to statement 7 for teachers of 5- and 6-year-olds.

When isolating responses from teachers of 7- and 8-year-olds, the mean was 2.00. Of the 10 respondents, only one (10%) expressed agreement with the statement, and none expressed strong agreement. Another single individual (10%) responded to the statement with neutrality. Five individuals (50%) disagreed with the statement with an additional three (30%) expressed strong disagreement (Figure 31).

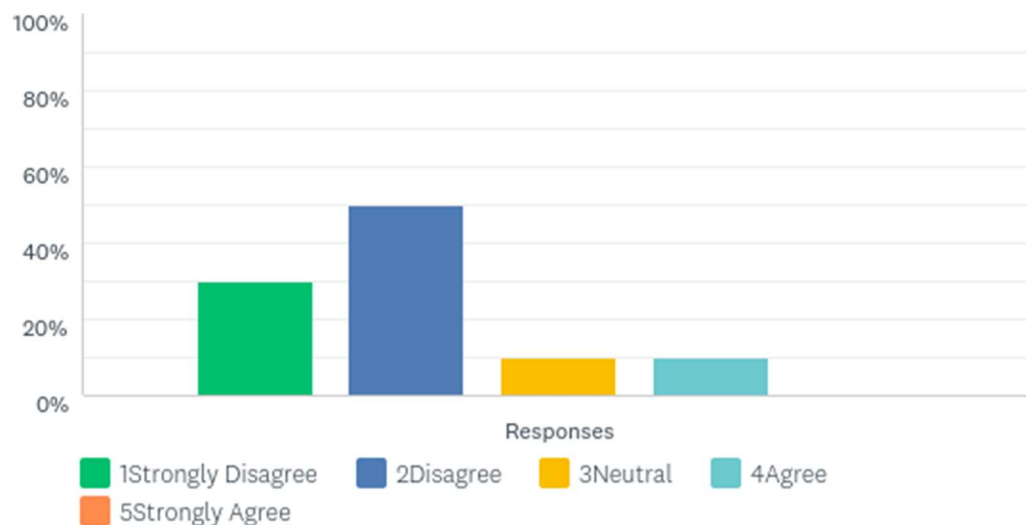
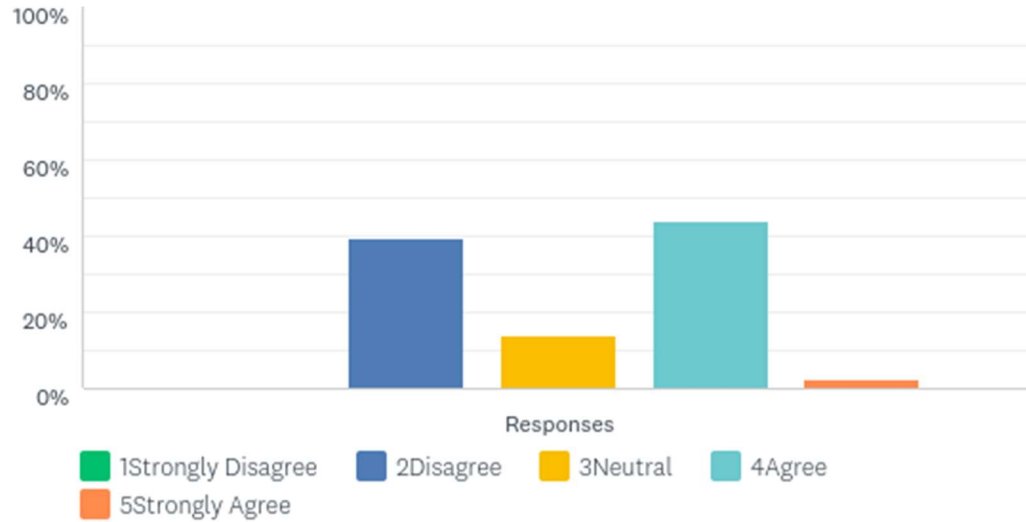


Figure 31. Responses to statement 7 for teachers of 7- and 8-year-olds.

**Statement 8: I am confident I can answer students' questions in STEM**

**subjects.** The mean for this statement across all 43 respondents was 3.09. None strongly disagreed with the statement and only one (2.3%) reported strong agreement. A response of neutral was given by six (14.0%) individuals. Seventeen (39.5%) respondents reported disagreement with the statement, and 19 (44.2%) agreed with the statement (Figure 32).



*Figure 32.* Responses to statement 8 for all teachers.

Disaggregating the data, the responses from the 19 teachers working with children aged 3-4 yielded a mean of 3.00. The same number, 8 (42.1%), both agreed and disagreed with the statement. None of these teachers reported strong agreement or strong disagreement and three (15.8%) responded *neutral* (Figure 33).

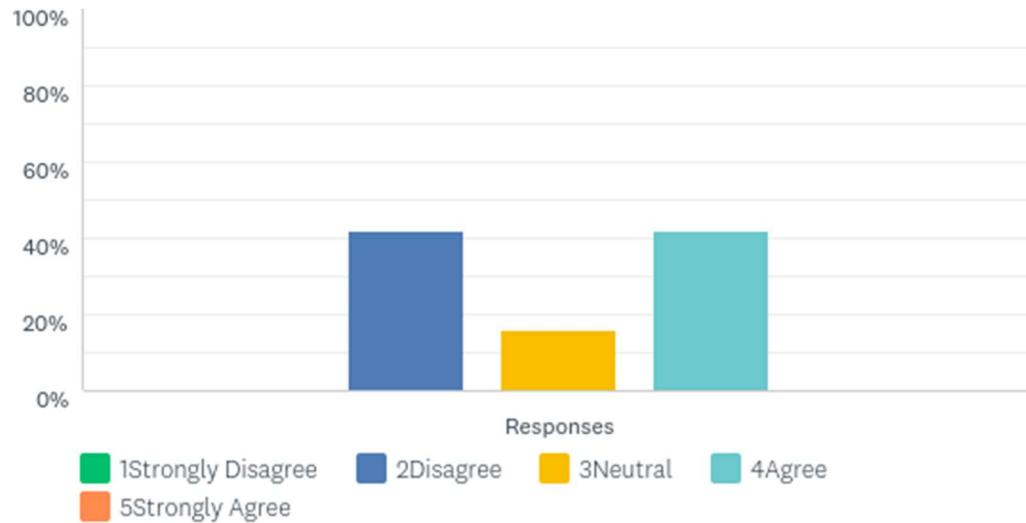


Figure 33. Responses to statement 8 for teachers of 3- and 4-year-olds.

No teachers working with children aged 5-6 strongly disagreed with the statement, although half (50%) disagreed with it. Two (14.3%) teachers were neutral toward the statement. Overall, five (35.7%) teachers reported some agreement with the statement, with one strongly agreeing (Figure 34). The mean value of scores from teachers of this age group was 2.93.

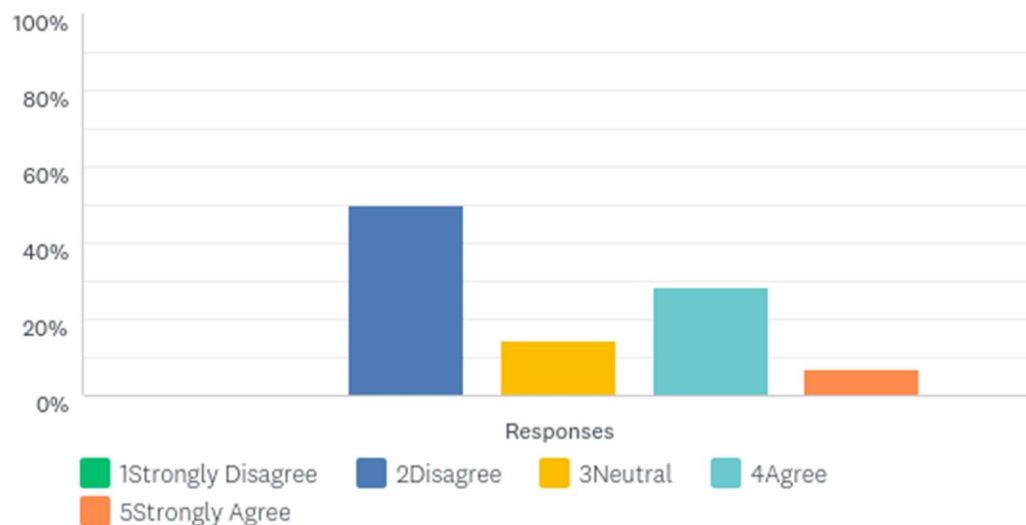


Figure 34. Responses to statement 8 for teachers of 5- and 6-year-olds.

The mean for teachers working with children aged 7-8 was 3.50. None of these individuals reported strong agreement or strong disagreement with the statement. One (10%) responded *neutral*, two (20%) marked *disagree*, and seven (70%) marked *agree* (Figure 35).

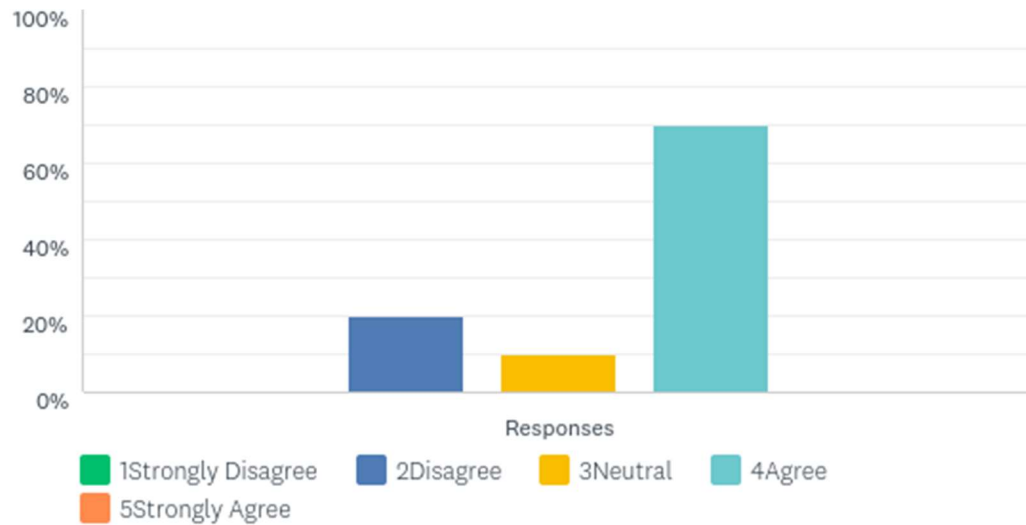


Figure 35. Responses to statement 8 for teachers of 7- and 8-year-olds.

**Statement 9: When a student has difficulty understanding a STEM concept, I am confident I know how to help the student understand it better.** Responses to this statement varied, although the extreme values of *strongly agree* and *strongly disagree* only had one respondent each, representing 2.3% of the sample each. The most common response was *disagree* with 22 (51.2%) respondents. Agreement with the statement was indicated by 15 individuals, or 34.9%. An additional four (9.3%) individuals indicated a *neutral* response to the statement (Figure 36).

