Examining the Impact of Professional Development and Instructional Coaching on Special Education Teachers’ Mathematics Knowledge for Teaching and Mathematics Teaching Efficacy

By

Allie Stiles Watkins IV

A dissertation submitted to Johns Hopkins University in conformity with the requirements for the degree of Doctor of Education

Baltimore, MD

December 2018
Abstract

Elementary special education teachers have accepted the responsibility of teaching students with special needs, managing special education caseloads, and addressing the achievement gap in mathematics, often despite the lack of appropriate professional learning opportunities. This study examined elementary special education teachers’ mathematics teaching efficacy and mathematics knowledge for teaching through face-to-face professional development and one-on-one mathematics instructional coaching. Participants enhanced their knowledge of standards-based mathematics teaching in the areas of Operations and Algebraic Thinking, Number and Operations in Base Ten, and Number and Operations-Fractions. A mixed-methods study was conducted to determine whether participation in the elementary special education teacher cohort increased teaching efficacy and strengthened pedagogical content knowledge in mathematics through the administration of the Mathematics Teaching Efficacy Beliefs Instrument, Reformed Teaching Observation Protocol, Diagnostic Mathematics Assessment for Elementary School Teachers, and semi-structured interviews.

Dissertation Advisor: Dr. Karen Karp
Dissertation Approval Form

Student: Allie Watkins  Adviser: Dr. Karen Karp

Dissertation Title: Examining the Impact of PD and Instructional Coaching on Special Education Teacher’s MKT and MTE

Date Approved: 10/16/2013

Required Signatures:

Dissertation Advisor: [Signature]  Print Name: Karen Karp

Committee Member: [Signature]  Jennifer Morrison

Committee Member: [Signature]  Russell Gersten

Committee Member: [Signature]

Student: Allie Watkins

PASS X
PASS WITH CONDITIONS
FAIL

The Dissertation Adviser must submit the completed form to the Director(s) of the Doctor of Education Program for inclusion in student’s doctoral folder.

Please note any special requirements below.
Dedication

This dissertation is dedicated to my wife, Kathleen for her support, love, and encouragement and my children, Caroline and Stiles for always cheering me on even when I felt tired and defeated.
Acknowledgements

This dissertation highlights the work and dedication of the Elementary Special Education Teacher Cohort. My dissertation journey began with the desire to make a difference with some special education teachers in my district, however prior to sharing outcomes or having a discussion about mathematics efficacy or mathematics knowledge for teaching, it should be noted that the 13 participants who gave of their time and energy to make this study possible are commended for their contribution to the research. Without these dynamic, willing individuals, this dissertation would not have been possible.

I would like to express my sincerest, heartfelt gratitude to my advisor, Dr. Karen Karp for her thorough feedback, support, and encouragement every step of the way and to my dissertation committee, Dr. Jennifer Morrison and Dr. Russell Gersten for their keen expertise and belief in my research study. To my colleague and friend, Liz Worch for her encouragement and advice during my first two years in the program and to my executive sponsor, Dr. Mike Markoe for believing in me and removing barriers whenever necessary. To my parents, Allie and Evie Watkins, my in-laws, Brenda and Peter Moe, and best friends, Shannon and Jackie Storch, I thank you for encouraging me and checking in to make sure I was on track and moving forward day after day, week after week, and month after month.

Finally, my deepest thanks and gratitude is reserved for my wife, Kathleen and my kids, Caroline and Stiles. I am fortunate for having them believe in me and providing encouragement when I needed it most.
Table of Contents

Abstract ........................................................................................................................... ii
Dedication ......................................................................................................................... iii
Acknowledgements ......................................................................................................... iv
Table of Contents ............................................................................................................ v
List of Tables ..................................................................................................................... xiv
List of Figures ................................................................................................................... xv
Chapter 1 ......................................................................................................................... 1
  Literature Review ............................................................................................................ 1
  Problem of Practice ........................................................................................................ 4
    Theoretical Frameworks ............................................................................................... 6
    Self-Efficacy Theory ...................................................................................................... 5
    Pedagogical Content Knowledge .................................................................................. 7
    Mathematical Knowledge for Teaching (MKT) .......................................................... 9
      Common Content Knowledge .................................................................................... 10
      Specialized Content Knowledge ............................................................................... 10
      Knowledge of Content and Students ....................................................................... 11
      Knowledge of Content and Teaching ....................................................................... 11
    Supporting the Use of MKT ....................................................................................... 11
    Effects of MKT on Student Achievement .................................................................... 12
    The Role of MKT for Special Education Teachers ..................................................... 13
    Mathematics Teaching Efficacy .................................................................................... 15
    Pre-service Special Education Teachers’ Self-Efficacy ................................................ 19
In-service Special Education Teachers’ Self-Efficacy..............................21