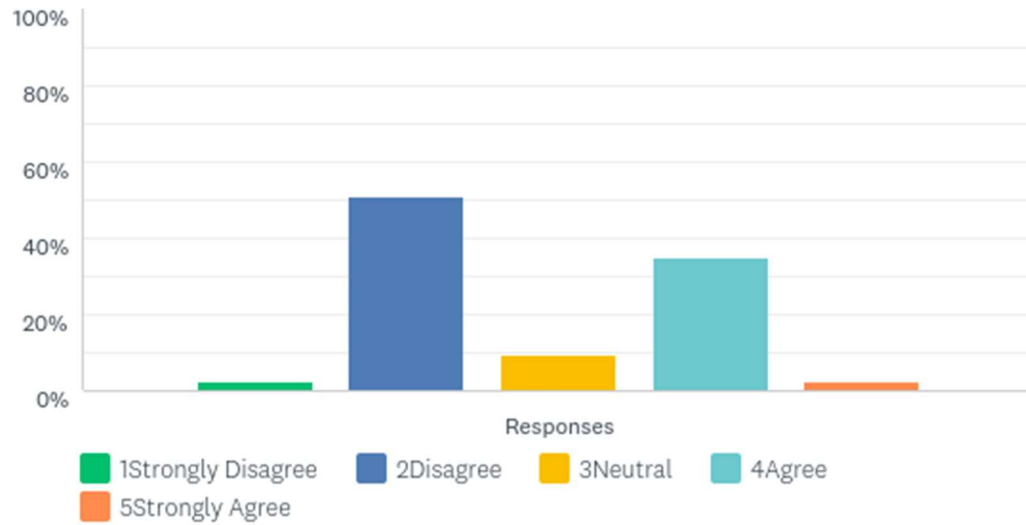


Figure 36. Responses to statement 9 for all teachers.

Teachers of 3- and 4-year-olds responded to this statement with a mean value of 2.89. None of these individuals reported strong agreement or strong disagreement. Three (15.8%) reported neutrality toward the statement. Disagreement with the statement was expressed by 9 of 19 individuals, or 47.4%. Seven (36.8%) agreed with the statement (Figure 37).

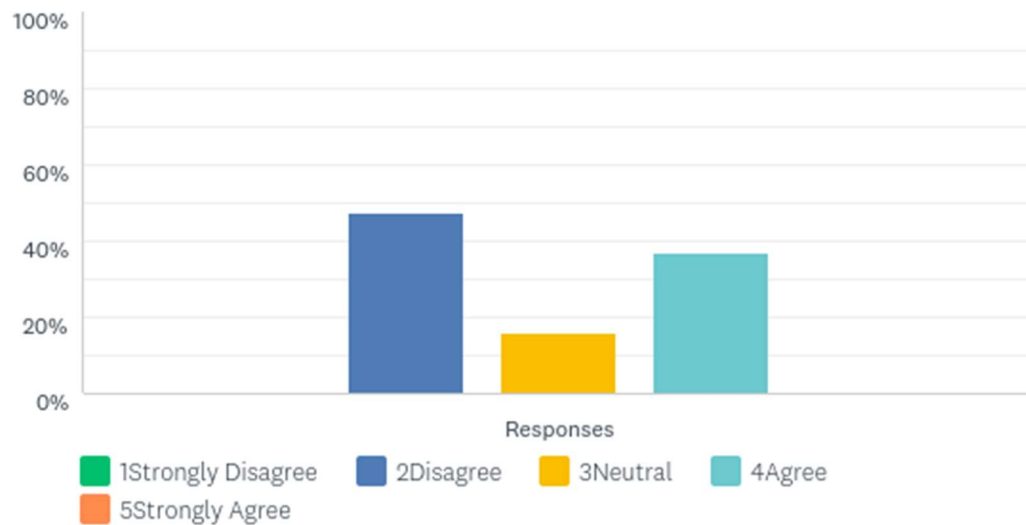


Figure 37. Responses to statement 9 for teachers of 3- and 4-year-olds.

When looked at in isolation, the mean for teachers of 5- and 6-year-olds was 2.93. Of the 14 applicable respondents in this subsample, one (7.14%) teacher each marked *strongly agree*, *neutral*, and *strongly disagree*. An additional six (42.9%) respondents reported disagreement and the remaining five (35.7%) agreed (Figure 38).

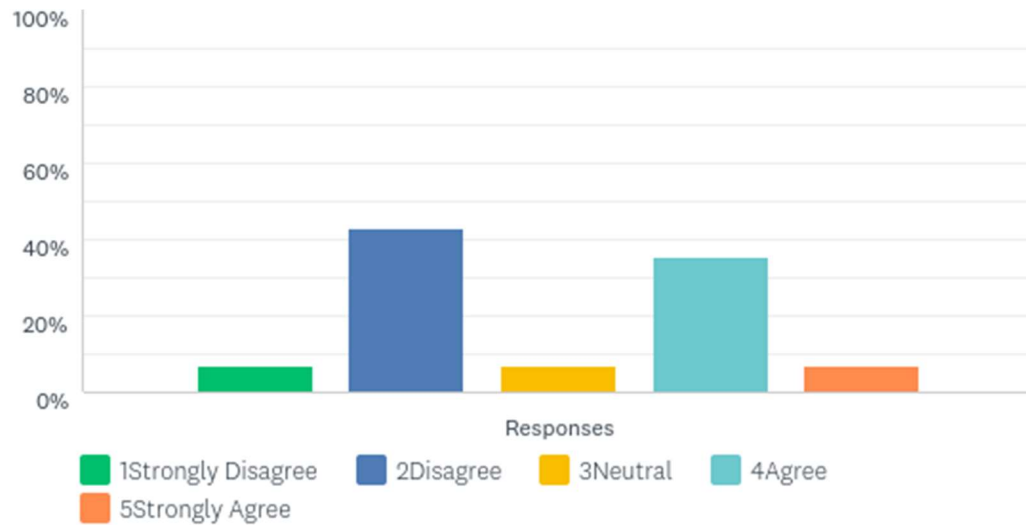


Figure 38. Responses to statement 9 for teachers of 5- and 6-year-olds.

The responses from teachers of 7- and 8-year-old students yielded a mean of 2.60. No individuals indicated strong agreement, strong disagreement, or neutrality toward the statement. Of the relevant respondents in this category, three (30%) reported agreement with the statement whereas seven (70%) reported disagreement with the statement (Figure 39).

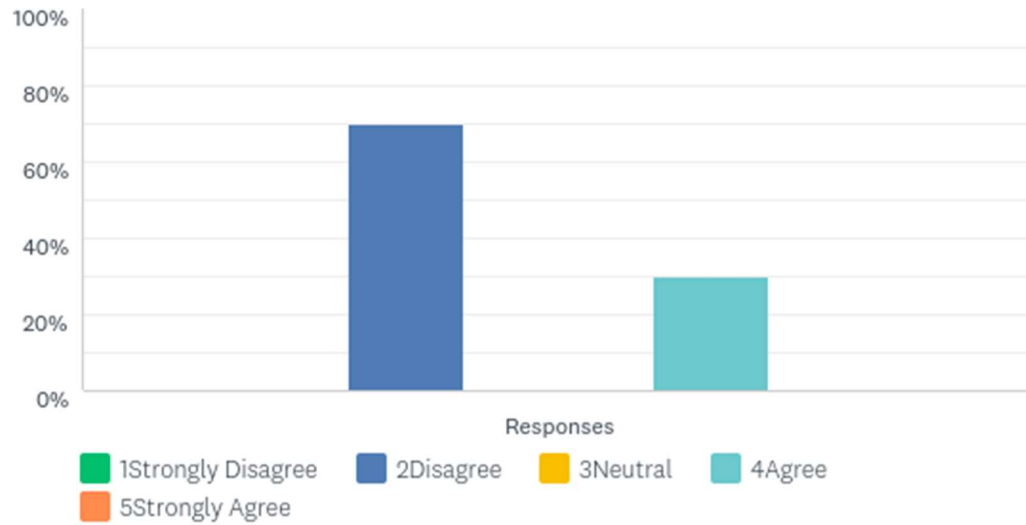


Figure 39. Responses to statement 9 for teachers of 7- and 8-year-olds.

**Statement 10: When teaching STEM subjects, I am confident enough to welcome student questions.** Responses to this statement from the 43 respondents yielded a mean of 3.58. No individuals marked *strongly disagree*. Seven (16.3%) individuals each gave a response of *disagree* or *neutral*. The most frequent response to this statement, given by 60.5% of the respondents, was *agree*. An additional three (7.0%) strongly agreed with the statement (Figure 40).

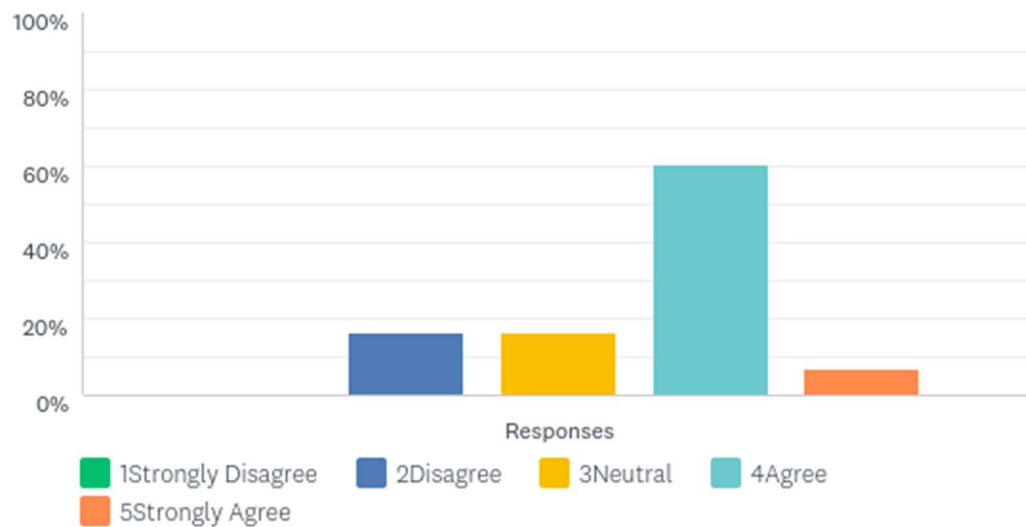
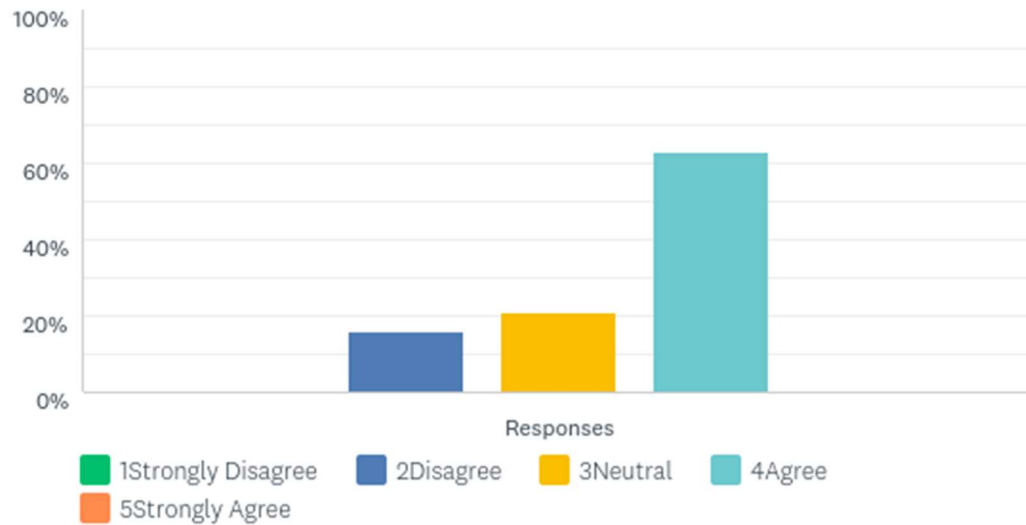


Figure 40. Responses to statement 10 for all teachers.

The isolated responses of teachers of 3- and 4-year-old students yielded a mean of 3.47. No respondents strongly agreed or strongly disagreed with the statement. Three (15.8%) expressed disagreement. Neutrality was expressed by four (21.1%). Most respondents in this group, 12 (63.1%), agreed with the statement (Figure 41).



*Figure 41.* Responses to statement 10 for teachers of 3- and 4-year-olds.

None of the teachers of 5- and 6-year-olds expressed strong disagreement with this statement. Three (21.4%) disagreed with the statement. Neutrality was expressed by two individuals (14.3%). Overall, nine (69.3%) expressed some level of agreement with the statement, three of whom strongly agreed (Figure 42). The mean for this subsample was 3.64.



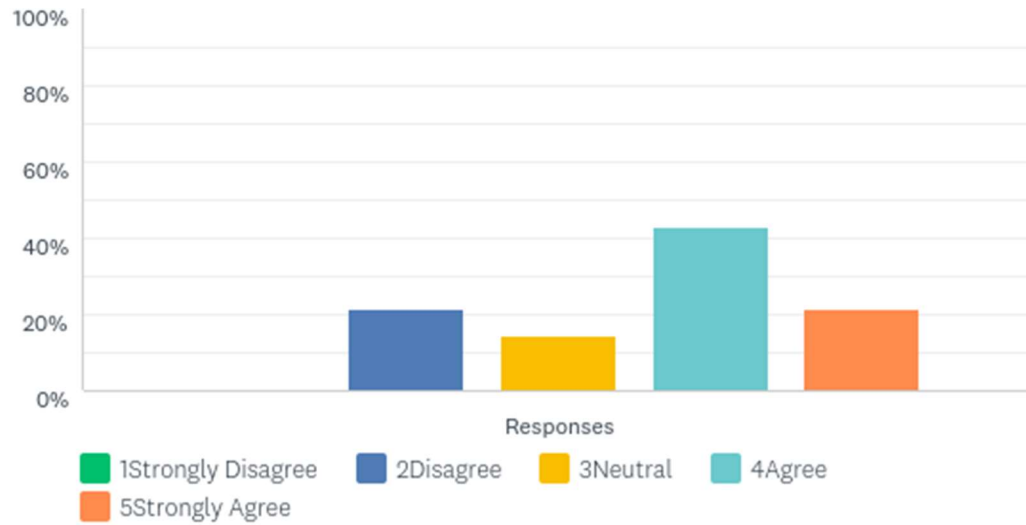


Figure 42 Responses to statement 10 for teachers of 5- and 6-year-olds.

Teachers of 7- and 8-year-old students had a mean of 3.70. None strongly agreed or strongly disagreed with this statement. One (10%) expressed disagreement and one (10%) expressed neutrality. The remaining eight respondents (80%) agreed with the statement (Figure 43).

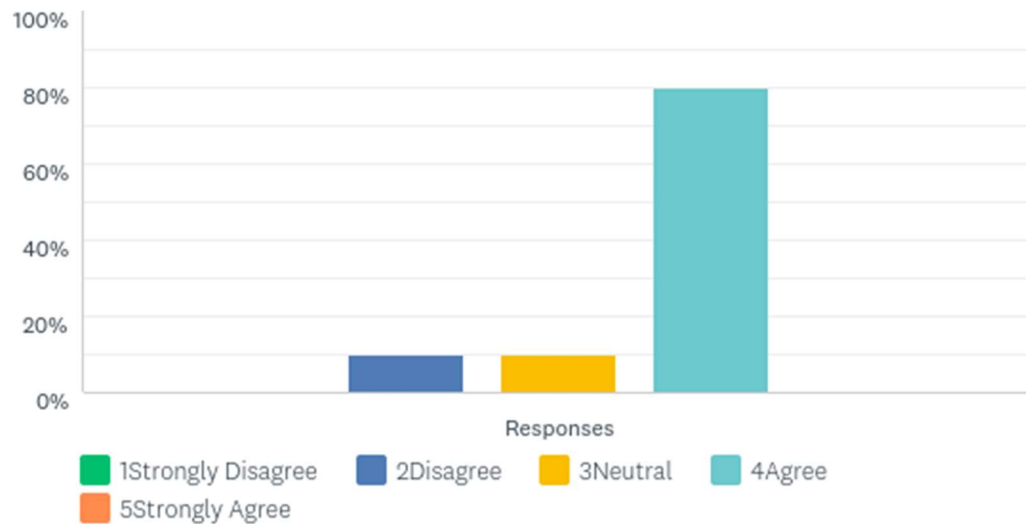
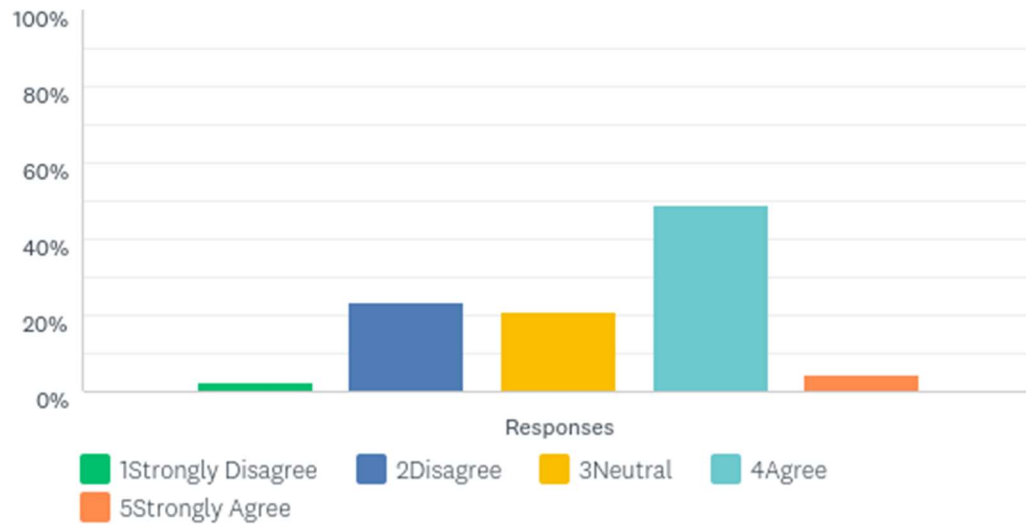


Figure 43. Responses to statement 10 for teachers of 8- and 9-year-olds.

**Statement 11: I know how to increase student interest in STEM subjects.** The mean for this statement was 3.30. A single individual (2.3%) reported strong

disagreement with the statement and 10 (23.3%) reported disagreement. Nine (20.9%) respondents indicated neutrality. The highest number of individuals, 21 (48.8%) indicated agreement with an additional two (4.7%) indicating strong agreement (Figure 44).



*Figure 44.* Responses to statement 11 for all teachers.

When isolating the results of teachers of 3- and 4-year-olds, the mean was 3.37. No individuals indicated strong disagreement and four (21.1%) indicated disagreement. Five (26.3%) indicated neutrality toward the statement. Agreement toward the statement was expressed by nine individuals (47.4%) with one additional person (5.26%) indicating strong disagreement (Figure 44).

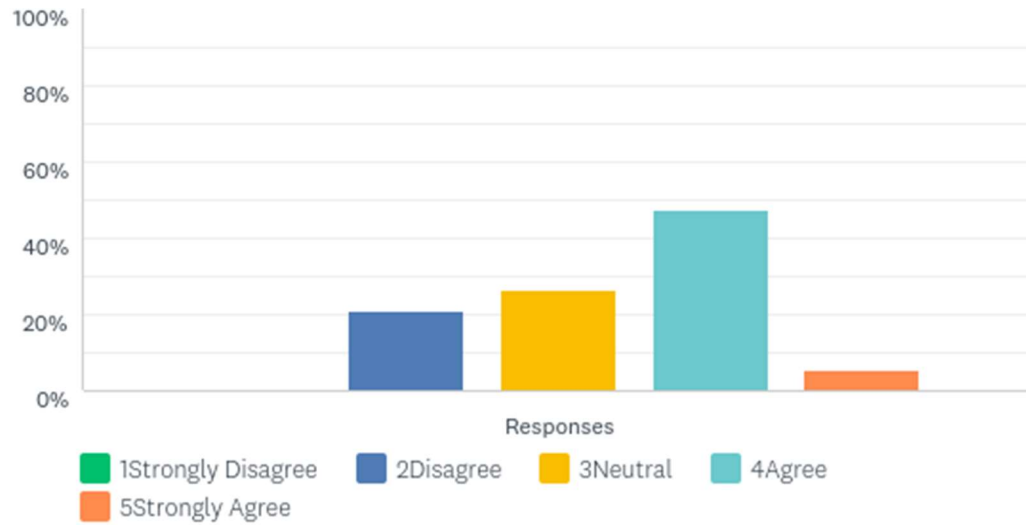


Figure 45. Responses to statement 11 for teachers of 3- and 4-year-olds.

Teachers of 5- and 6-year-olds had a mean of 3.21. Strong agreement and strong disagreement was each indicated by one individual (7.14%). Three (21.4%) indicated disagreement with the statement, whereas six (42.9%) indicated agreement. Three (21.4%) teachers expressed feelings of neutrality (Figure 46).

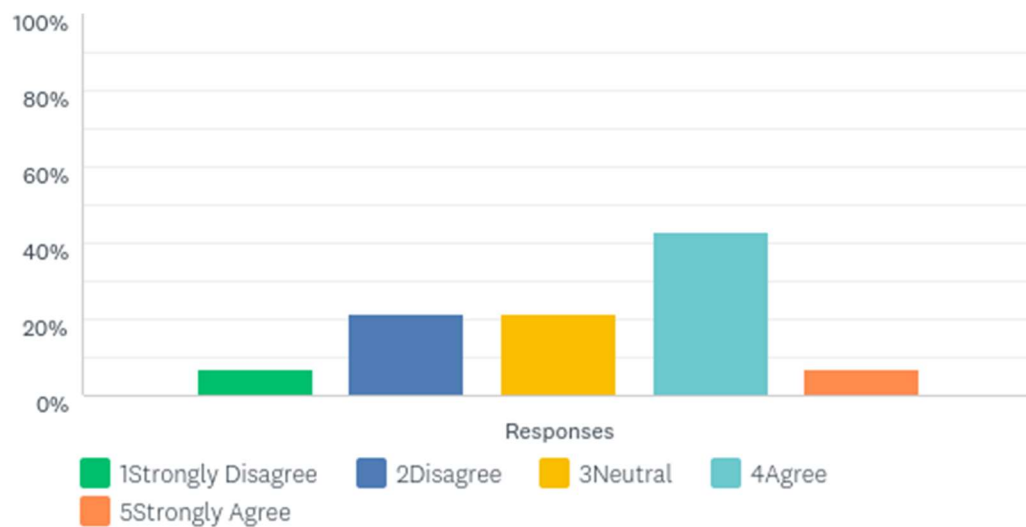


Figure 46. Responses to statement 11 for teachers of 5- and 6-year-olds.