Collective Teacher Efficacy.................................................................23

Conclusion...........................................................................................24

Chapter 2..............................................................................................26

Needs Assessment..................................................................................26

Goals and Objectives.............................................................................26

Context of Professional Practice.........................................................26

Research Questions...............................................................................27

Method.....................................................................................................28

Participants...........................................................................................28

Measures..................................................................................................29

Semi-Structured Interview....................................................................29

Relationship between Interview and Research Questions.................30

Mathematics Teaching Efficacy Beliefs Instrument..............................31

Data Analysis...........................................................................................32

Results......................................................................................................34

Research Question #1...........................................................................34

Research Question #2...........................................................................38

Research Question #3...........................................................................40

Research Question #4...........................................................................44

Discussion..............................................................................................46

Limitations............................................................................................48

Conclusion............................................................................................48
Chapter 3

Synthesis of Intervention Research Literature

Professional Development

Professional Learning Communities

Sustained Mathematics Professional Development

The Effects of Professional Development on MTE

The Effects of Professional Development on MKT

Mathematics Instructional Coaching

Administrative Perspective

Cognitively Guided Instruction

Studies on the Effectiveness of CGI Professional Development

Data Teams Process

Studies on the Effectiveness of DT’s Process

Overview of the Proposed Intervention

Conclusion

Chapter 4

Elementary Special Education Teacher Cohort

Intervention Framework

Purpose of the Study

Research Design

Process Evaluation Design

Outcome Evaluation Design

Method

viii
Participants………………………………………………………………………………84

Instruments………………………………………………………………………………85
   Mathematics Teaching Efficacy Beliefs Instrument…………………………86
   Reformed Teaching Observation Protocol……………………………………86
   Professional Development Feedback Form…………………………………87
   Diagnostic Teacher Assessments in Mathematics and Science……………87
   Special Education Teacher Interview Questions……………………………88

Procedure…………………………………………………………………………………88
   ESETC Intervention……………………………………………………………89
      Face-to-Face Professional Development…………………………………90
      Instructional Coaching…………………………………………………91
      Instructional Resources…………………………………………………92

Data Collection…………………………………………………………………………94
   Survey………………………………………………………………………………94
   Interviews……………………………………………………………………….94
   Participants’ Attendance………………………………………………………94
   Instructional Coaching Log…………………………………………………94
   Reformed Teaching Observation Protocol………………………………95
   Diagnostic Teacher Assessments in Mathematics and Science…………95

Data Analysis……………………………………………………………………………95
   Statistical Tests…………………………………………………………………96
   Qualitative Data Coding………………………………………………………97

Conclusion……………………………………………………………………………97
<table>
<thead>
<tr>
<th>Chapter 5</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary Special Education Teacher Cohort</td>
<td>99</td>
</tr>
<tr>
<td>Face-to-Face Professional Development</td>
<td>101</td>
</tr>
<tr>
<td>Professional Development Session One</td>
<td>101</td>
</tr>
<tr>
<td>Professional Development Session Two</td>
<td>103</td>
</tr>
<tr>
<td>Professional Development Session Three</td>
<td>104</td>
</tr>
<tr>
<td>Professional Development Session Four</td>
<td>105</td>
</tr>
<tr>
<td>Professional Development Session Five</td>
<td>106</td>
</tr>
<tr>
<td>One-on-One Mathematics Instructional Coaching</td>
<td>108</td>
</tr>
<tr>
<td>Shifts in Classroom Practice</td>
<td>109</td>
</tr>
<tr>
<td>Mathematics Teaching Efficacy</td>
<td>111</td>
</tr>
<tr>
<td>Mathematics Instructional Coaching Matters</td>
<td>112</td>
</tr>
<tr>
<td>All Participants</td>
<td>112</td>
</tr>
<tr>
<td>Professional Development Only Participants</td>
<td>113</td>
</tr>
<tr>
<td>Professional Development and Coaching Participants</td>
<td>113</td>
</tr>
<tr>
<td>A Look Behind the Numbers</td>
<td>113</td>
</tr>
<tr>
<td>Extra Attention</td>
<td>114</td>
</tr>
<tr>
<td>Ineffective Instructional Practices</td>
<td>116</td>
</tr>
<tr>
<td>Effective Teaching Practices</td>
<td>118</td>
</tr>
<tr>
<td>Mathematics Knowledge for Teaching</td>
<td>124</td>
</tr>
<tr>
<td>Diagnostic Teacher Assessments in Mathematics and Science</td>
<td>121</td>
</tr>
<tr>
<td>Qualitative Data to Support the DTAMS Results</td>
<td>123</td>
</tr>
<tr>
<td>Reformed Teaching Observation Protocol</td>
<td>124</td>
</tr>
</tbody>
</table>
Biographical Information…………………………………………………………………………204
Appendix A: Logic Model………………………………………………………………………………187
Appendix B: Mathematics Teaching Efficacy Beliefs Instrument……………………………………188
Appendix C: Professional Development Feedback Form …………………………………………190
Appendix D: Semi-Structured Mathematics Interview …………………………………………191
Appendix E: Reformed Teaching Observation Protocol …………………………………………194
Appendix F: Diagnostic Teacher Assessments in Mathematics and Science…………………198
List of Tables