No teachers of 7- and 8-year-old students indicated strong agreement or strong disagreement. One (10%) marked *disagree* and another (10%) marked *neutral*. The remaining eight (80%) respondents agreed with the statement (Figure 47).

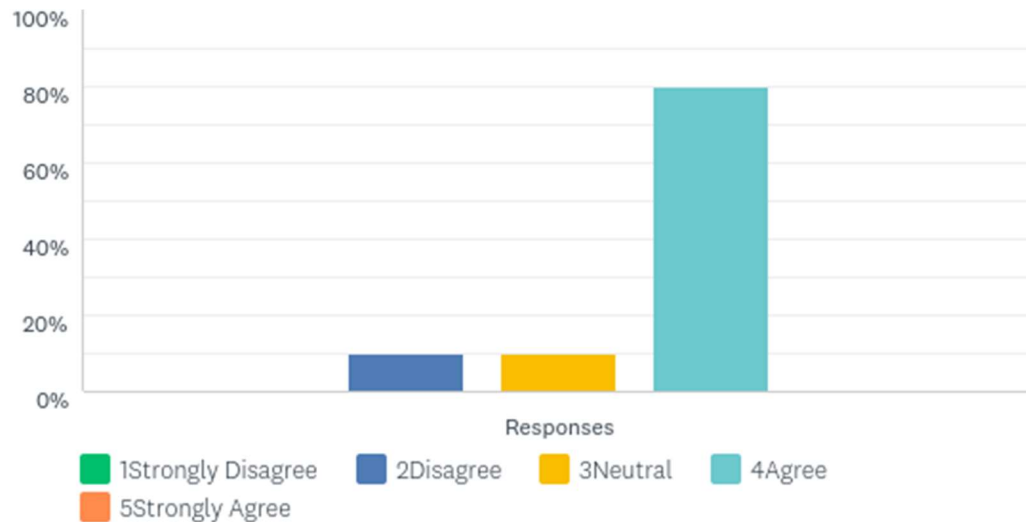


Figure 47. Responses to statement 11 for teachers of 7- and 8-year-olds.

### Summary Analysis for Research Question One

In this study, the first research question was “What is the degree of self-efficacy of early childhood teachers in STEM subjects as measured by the T-STEM (FIEI, 2012)?” The findings of this research question are presented in the table below. The responses from each question of the T-STEM are presented in descending order from those with the highest mean value of responses, to those with the lowest mean value of responses.

Table 1

*Statement Means in Descending Order*

	Mean
Statement 10: When teaching STEM subjects, I am confident enough to welcome student questions.	3.74
Statement 1: I am continually improving my STEM subjects teaching practice.	3.65
Statement 5: I wonder if I have the necessary skills to teach STEM subjects.	3.53
Statement 11: I know what to do to increase student interest in STEM subjects.	3.30
Statement 8: I am confident that I can answer students' questions in STEM subjects.	3.09
Statement 3: I am confident that I can explain to students why experiments in STEM subjects work.	2.86
Statement 5: I am confident that I can teach STEM subjects effectively.	2.86
Statement 9: When a student has difficulty understanding a STEM concept, I am confident that I know how to help the student understand it better.	2.84
Statement 6: I understand STEM concepts enough to be effective in teaching STEM subjects.	2.77
Statement 2: I know the steps necessary to teach STEM subjects effectively.	2.60
Statement 7: Given a choice, I would invite a colleague to evaluate my teaching of STEM subjects.	2.16

### **Presentation and Analysis of Qualitative Data**

The following section contains a presentation of the qualitative data and the analysis directly pertaining to answering the study's research questions. Qualitative data were exclusively retrieved from the 43 completed responses to the electronic survey provided to the target population. Questions 15 and 16 of the survey were designed to elicit qualitative responses, with respondents provided an open text box to type their responses. Guidelines on length of response or format were not provided. The entirety of each response was reviewed for specific factors, which then became codes. The frequency of these codes was then identified and analyzed.

## **Intercoder Reliability**

To assure the reliability of the coding, the researcher initially completed all the coding, then an independent consultant double-coded 10% of the data to check for consistency and accuracy. Only one discrepancy was noted in this coding, with the researcher identifying one additional instance of a code. This was determined to be an acceptable level of reliability for the study.

## **Data Analysis for Research Question Two**

This section provides an analysis of responses aimed at answering research question 2, “What factors do early childhood teachers identify as barriers to increased confidence in teaching STEM subjects?” This question was addressed through open-ended responses to “What factors negatively influenced your confidence in teaching STEM subjects to your students?” To analyze these data, each response was coded for factors and the frequency of those factors across all respondents was tabulated. From this analysis, three major factors (cited by 10 or more people) and two minor factors (cited by 2-9 people) emerged. Other factors were only mentioned by single individuals and were not considered in this analysis of results. Table 2 presented the frequencies of the themes.

Table 2

### *Frequency of Themes for Research Question 2*

Theme/Pattern	Frequency of Reference
Lack of Experience/Education/Training	17
Lack of Time/Resources/Materials	13
The Role of STEM in Early Childhood Education	12
Isolation of STEM Disciplines	7
Lack of Collaborators	5

**Lack of experience/education/training.** The most common barrier identified by respondents limited training, education, and experiences to be effective teachers of STEM subjects for their students. This factor was highlighted by 39.5% of respondents using phrases such as “I have not had much experience with it or much exposure in my own schooling (which mostly focused on liberal arts),” “I didn't really have the preparation for it in my teacher training program,” and “I have not really had exposure to teaching engineering or technology, and have done very little specific science teaching.” These responses closely aligned with the research emphasizing the variation in teacher training for early childhood educators.

**Lack of time/resources/materials.** Another common barrier identified by respondents was a lack of time, resources, and materials to support the teaching of STEM subjects. This highlighted a perception that specific tools or objects were needed to effectively teach STEM, but also helped identify a major aspect of tension in any teacher’s day – time management. This factor was identified by more than one in four respondents (30.2%). Phrases such as “not having fancy circuits or other STEM specific materials,” “Not enough support materials or curriculum,” and “There never seems to be enough time to do STEM activities” highlighted the widespread concern indicated by this commonly identified barrier.

**The role of STEM in early childhood education.** This major factor was indicated by 27.9% of respondents. They indicated STEM was not valued or did not have a place in a quality early childhood education program. Responses included phrases such as “It is hard to think of ways that STEM is used in preschool. We are a play-based program, so we don’t teach lessons in STEM,” “I don’t really know what STEM looks

like with my students, usually when people talk about STEM they are talking about kids programming robots or building video games, my kids are too young for that,” and “STEM is more for older grades - preschool kids should play.”

**Isolation of STEM disciplines.** Responses from 16.3% of the individuals completing the survey indicated a lack of integration of the STEM disciplines contributed as a barrier to their feelings of efficacy in teaching STEM to young students. This was indicated by phrases such as “We always did science and math, but now we need to teach 7-year-olds to code computers too,” and “I feel good about teaching science, but struggle with understanding how to make that STEM.” These perspectives indicated STEM was not seen as an integrated discipline, but rather a series of skills taught in isolation.

**Lack of collaborators.** Of 43 respondents, 11.6% identified a lack of collaborators in teaching STEM subjects to young children as a barrier to efficacy. These individuals used phrases such as “It has been hard to find colleagues who want to do this work with me, most are more focused on reading or math alone” or “there is a lack of colleagues interested in working together” to call out this deficit. An assumption of this factor was that a teacher’s efficacy would be increased when working in collaboration with other educators.

### **Data Analysis for Research Question Three**

This section provides an analysis of the responses aimed at answering research question three, “What factors do early childhood teachers identify as positively influencing their confidence in teaching STEM subjects?” This question was addressed through open-ended responses to survey question 15, “What factors positively influenced your confidence in teaching STEM subjects to your students?” To analyze these data, the



entirety of each response was coded for factors identified, then the frequency of these factors across all 43 respondents was tabulated. From this analysis, four major factors emerged (Table 2). Other factors indicated in responses to this question were only mentioned by one or two individuals and not considered in this analysis of results.

It is worth noting in the analysis of data gathered from question 15, a question specifically targeted at seeking responses that identified factors that *positively* influenced confidence, many respondents chose to articulate their lack of confidence rather than express these positive factors. Phrases used in this way included “There has not been much that has specifically addressed this is my training,” “I have a colleague who does the STEM teaching for our class, I have learned some things from him, but would not want to do it myself,” “In preschool we don’t really teach STEM,” and “My students are interested in STEM activities like building, playing in the sandbox, and using the iPad, but I have not had much training in what kind of teaching I should be doing besides having these things.” This tendency to highlight a lack of connection to and confidence in STEM, even when asked to identify positives, underscored the overall relevance of this study. Table 3 summarized the frequency of references to each theme.

Table 3

*Frequency of Themes for Research Question 3*

Theme/Pattern	Frequency of Reference
Collaboration	19
Professional Development Opportunities	16
Opportunities for Integration and Hands on Practice Across the School Day	13
Access to Curriculum and Materials	12

## **Collaboration**

The most frequently mentioned factor positively influencing survey respondents' confidence in teaching young children was collaboration. Having other educators to connect with in the planning and implementation of STEM experiences was mentioned by 44.2% of respondents. These included phrases such as "Working with my colleagues, we provide our students with high quality materials and time to experiment so they can build comfort with STEM," "In the last several years I have worked with colleagues to think about our teaching in STEM subjects and to find more opportunities to expose our students to the content and behaviors of STEM learning," and "Colleagues who help me see connections between the children's play and STEM learning help." One specific type of collaboration, which occurred in mentorship relationships, emerged as a theme within this factor – it was mentioned by 7 of 19 individuals whose responses indicated collaboration as a positive.

## **Professional Development Opportunities**

Another major factor positively influencing early childhood educators' feelings of confidence in teaching STEM subjects was the participation in professional development opportunities. This factor was mentioned by 37.2% of the 43 respondents using phrases such as "I recently attended a workshop that helped me see the ways that science, math, tech, and engineering can work together in my classroom" and "Opportunities to learn more about STEM and how it can show up in my classroom in workshops and conferences." Another teacher wrote:

I have tried to cultivate my understanding of STEM subjects in recent years, reading blogs, attending classes, and participating in professional

development experiences. I still have a lot to learn, but have developed a more complete understanding of the ways STEM can show up in my classroom.

The need for additional access to such opportunities focused on early childhood was also called out, such as a respondent who said, “Specific classes in how to teach STEM to 2nd graders through a professional development opportunity were helpful. I wish there were more options for classes on how to integrate STEM with young children.”

### **Opportunities for Integration and Hands on Practice Across the School Day**

Opportunities to connect STEM to all aspects of early childhood hands-on learning was identified as another major factor positively influencing feelings of confidence. Of the survey respondents, 30.2% indicated this through phrases such as “STEM works so seamlessly with the work in our PreK class, because students are already curious and exploring throughout the day. Having high-quality, integrated STEM materials and time to explore helps my kids and me as STEM learners” and “Thinking about STEM all together, rather than as separate disciplines.” Another teacher shared:

With young children, STEM is so much about play, but the behaviors they use in that play help build their STEM skills for later learning as well.

Knowing this helps me build STEM concepts into their playful learning in all aspects of the school day.

### **Access to Curriculum and Materials**

Another major factor positively influencing feelings of confidence among teachers was the availability of relevant STEM curriculum supports and high-quality

materials, which was mentioned by 27.9% of respondents. They used phrases such as “The recent influx of stem curriculum and materials has helped guide my learning,” “Having STEM materials for children to play with like water table, light table, and lots of different blocks,” “Having a curriculum and lessons to follow - not having to make it up,” and “Materials that support a variety of building projects.” Responses identifying this factor primarily focused on an external item (e.g., a particular curriculum, resource, tool) brought into the learning environment.

### **Summary**

In this chapter, qualitative and quantitative data were presented to address the study’s three research questions. All data were anonymously collected through the electronic survey instrument. The quantitative data were analyzed using statistical measures of central tendency. The data were presented for the sample overall, as well as disaggregated by subsamples based on the age of students taught. The qualitative data were presented as they aligned with influencing factors, both positive and negative.

These major findings for research question one included the prevalence of responses to the T-STEM survey that indicated a lack of teacher self-efficacy. Trends showed disagreement with statements that expressed confidence in one’s ability to appropriately guide their students in STEM subjects, and disagreement with the statement regarding openness to observation by colleagues. For research question two, the major findings include the prevalence of concerns related to lack of experience/education/training, lack of time/resources/materials, and the role of STEM in early childhood education. The major findings for research question three included the four most commonly identified positive influences by the respondents. These include

collaboration, professional development opportunities, opportunities for integration and hands-on practice across the school day, and access to curriculum and materials. The major findings, as well as conclusions, implications, and recommendations for further research, are further explored in Chapter V.

## CHAPTER V: FINDINGS, CONCLUSIONS, AND RECCOMENDATIONS

Findings, conclusions, and recommendations on the self-efficacy of early childhood teachers in STEM subjects are delivered in this final chapter. A presentation of the study's major findings, as well as unexpected findings, begin this chapter's discussion. Additionally, the chapter provides an overview of the conclusions gathered through the research and implications for action based on the study's conclusions. Recommendations for further research are outlined within this chapter as well. These recommendations indicate how future studies may play a role in expanding on this study, offering a deeper understanding of the topic. This chapter closes with the researcher's concluding remarks and reflections.

### **Purpose Statement**

The purpose of this study was to identify the self-efficacy of early childhood teachers toward STEM subjects as measured by the Teacher Efficacy and Attitudes toward STEM survey (T-STEM; FIEL, 2012) and to explore factors that influence confidence in teaching STEM.

### **Research Questions**

This study sought to address the following research questions:

1. What is the degree of self-efficacy of early childhood teachers in STEM subjects as measured by the T-STEM (FIEL, 2012)?
2. What factors do early childhood teachers identify as barriers to increased confidence in teaching STEM subjects?
3. What factors do early childhood teachers identify as positively influencing their confidence in teaching STEM subjects?

## **Methodology Review**

This study sought to identify self-efficacy toward STEM subjects among teachers of children ages three to eight. It also sought to explore and describe trends in factors that influence these scores. The primary instrument for this study was an adaptation of the T-STEM survey developed by FIEI (2012). This quantitative measure was supplemented with two open-ended qualitative inquiries designed to identify the positive and negative factors that influenced the T-STEM scores.

Data collection for this study began with a field test. Current and former colleagues of the researcher who otherwise met the requirements for study participation were asked to field test the survey. After completion of the field test, the survey was distributed to 210 potential respondents via a group email with an embedded link to an online survey. Forty-four individuals responded, 43 of whom met the study criteria and completed all the questions. This number of respondents met the minimum number to obtain the desired confidence level of 95% and the confidence interval of 15.

The target population for this study was teachers currently working in schools that were members of the Northwest Association of Independent Schools (NWAIS). This represented approximately 1,500 teachers during the 2017-18 school year, with an estimated 210 teaching children aged three to eight (Northwest Association of Independent Schools, 2015). All 210 individuals listed in the NWAIS directory as early childhood teachers were e-mailed the survey. All completed surveys were used when compiling both quantitative and qualitative data.

## Major Findings

Below is a summary of the major findings. Findings were organized by research question and stemmed from the responses reported in Chapter IV. The quantitative data were used to address research question one, whereas the qualitative data in the form of open-ended responses were used to address research questions two and three. These open-ended responses were most often presented as a short phrase, a series of short phrases, or a one to two sentence constructed response.

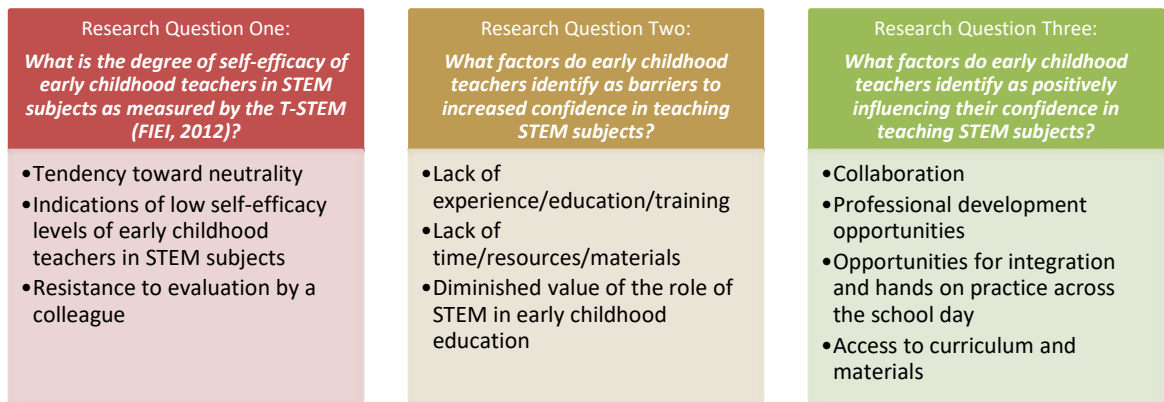


Figure 48. Summary of major findings.

### Major Findings from Research Question 1

This section highlights findings for Research Question 1: *What is the degree of self-efficacy of early childhood teachers in STEM subjects as measured by the T-STEM (FIEI, 2012)?*

**Finding 1: Tendency toward neutrality.** When aggregating the responses to individual questions on the Likert scale, the means for every question centered around the score of 3.0, indicating neutrality. Most scores fell between 2.50 and 3.50, with only one score below this range and two above it. Even these outliers did not go lower than 2.00 or higher than 4.00. This tendency toward the center of the Likert scale responses indicated



there was not clear agreement among early childhood professionals related to T-STEM questions designed to identify self-efficacy levels in STEM subjects.

On only one T-STEM question did more than 10% of respondents indicate strong agreement with the statement. Even when correcting for the reverse wording of Statement 5 (the only question to which a high score on the Likert scale indicated low feelings of self-efficacy), strong agreement with statements indicating high confidence in teaching STEM subjects was not common. The statement receiving the most responses of strongly agree was “I am continually improving my STEM subjects teaching practice.” This statement is remarkable in the series as it asks teachers to consider their stance toward improvement in their teaching practice, rather than confidence in it. A Likert scale response of 1, indicating strong disagreement, was rare across the entirety of the T-STEM.

**Finding 2: Indications of low self-efficacy levels of early childhood teachers in STEM subjects.** When looking closer at the neutrality indicated by Finding 1, it is important to note this tendency toward neutrality pertained to the sample overall, rather than reflective of any individual’s personal experience. When exploring the data on an individual level, patterns pertaining to teachers emerged that indicated feelings of low self-efficacy in the teaching of STEM subjects. Many more individuals indicated specific agreement or disagreement with a statement, leading to a statistical mean of neutrality, than individuals choosing *neutral* on the Likert scale.

When following the thread of an individual teacher’s responses, indications showed low levels of self-efficacy among most respondents. This was most clearly indicated by responses for statements 2, 3, 4, 6, 7, and 9. It is relevant to note differences

in responses to statements asking teachers about their confidence in content knowledge versus their confidence in responding to students.

**Finding 3: Resistance to evaluation by a colleague.** Statement 7, “Given a choice, I would invite a colleague to evaluate my teaching of STEM subjects,” had the most remarkably negative responses from early childhood teachers. It was the only statement to which more than two individuals expressed strong disagreement. Fifteen respondents strongly disagreed with the statement and another 15 individuals disagreed. None of the other statements had 30 respondents express disagreement.

### **Major Findings from Research Question 2**

This section highlights findings to Research Question 2: *What factors do early childhood teachers identify as barriers to increased confidence in teaching STEM subjects?*

**Finding 3: Lack of experience/education/training.** The most common barrier to increased confidence in STEM subjects identified by respondents was they lacked sufficient enough training, education, or experience to be effective teachers of STEM subjects for their students. This was expressed through phrases such as “lack of training in teacher preparation,” “I have not had much experience with it or much exposure in my own schooling (which mostly focused on liberal arts),” and “Lack of exposure and training.” Although respondents did not identify specific areas of training they would like to receive, opportunities they hoped were part of their education, or experiences they felt would be supportive, lack of these opportunities was the most commonly identified barrier.

**Finding 4: Lack of time/resources/materials.** Another common barrier identified by respondents was a lack of time, resources, and materials to support the teaching of STEM subjects. This finding was informed by phrases such as “We don’t have a lot of resources to support this for young kids in our school,” “Not having fancy circuits or other STEM specific materials,” and “There is not enough time in the day to focus on it.” These responses highlighted a perception that specific toys, tools, or objects were needed to effectively teach STEM. The accuracy of this perception was not within the scope of this study, but it identified a contributing factor to the results and related to the role of time management in teachers’ daily work.

**Finding 5: Diminished value of the role of STEM in early childhood education.** Respondents indicated STEM was not valued or did not have a place in quality early childhood education programs. Responses included phrases such as “It is hard to think of ways that STEM is used in preschool,” “I don’t really know what STEM looks like with my students, usually when people talk about STEM they are talking about kids programming robots or building video games, my kids are too young for that,” and “STEM is more for older grades - preschool kids should play.” This perception was expressed both by individuals claiming it as their own belief system, and by those identifying its place in the belief systems of others as a barrier.

### **Major Findings from Research Question 3**

This section highlights findings to Research Question 3: *What factors do early childhood teachers identify as positively influencing their confidence in teaching STEM subjects?*

**Finding 6: Collaboration.** The most common positive influence these educators identified in their increased confidence in STEM subjects was the opportunity to collaborate with colleagues. Respondents identified positive feelings toward collaboration both in the pre-planning process before teaching a lesson, and in the co-teaching of a lesson alongside like-minded colleagues.