Table 2.1. 2016 PARCC Performance Level Grouping by School and Student Group. ..........27
Table 2.2. School Demographics. .........................................................................................29
Table 2.3. Semi-Structured Interview Questions.................................................................30
Table 2.4. Individual Teacher Responses for Knowledge of Content and Teaching.............40
Table 2.5. Individual Teacher Responses for Knowledge of Core Instructional Strategies.....42
Table 2.6. Correlation Between Years of Experience and Teacher Efficacy Beliefs..............44
Table 2.7. Results of Regression Analysis of Teacher SE and Years of Teaching Experience...45
Table 4.1. ESETC Component, Timeframe, Duration, Activity, and Example. ....................89
Table 4.2. Outline for Professional Learning-Sessions One through Five. .............................90
Table 4.3. Coaching and the Five Features of Effective Professional Development...............92
Table 4.4. ESETC Mixed Methods Data Collection Table. ....................................................95
Table 4.5. Research Question, Measure, Timeframe, and Analysis. .....................................96
Table 5.1. Background Information Regarding Participants’ Special Education Caseloads.....113
Table 5.2. RTOP Contextual Information for Pre- and Post-Intervention Observations.........126
Table 5.3. Caroline’s PMTE Subscale Statements.................................................................138
Table 5.4. Kathleen’s MTOE and PMTE Subscale Statements..............................................140
Table 5.5. Changes in Mathematics Teaching Efficacy Versus Overall Participation.............150
List of Figures

Figure 1.1. Conceptual Framework ................................................................. 5

Figure 3.1. Conceptual Framework ................................................................. 50

Figure 3.2. Data Teams Process and the Cycle of Continuous Improvement .... 70

Figure 4.1. Conceptual Framework ................................................................. 80

Figure 5.1. Comparing Fractions ................................................................. 106

Figure 5.2. Math with a Partner ................................................................. 143

Figure 5.3. Caroline’s Constructed Response Sample ................................ 143

Figure 5.4. Sample Problems for 3.OA.3 ..................................................... 145
Fourteen years have passed since President George W. Bush signed the No Child Left Behind (NCLB) Act into law (Bell & Meinelt, 2011). NCLB’s central focus was to have all students “proficient” in reading and mathematics by 2014. Although ambitious and never realized, NCLB (2002) did succeed in placing emphasis on subgroups that contributed to the achievement gap (Bell & Meinelt, 2011). Additionally in 2004, Congress passed into law the reauthorization of the Individuals with Disabilities Act (IDEA, 2004). The goal of IDEA (2004) was to provide children with disabilities the same opportunity for education as those students without a disability. Both NCLB (2001) and IDEA (2004) increased accountability to special education students by requiring schools to measure progress, disaggregate data to track subgroup performance, emphasize research-based instruction, and include students with disabilities in general education (Bell & Meinelt, 2011; Brownell, Bishop, Malik & Langley, 2007).

Despite an increased focus on curriculum and assessment standards, national and state data continue to reveal an achievement gap between students with special needs and their non-disabled peers (National Assessment of Educational Progress [NAEP], 2015). In 2015 “proficiency” on the NAEP was scored at or above 249 points. The average scale score for fourth grade students with special needs on the NAEP mathematics was 218. The average scale score for non-disabled peers in fourth grade was 244. In eighth grade the gap in mathematics achievement widened. The average scale score for students with special needs was 247 and the average scale score for non-disabled peers was 287 (National Assessment of Educational Progress, 2015).
The performance of students with disabilities at the national level coincides with one mid-Atlantic state’s results on the 2015 Partnership for Assessment of Readiness for College and Careers (PARCC) assessment. Students with special needs in grades 3-5 attending this school system had a mathematics proficiency score of 31% whereas students not identified as special education had a mathematics proficiency score of 75% (http://reportcard.msde.maryland.gov/). Considering gap that exists between students with special needs and students without special needs in mathematics, research suggests identifying the conditions under which special education students are taught and how teachers of special education students are prepared to teach mathematics effectively (Bell & Meinelt, 2011; Greer & Meyen, 2009; Meyen, Greer, & Poggio, 2008).