**Finding 7: Professional development opportunities.** Another major factor positively influencing early childhood educators' feelings of confidence in teaching STEM subjects was participation in professional development opportunities. Phrases from respondents demonstrated the value of professional development influencing feelings of confidence in teaching STEM. The need for additional access to these opportunities focused on early childhood was also identified.

**Finding 8: Opportunities for integration and hands on practice across the school day.** Opportunities to connect STEM to all aspects of early childhood hands-on learning was identified as another major factor positively influencing feelings of confidence. Respondent statements focused on integrated learning and STEM being a part of many aspects of the school day rather than taught as isolated lessons.

**Finding 9: Access to curriculum and materials.** Another finding in seeking to understand factors that positively influence feelings of confidence among teachers surveyed was the availability of relevant STEM curriculum supports and high-quality materials. Respondents identified the value this access had to their teaching. Responses identified this factor primarily focused on an external item (a particular curriculum, resource, tool, or toy) brought into the learning environment.

## Unexpected Findings

Two unexpected findings were noted during this investigation. The first was the tendency toward neutrality in the responses. Few individuals chose responses expressing strong agreement or disagreement on multiple statements. The early childhood educators responding to the survey overall did not lean toward strong statements of confidence in their STEM teaching, nor did they strongly express a lack of confidence in their STEM teaching. Even in the qualitative responses, teachers were hesitant to make definitive statements about the factors influencing their confidence. Qualifying expressions such as “Maybe,” “Sometimes,” “Possibly,” and “I guess” were frequently included in responses, indicating this tendency away from making definitive statements and expressing strong preferences.

The second unexpected finding was the frequency with which factors influencing confidence negatively were identified, even when factors positively influencing it were specifically sought. When considering responses to the question “What factors have positively influenced your confidence in teaching STEM subjects to your students,” the researcher expected positive influences to be identified. However, a lack of positive influences was often expressed, including statements such as: “In preschool we don't really teach STEM,” “There has not been much that has specifically addressed this in my training,” and “Young students should play...with blocks to learn about STEM, I don't teach it.” These statements indicated a difficulty in identifying positive influences, which was an unexpected finding of the study.

## **Conclusions**

The findings of this study helped form four conclusions about the self-efficacy of early childhood teachers toward STEM subjects as measured by T-STEM and factors that influence confidence in teaching STEM. This section explores all four of the study's conclusions with supporting evidence for each.

### **Conclusion 1**

It was concluded early childhood educators lacked high levels of self-efficacy toward teaching of STEM subjects. This aligned with previous research into self-efficacy levels of teachers of STEM subjects at all student ages (Fairweather, 2008; Goldberg, 2015; Teo, 2014; Wimsatt, 2012). Although many indicated agreement with individual questions from the T-STEM survey, the overall results indicated a tendency toward neutrality. The following evidence supports this first conclusion:

1. No single question from the T-STEM survey had a mean response above 3.74, and most of responses had a mean below 3.00.
2. When asked to identify positive factors influencing their confidence in teaching STEM subjects, many respondents were unable to generate at least one positive factor.

### **Conclusion 2**

It was concluded explicit instruction for early childhood educators in STEM subjects and techniques for instruction with young children helps build confidence. The research indicated the relevance of instruction in teacher preparation programs and ongoing professional development. The role of pre-service and ongoing professional development in supporting teacher efficacy across subject areas was well supported by

existing research (Guskey, 2009; Patton, 2015). The content and quality of these experiences, although certainly relevant, were beyond the scope of this research. The following evidence supports this second conclusion:

1. Responses to the T-STEM survey indicating agreement or strong agreement with the statement about continuous improvement.
2. Less favorable responses to the T-STEM survey statement regarding confidence in having the appropriate content knowledge to teach STEM subjects effectively.
3. The frequency of responses to the short answer questions identifying these types of experiences as positive influences and the lack of them as negative influences.

### **Conclusion 3**

It was concluded having supportive and collaborative colleagues in the instruction of STEM subjects was an important factor in building early childhood teacher confidence in the instruction of these subjects. The presence of colleagues to both plan lessons and implement them supports the development of self-efficacy in teaching STEM topics, whereas an openness to receiving feedback on STEM instruction from colleagues may be an important indicator of confidence. This aligned with conclusions about the role of collegial relationships reached in other educational research into self-efficacy levels (Lumpe, 2014; Patton, 2015; Smylie, 2014; Wojnowski, 2014). The following evidence supports this third conclusion:

1. Extreme reluctance to receiving feedback in STEM instruction from colleagues indicated on the T-STEM survey by individuals who otherwise tended toward neutrality in their responses.
2. The large number of responses indicting colleagues to plan and implement lessons were a factor positively influencing a respondent's feelings of self-efficacy in teaching STEM subjects.
3. The large number of responses indicating a lack of colleagues to plan and implement lessons was a factor negatively influencing a respondent's feelings of self-efficacy in teaching STEM subjects.

#### **Conclusion 4**

It was concluded perceptions of the importance of STEM in early childhood education influence a teacher's feelings about his or her self-efficacy teaching it. Indications that specific learning environments do not value STEM instruction, and questions about its developmental appropriateness for children aged three to eight, impacted the availability of professional development, access to materials, and other confidence-building opportunities. Although minimal research examined these perceptions of importance, Briseno (2015) and Torres-Crespo et al. (2014) indicate the ongoing need for a better understanding of how these values impact programs. The following evidence supports this fourth conclusion:

1. The need for the researcher to adapt, with permission, the T-STEM for implementation with early childhood teachers. Previously, the youngest instructional group it was used with was elementary teachers. This indicated



an undervaluing of the role of STEM before kindergarten on a widespread level.

2. The number of responses indicating a perceived conflict between values in early childhood education, such as play-based learning and STEM. This indicated a lack of understanding about the complementary nature of these topics.
3. The number of responses indicating a lack of support for STEM in early childhood classrooms, either by school administrators, families of students, or colleagues.

### **Implications for Action**

Based on the findings and conclusions from this study and an extensive review of the literature, the following implications for action regarding building early childhood teacher self-efficacy levels in STEM subjects are recommended:

#### **Implication for Action 1: Increase Exposure to STEM Topics in Early Childhood Teacher Preparation Programs**

University programs that prepare the early childhood teaching workforce are on the rise. As these programs grow and develop, it is essential they increase participant exposure to STEM topics and their relevance in early childhood education. These programs need to emphasize the importance of developing attitudes, behaviors, and knowledge in young children that support solid foundations for ongoing STEM learning. These programs should also emphasize the role of the teacher in developing student perspectives and seek to increase feelings of teacher self-efficacy in these areas.

## **Implication for Action 2: Increase Opportunities for Ongoing Professional Development in STEM Topics for Early Childhood Teachers**

Many teachers currently working in the early childhood field are veterans with decades of experience with young children. Often, this experience lacked formal educational opportunities. For this reason, as well as for the ongoing development of more formally trained teachers, a system of professional development that supports continued growth is essential. The importance of this ongoing professional development should be highlighted by governing agencies, including lawmakers and accrediting bodies, through certification requirements and continuing education expectations. The opportunities should then be provided by these bodies, as well as by independent bodies including schools, districts, and certified trainers to provide professionals with a wide array of pathways to growth. Although systems such as this are expanding throughout the United States, they are still minimal compared to other professions. An increase in these opportunities overall, and specific to STEM subjects, is essential to supporting gains in teacher self-efficacy. Many of the misconceptions identified by participants in this research study, including the idea STEM learning conflicts with a play based early childhood curriculum, could be effectively addressed through more robust professional development opportunities.

## **Implication for Action 3: Foster Supportive Environments for STEM learning in Early Childhood Classrooms by Building Administrative Understanding**

For early childhood classrooms to be supportive environments for STEM learning, the individuals making the fiscal, personnel, and visionary decisions for those classrooms must fully grasp the value of such an environment. Thus, building the

understanding of school and center administrators at all levels is essential. This can be done through professional development for these educators, as well as through the implementation or revision of standards that clearly indicate the importance of STEM education in early childhood classrooms. This clarity of importance supports the allocation of funds or resources to materials, learning, and systems that cultivate nurturing STEM environments.

**Implication for Action 4: Increase Societal Understanding of the Importance of Early Childhood Education and the Foundations it Builds for all Subject Areas**

Despite some political and social gains, early childhood education remains undervalued throughout American society, as demonstrated by factors that include teacher compensation, government funding, and accessibility. This means any initiatives to increase the value of a specific aspect of this work are already operating at a deficit. Positive action in this area to increase the societal value of early childhood education as a whole and more centrally place its importance for all children will be an essential part of the solid foundation needed to make lasting change. This includes legislation at the state and federal levels that supports the funding of and access to early childhood education. Primarily for economic reasons, teacher turnover rates in early childhood education are remarkably high, meaning any investment in increasing early childhood teacher self-efficacy levels in STEM subjects would be short lived until this shifts. A reorganization of early childhood teacher training programs with an emphasis on recognition of the value of longevity in the profession and ongoing professional development standards to support stabilization of the workforce is one pathway to this. Any revision of policies in this area must be strongly substantiated by funding to support additional teacher

compensation. Government subsidized professional development and training programs for early childhood teachers is an important first step toward moving societal perceptions of the profession forward.

### **Recommendations for Further Research**

Based on the findings and limitations of this study, the following recommendations for further research are suggested:

1. This study clearly identified professional development has an important role in feelings of self-efficacy for early childhood teachers when teaching STEM subjects. The researcher recommends further research be conducted into the effectiveness of professional development, specifically identifying factors that lead to more or less effective professional development experiences for early childhood educators.
2. The importance of meaningful collaboration also emerged as a theme, both from the qualitative responses and from the remarkable reluctance of early childhood educators to receive feedback on their teaching of STEM subjects from colleagues. The role of collegial relationships in early childhood, and their impact on feelings of self-efficacy, is recommended as an area for further research.
3. Additionally, a specific aspect of collegiality, that of a mentor/novice relationship is recommended for further research. Several participants specifically identified the role of mentorship in their feelings of self-efficacy and explorations into identifying aspects of effective mentoring relationships is deemed worthy.

4. This study specifically found positive collaboration and ongoing professional development were effective as having a positive impact on feelings of self-efficacy in STEM subjects. Further research into the intersection of these factors, addressing questions such as “Are professional development opportunities more effective when engaged with collaboratively?” or “What is the role of colleague support when implementing new professional learning?” would be an effective area of further research.
5. Finally, further research into the importance of integrated learning experiences in early childhood education is needed. STEM learning initially emerged in response to understanding the intersection between science, technology, engineering, and mathematics provided a richer landscape than these subjects in isolation. The early childhood classroom is an ideal landscape for researching further opportunities for curricular integration, including ways early literacy can support STEM learning.

### **Concluding Remarks and Reflections**

This dissertation spanned some of the most transformational years of my life and provided a backdrop for profound personal and societal change. My passion for early childhood education and personal crusade for its validation on the educational landscape and beyond initially inspired this work. This passion intersected with my strong belief in teachers at all levels as highly qualified professionals’ worthy of regard. These values led me toward a study of early childhood self-efficacy and the current educational climatic drive toward STEM provided an ideal backdrop. Although this dissertation spanned half

a decade, the intersection of teacher self-efficacy, STEM learning, and early childhood education remains a relevant topic in need of greater understanding.

Through this research, I grew in my depth of knowledge on both macro and micro levels. In looking at the big picture, I have a more nuanced view of the societal, political, and historical perspectives that influence how early childhood education, its teachers, and STEM education are regarded. At times, this broadened perspective is a source of frustration. The depth of complexity can make systemic change feel impossible. However, with this greater understanding also comes hope for a long-term, overall shift taking place at a slow pace. On the micro level, analyzing the individual responses from the 43 teachers participated in my survey provided unique insights into the complexity of feelings of self-efficacy. My overall impressions from this work are encapsulated in a sense of awe for every individual who spends their days enriching the minds of young children. It is work that requires deep investment of intellect and emotion with no easy answers and an endless capacity for improvement.

Overall, the completion of this dissertation made me a better educational professional. It increased my capacity for empathy both toward the flawed, but ambitious system we constructed to teach children, and toward the hard-working teachers on the front lines of that system. Completing this dissertation also made me a better person. It taught me about persistence, follow through, and the importance of believing in myself in ways that forever changed me. Professionally and personally, my most valuable lesson from this process was the power of relationships. No one exists in a vacuum and the power to create change lies in the places where our lives intersect with the lives of others.

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APPENDICES

APPENDIX A – SYNTHESIS MATRIX

	Professional Development	STEM Education	Early Childhood Education	The Role of Efficacy	Research Design
Airasian, P. W., & Gay, L. R. (2003)					X
Andersson, K., & Gullberg, A. (2014)	X	X	X		
Appleton, K. (1995)	X	X			
Armor, D., Conry-Oseguera, P., Cox, M., King, N., McDonnell, L., Pascal, A., Pauly, E., & Zellman, G. (1976)				X	
Ashton, P. T., & Webb, R. B. (1986)				X	
Bagiati, A., & Evangelou, D. (2015)		X	X		
Bagiati, A., & Evangelou, D. (2016)		X	X		
Ball, D. L. (2002)	X				
Bandura, A. (1977)				X	
Bandura, A. (1994)				X	
Bandura, A. (1995)				X	
Baxter, J. A., Ruzicka, A., Beghetto, R. A., & Livelybrooks, D. (2014)	X	X			
Beatty, A. S. (2011)		X			
Bechtel, P. A., & O'Sullivan, M. (2006)	X				
Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012)		X			
Blackwell, C. K., Lauricella, A. R., & Wartella, E. (2014)		X	X		
Blackwell, C. K., Lauricella, A. R., Wartella, E., Robb, M., & Schomburg, R. (2013)		X	X	X	
Borko, H. (2004)	X				
Brendefur, J. j. b. e., Strother, S., Thiede, K., Lane, C., & Surges-Prokop, M. (2013)	X	X	X		
Brenneman, K., Stevenson-Boyd, J., & Frede, E. C. (2009)		X	X		
Briseno, L. M. (2015)		X	X		
Brownrigg, J., Carey, C., & Fredericks, B. (2013)		X	X		
State of the Union Address (2006)		X			
Bybee, R. W. (2010)		X			



Chen, J.-Q., McCray, J., Adams, M., & Leow, C. (2014)		X	X	X	
Ching-Ting Hsin, c. n. e. t., Ming-Chaun Li, m. t. g. c., & Chin-Chung Tsai, c. m. n. e. t. (2014)		X	X		
Clements, D. H., Copple, C., & Hyson, M. (2002)	X	X	X		
Coladarci, T. (1992)				X	
Common Core State Standards, I. (2011)		X			
Creswell, J. W. (2008)					X
Creswell, J. W. (2013)					X
Darling-Hammond, L. (1994)	X				
Darling-Hammond, L., & Sykes, G. (1999)	X				
Daugherty, L., Dossani, R., Johnson, E.-E., Wright, C., & Education, R. (2014)		X	X		
Deutschlander, D. (2016)			X		
Dietze, B., & Kashin, D. (2013)		X	X		
Donnelly, M. (2008)		X			
Duncan, A. (2015)			X		
Early Learning  U.S. Department of Education. (2015)			X		
Edwards, J. L. (1996)				X	
Epstein, A., & Willhite, G. L. (2015)	X		X	X	
Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010)		X		X	
Essa, E. (2013)			X		
Fairweather, J. (2008)		X			X
Fitzpatrick, M. D. (2008)			X		
Garbett, D. (2003)		X	X	X	
Garg, K. (2010)		X			
Gibson, C. B., & Earley, P. C. (2007)				X	
Goddard, R. D., & Goddard, Y. L. (2001)				X	
Goddard, R. D., Hoy, W. K., & Hoy, A. W. (2000)				X	
Gomez, R. E., Kagan, S. L., & Fox, E. A. (2015)	X		X		
Gonzalez, H. B., & Kuenzi, J. J. (2012)		X			
Goodson, L. A., Slater, D., & Zubovic, Y. (2015)				X	
Hanson, K., & Carlson, B. (2005)		X			
Harlen, W., & Holroyd, C. (1997)		X	X	X	
Hayden, K., Ouyang, Y., Scinski, L., Olszewski, B., & Bielefeldt, T. (2011)	X	X			
Heckman James, J. (2008)			X		
High/Scope Perry Preschool Study. (2007)			X		
Hill, H. C., Beisiegel, M., & Jacob, R. (2013)	X				

Honardoost, E. (2014)	X	X			
Howes, C., Burchinal, M., Pianta, R., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (2008)			X		
Friday Institute for Educational Innovation [FIEI], (2012)		X		X	
Kaderavek, J. N., North, T., Rotshtein, R., Dao, H., Liber, N., Milewski, G., . . . Czerniak, C. M. (2015)		X	X		X
Katz, L. G. (2010)		X	X		
Kaufman, M. J., Kaufman, S. R., & Nelson, E. C. (2015)			X		
Kidd, L. (2014)		X		X	
Klassen, R. M., & Tze, V. M. C. (2014)				X	
Lascarides, V. C., & Hinitz, B. F. (2013)			X		
Linder, S. M., Emerson, A. M., Hefron, B., Shevlin, E., & Vest, A. (2016)		X	X		
Linder, S. M., Rembert, K., Simpson, A., & Ramey, M. D. (2016)	X		X		
Lumpe, A., Vaughn, A., Henrikson, R., & Bishop, D. (2014)	X			X	
Lunenburg, F. C. (2011)				X	
Lux, N., & Lux, C. (2015)		X	X		
McMillan, J. H., & Schumacher, S. (2010)					X
Moomaw, S., & Davis, J. A. (2010)		X	X		
Moore, B. M. (1952)				X	
Munck, M. (2007)		X			
Nadelson, L. S., Callahan, J., Pyke, P., Hay, A., Dance, M., & Pfiester, J. (2013)	X	X			
National Research Council. (2011)		X			
Northwest Association of Independent Schools. (2015)					X
Nutbrown, C., & Clough, P. (2014)			X		
Nuttall, J. (2014)	X		X		
Pantoya, M. L., Aguirre-Munoz, Z., & Hunt, E. M. (2015)		X	X		
Patton, K., Parker, M., & Tannehill, D. (2015)	X				
Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007)	X				
Redmond, B. F. (2010)				X	
Ricks, E. D. (2012)		X	X		
Riggs, I. M., & Enochs, L. G. (1989)		X		X	
Ritblatt, S. N., Garrity, S., Longstreth, S., Hokoda, A., & Potter, N. (2013)			X		
Roberts, C. M. (2010)					X

Rockland, R., Bloom, D. S., Carpinelli, J., Burr-Alexander, L., Hirsch, L. S., & Kimmel, H. (2010)		X			
Rushton, S., & Juola-Rushton, A. (2011)			X		
Saracho, O. N. (2012)			X		
Schweingruber, H. A., Woods, T. A., Cross, C. T. (2009)		X	X		
Slack, M. (2013)			X		
Smith, K. A., Douglas, T. C., & Cox, M. F. (2009)		X			
Smylie, M. (2014)	X				
Snyder, P., Hemmeter, M. L., Meeker, K. A., Kinder, K., Pasia, C., & McLaughlin, T. (2012)	X		X		
Spodek, B., & Saracho, O. N. (2007)		X	X		
Stipek, D. J., Givvin, K. B., Salmon, J. M., & MacGyvers, V. L. (2001)		X		X	
Tank, K., Pettis, C., Moore, T., & Fehr, A. (2013)		X			
Tashakkori, A., & Teddlie, C. (1998)					X
Teo, T. W., & Ke, K. J. (2014)	X	X			
Terrell, S. R. (2012)					X
Thomas, T. A. (2014)		X			
Torres-Crespo, M. N., Kraatz, E., & Pallansch, L. (2014)		X	X		
Tschannen-Moran, M., & Hoy, A. W. (2001)				X	
Tschannen-Moran, M., Hoy, A. W., & Hoy, W. K. (1998)				X	
Urban, W. J., & Wagoner, J. L. (2009)	X				
van der Bijl, J. J., & Shortridge-Baggett, L. M. (2001)				X	
Webb, D. L. (2015)	X			X	
Weber-Mayrer, M. M., Piasta, S. B., & Yeager Pelatti, C. (2015)	X		X		
Wei, R. C., Darling-Hammond, L., Andree, A., Richardson, N., Orphanos, S., & National Staff Development, C. (2009)	X				
Wimsatt, M. J. (2012)		X		X	
Wojnowski, B. S., & Pea, C. H. (2014)	X	X			
Wong, V. C., Cook, T. D., Barnett, W. S., & Jung, K. (2008)			X		
Woods, T. A., Hyson, M., & Ginsburg, H. (2014)	X	X	X		
Yager, R. E. (2015)		X			

## APPENDIX B – DISSERTATION SURVEY

### Dissertation Survey

Welcome!

**Thank you for your willingness to participate in this short survey about your experience teaching STEM subjects (Science, Technology, Engineering, and Math) to young children.**

**The survey will take no more than 20 minutes of your time.**

**Please read the information below and answer the question that follows to proceed to the survey.**

*You are being asked to participate in a research study conducted by Rachel Donnelley, a doctoral student from the College of Education at Brandman University. The purpose of this research study is to identify the self-efficacy of early childhood teachers have toward STEM subjects as measured on the Teacher Efficacy and Attitudes toward STEM Survey\* and to explore factors that influence this confidence.*

*Your participation in this survey is voluntary. You may choose not to participate. If you decide to participate in the electronic survey you can withdraw at any time. The survey has 15 questions and will take 10-20 minutes to complete. The survey questions will pertain to your own experiences as a teacher and ask you to consider how confident you feel when conducting STEM lessons. The survey is anonymous, no personal data, beyond assurances of your membership in the target population, will be collected. There are minimal risks associated with participating in this research.*

*I understand that I may refuse to participate in or I may withdraw from this study at any time without any negative consequences. Also, the investigator may stop the study at any time. I understand that if I have any questions, comments, or concerns about the study or the informed consent process, I may write or call the Office of the Vice Chancellor of Academic*

*Affairs, Brandman University at 16355 Laguna Canyon Road, Irvine, California, 92618 (949) 341-7641.*

*The Brandman University Institutional Review Board's Research Participant's Bill of Rights can be found at:*

*[https://irb.brandman.edu/Guidelines\\_Forms/ResearchParticipantsBillofRights.pdf](https://irb.brandman.edu/Guidelines_Forms/ResearchParticipantsBillofRights.pdf)*

*If you have any questions about completing this survey or any aspects of this research, please contact Rachel Donnelley at [adonn@mail.brandman.edu](mailto:adonn@mail.brandman.edu) or by phone at (206) 920-0683. You may also contact Dr. Julie Hadden, advisor, at [jhadden@brandman.edu](mailto:jhadden@brandman.edu).*

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

1. ELECTRONIC CONSENT: Please select your choice below.

Clicking on the agree button indicates that you have read the informed consent form and the information in this document and that you voluntarily agree to participate. If you do not wish to

participate in this electronic survey, you may decline participation by clicking on the disagree button. The survey will not open for responses unless you agree to participate.

AGREE:

I acknowledge receipt of the complete Informed Consent packet and "Bill of Rights." I have read the materials and give my consent to participate in the study.

DISAGREE:

I do not wish to participate in this electronic survey

## Dissertation Survey

### Demographic Questions

2. I am a general education teacher in an independent school accredited by the Northwest Association of Independent Schools for the 2017 - 2018 school year.

Yes

No

3. Most of my students are age:

3-4 years old

5-6 years old

7-8  
years  
old

Other

## Dissertation Survey

### Scaled Response Questions

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

**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 things that have happened to you make your choice.**

4. I am continually improving my STEM subjects teaching practice.

1

2

3

4

5

Strongly Disagree                      Disagree                      Neutral                      Agree                      Strongly Agree

5. I know the steps necessary to teach STEM subjects effectively.

1                      2                      3                      4                      5  
Strongly Disagree                      Disagree                      Neutral                      Agree                      Strongly Agree

6. I am confident that I can explain to students why experiments in STEM subjects work.

1                      2                      3                      4                      5  
Strongly Disagree                      Disagree                      Neutral                      Agree                      Strongly Agree

7. I am confident that I can teach STEM subjects effectively.

1                      2                      3                      4                      5  
Strongly Disagree                      Disagree                      Neutral                      Agree                      Strongly Agree

8. I wonder if I have the necessary skills to teach STEM subjects.

1                      2                      3                      4                      5  
Strongly Disagree                      Disagree                      Neutral                      Agree                      Strongly Agree

9. I understand STEM concepts enough to be effective in teaching STEM subjects.

1                      2                      3                      4                      5  
Strongly Disagree                      Disagree                      Neutral                      Agree                      Strongly Agree

10. Given a choice, I would invite a colleague to evaluate my teaching of STEM subjects.

1                      2                      3                      4                      5  
Strongly Disagree                      Disagree                      Neutral                      Agree                      Strongly Agree

11. I am confident that I can answer students' questions in STEM subjects.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

12. When a student has difficulty understanding a STEM concept, I am confident that I know how to help the student understand it better.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

13. When teaching STEM subjects, I am confident enough to welcome student questions.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

14. I know what to do to increase student interest in STEM subjects.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

## Dissertation Survey

### Open Response Questions

**For each of the following questions, please respond based on your own experiences, beliefs, etc.**

15. What factors have **positively influenced** your confidence in teaching STEM subjects to your students?

16. What factors have **negatively influenced** your confidence in teaching STEM subjects to your students?

Dissertation Survey

Thank you

**I am grateful to you for completing this survey and supporting me on my educational journey.**

**Any questions or comments can be sent to [rdonnell@mail.brandman.edu](mailto:rdonnell@mail.brandman.edu)**



## APPENDIX C – DISSERTATION FIELD TEST

### Dissertation Field Test

#### FIELD TEST WELCOME

Dear current and former colleagues,

**THANK YOU!** I really appreciate you taking a few minutes to complete this survey for me as I work toward finishing my dissertation. Since we have worked together, I cannot use your responses in my actual data collection. However, you completing this field test version of the survey is an essential step and I am grateful for your participation.

Below, you will find a copy of the e-mail potential participants will receive. Then, on the pages that follow you will see the survey exactly as they will. Please complete it, then at the end is an additional question for you to provide me feedback on your experience. The whole process can be anonymous and should take less than 25 minutes! Please don't hesitate to reach out with any questions, and thank you for your support.

Kind regards,

Rachel

Dear colleague,

I hope your school year is off to a great start! If we have not met, my name is Rachel Donnelley and I am the Director of Teaching and Learning at Giddens School in Seattle. I am writing to ask for your help in supporting the future of Early Childhood Education.

I am currently working toward my doctorate in education and my dissertation topic is "The Self Efficacy of Early Childhood Teachers in Science, Technology, Engineering, and Mathematics." I am collecting data from early childhood teachers about their teaching in STEM subjects.

Below, please find a link to a short survey. Most of the questions are multiple choice and the whole thing will take you less than 20 minutes. *Your participation is a key component to the success of this research!*

Please complete the survey as soon as possible. All responses need to be in by midnight on September 30, 2017.

**Thank  
you in  
advance,  
Rachel**

***survey link forthcoming***

## Dissertation Field Test

Welcome!

**Thank you for your willingness to participate in this short survey about your experience teaching STEM subjects (Science, Technology, Engineering, and Math) to young children.**

**The survey will take no more than 20 minutes of your time.**

**Please read the information below and answer the question that follows to proceed to the survey.**

*You are being asked to participate in a research study conducted by Rachel Donnelley, a doctoral student from the College of Education at Brandman University. The purpose of this research study is to identify the self-efficacy of early childhood teachers have toward STEM subjects as measured on the Teacher Efficacy and Attitudes toward STEM Survey\* and to explore factors that influence this confidence.*

*Your participation in this survey is voluntary. You may choose not to participate. If you decide to participate in the electronic survey you can withdraw at any time. The survey has 15 questions and will take 10-20 minutes to complete. The survey questions will pertain to your own experiences as a teacher and ask you to consider how confident you feel when conducting STEM lessons. The survey is anonymous, no personal data, beyond assurances of your membership in the target population, will be collected. There are minimal risks associated with participating in this research.*

*I understand that I may refuse to participate in or I may withdraw from this study at any time without any negative consequences. Also, the investigator may stop the study at any time. I understand that if I have any questions, comments, or concerns about the study or the informed consent process, I may write or call the Office of the Vice Chancellor of Academic*

*Affairs, Brandman University at 16355 Laguna Canyon Road, Irvine, California, 92618 (949) 341-7641.*

**The Brandman University Institutional Review Board's Research Participant's Bill of Rights can be found at:  
[https://irb.brandman.edu/Guidelines\\_Forms/ResearchParticipantsBillofRights.pdf](https://irb.brandman.edu/Guidelines_Forms/ResearchParticipantsBillofRights.pdf)**

**If you have any questions about completing this survey or any aspects of this research, please contact Rachel Donnelley at [adonn@mail.brandman.edu](mailto:adonn@mail.brandman.edu) or by phone at (206) 920-0683. You may also contact Dr. Julie Hadden, advisor, at [jhadden@brandman.edu](mailto:jhadden@brandman.edu).**

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

**Author.**

1. ELECTRONIC CONSENT: Please select your choice below.

Clicking on the agree button indicates that you have read the informed consent form and the information in this document and that you voluntarily agree to participate. If you do not wish to participate in this electronic survey, you may decline participation by clicking on the disagree button. The survey will not open for responses unless you agree to participate.

AGREE:

I acknowledge receipt of the complete Informed Consent packet and "Bill of Rights." I have read the materials and give my consent to participate in the study.

DISAGREE:

I do not wish to participate in this electronic survey

Dissertation Field Test

Demographic Questions

2. I am a general education teacher in an independent school accredited by the Northwest Association of Independent Schools for the 2017 - 2018 school year.

Yes

No

3. Most of my students are age:

3-4 years old

5-6 years old

7-8 years old

Other

## Dissertation Field Test

### Scaled Response Questions

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

**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 things that have happened to you make your choice.**

4. I am continually improving my STEM subjects teaching practice.

1

2

3

4

5

Strongly Disagree

Disagree

Neutral

Agree Strongly Agree



5. I know the steps necessary to teach STEM subjects effectively.

1

2

3

4

5

Strongly Disagree

Disagree

Neutral

Agree Strongly Agree



6. I am confident that I can explain to students why experiments in STEM subjects work.

1

2

3

4

5

Strongly Disagree

Disagree

Neutral

Agree Strongly Agree



7. I am confident that I can teach STEM subjects effectively.

1

2

3

4

5

Strongly Disagree

Disagree

Neutral

Agree Strongly Agree



8. I wonder if I have the necessary skills to teach STEM subjects.

1

2

3

4

5

Strongly Disagree

Disagree

Neutral

Agree Strongly Agree



9. I understand STEM concepts enough to be effective in teaching STEM subjects.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

10. Given a choice, I would invite a colleague to evaluate my teaching of STEM subjects.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

11. I am confident that I can answer students' questions in STEM subjects.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

12. When a student has difficulty understanding a STEM concept, I am confident that I know how to help the student understand it better.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

13. When teaching STEM subjects, I am confident enough to welcome student questions.

1                                  2                                  3                                  4                                  5  
Strongly Disagree                  Disagree                  Neutral                  Agree Strongly Agree

14. I know what to do to increase student interest in STEM subjects.

1                                  2                                  3                                  4                                  5  
Strongly Disagree                  Disagree                  Neutral                  Agree Strongly Agree

Dissertation Field Test

Open Response Questions

**For each of the following questions, please respond based on your own experiences, beliefs, etc.**

15. What factors have **positively influenced** your confidence in teaching STEM subjects to your students?

16. What factors have **negatively influenced** your confidence in teaching STEM subjects to your students?

## Dissertation Field Test

Thank you

**I am grateful to you for completing this survey and supporting me on my educational journey.**

**Any questions or comments can be sent to [rdonnell@mail.brandman.edu](mailto:rdonnell@mail.brandman.edu)**

### 17. FIELD TEST FEEDBACK

Please comment on your experience with the survey. Make sure to note how long it took you to complete and any areas of ambiguity. Thanks!



## T-STEM survey

February 10, 2015 at 6:17 AM

From: [REDACTED]

To: [REDACTED]

Reply-To: [REDACTED]

Thank you for your interest in using our evaluation instruments. These evaluation instruments were identified, modified, or developed through support provided by the Friday Institute. The Friday Institute grants you permission to use these instruments for educational, non-commercial purposes only. You may use an instrument "as is", or modify it to suit your needs, but in either case you must credit its original source. By using this instrument, you agree to allow the Friday Institute to use the data collected for additional validity and reliability analysis. You also agree to share with the Friday Institute publications, presentations, evaluation reports, etc. that include data collected and/or results from your use of these instruments. The Friday Institute will take appropriate measures to maintain the confidentiality of all data. Please use the recommended citations for the T-STEM surveys:

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

If you would like to read about the survey background, development, appropriate uses, and related publications (including validity and reliability analysis information), please go to the following link: <http://go.ncsu.edu/misotsteminfo>

The development of these surveys was partially supported by the National Science Foundation under Grant No. 1038154 and by the Golden LEAF foundation.

The surveys are attached as PDFs. Please feel free to contact me if you have any further questions or inquiries related to the T-STEM surveys. Thank you.

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Regards,

Tracey L. Collins  
Project Coordinator, MISO Project  
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<http://www.fi.ncsu.edu/miso>

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