When considering the conditions under which students with learning disabilities are taught and learn mathematics, educators must be mindful of the Standards for Mathematical Practice (corestandards.org) and the Principles and Standards for School Mathematics, developed by the National Council of Teachers of Mathematics (NCTM, 2000). Further, it is NCTM’s belief that all students can learn mathematics with depth and understanding (NCTM, 2000). It is also a belief that teachers who engage students’ prior knowledge, consider the way students think, address students’ misconceptions, and design better instructional tasks support student learning more effectively (Steinberg, Epson & Carpenter, 2004). When students receive instruction based on mathematics content that addresses background knowledge and misconceptions, the outcome is likely student achievement (Greer & Meyen, 2009). With greater emphasis placed on the effectiveness of instruction the gap in achievement could be narrowed by examining teacher preparation standards that are inadequately preparing special education teachers to meet the needs of students with learning disabilities to successfully learn
mathematics (Greer & Meyen, 2009). This way, special education students are not at a
disadvantage when being measured against accountability mandates set forth by the federal
government (Darling-Hammond & Haselkorn, 2009).

Despite accountability mandates, it is this researcher’s and others’ belief that data
currently reflect a gap in achievement that is unlikely to improve without careful examination of
teachers’ mathematical knowledge for teaching (MKT) and mathematics teaching efficacy
(MTE) (Chang, 2015; Faulkner & Cain, 2013). In simplified terms mathematical knowledge for
teaching is the mathematics teachers’ “use” in classrooms (Delaney, Loewenberg Ball, Hill,
Schilling, & Zopf, 2008). Teachers with strong MKT offer clear explanations to students, pose
meaningful problems, examine mathematical materials with a critical eye, and address
inaccuracies or misconceptions in students’ thinking about mathematics (Hill, Rowan, & Ball,
2005). Mathematics teaching efficacy (MTE), or teachers’ beliefs in their abilities to organize
and execute courses of action necessary to bring about desired results in mathematics correlates
to teachers’ ability to design instructional tasks to support student learning (Chang, 2015;
Faulkner & Cain, 2013). For in-service special education teachers’ professional learning
opportunities to develop mathematical knowledge and strengthen teacher efficacy have been
limited (Faulkner & Cain, 2013). Additionally, some special educators enter the profession
lacking an understanding of effective mathematics teaching and learning and rely on teaching
procedures while using mathematics resources inappropriately (Faulkner & Cain, 2013; van
Garderen, Thomas, Stormont, & Lembke, 2013). The result has been a continued gap in
achievement for special education students and the failure to develop foundational skills needed
for subsequent learning of advanced mathematics concepts (Greer & Meyen, 2009). To address
these issues, school system leaders are encouraged to provide special education teachers with the
necessary opportunities and skills to be more effective in augmenting the academic achievement of children with special needs (Desimone, Smith & Phillips, 2013; Greer & Meyen, 2009).

**Problem of Practice**

The problem of practice (PoP) is that special education teachers lack appropriate MKT and MTE to effectively translate curriculum standards into aligned instruction (Greer & Meyen, 2009). Aligned instruction refers to the expectation that students with special needs have access to the same curriculum as their nondisabled peers (IDEA, 2004). Special educators express concern over the fact that much of their professional development in mathematics has focused on the implementation of cognitive strategies to satisfy Individualized Education Plan (IEP) goals rather than on objectives aligned with general education standards (Maccini & Gagnon, 2002). As a result, some special education teachers are ill-prepared to meet the needs of students with learning disabilities in mathematics at the elementary level (Greer & Meyen, 2009; Hill, Ball & Schilling, 2008).

There is agreement among some researchers that teachers’ efficacy in mathematics is associated with teaching performance and students’ learning in the classroom (Chang, 2015; Nurlu, 2015). In a study conducted by Floyd and Rice (2009) elementary teachers’ confidence in their ability to teach mathematics relative to the goals of the NCTM Standards was 63%. When the data were disaggregated by teacher group, the percentage of teachers with confidence to effectively teach mathematics increased to 92% of general education teachers and decreased to 37.9% of special education teachers. This difference according to Floyd and Rice (2009) was alarming considering both groups were responsible for educating students with special needs. Further, Floyd and Rice (2009) also revealed that special educators took fewer mathematics courses than general educators and were provided with fewer opportunities for in-service training.
and professional development in the area of mathematics (Floyd & Rice, 2009). For some special education teachers, a lack of confidence and MKT translates to weaknesses in differentiating instruction for diverse learners and translating curriculum standards into aligned instruction (Chang, 2015; Delaney et al., 2008; Faulkner & Cain, 2013; Greer & Meyen, 2009).

**Theoretical Frameworks**

The study’s hypothesis is that teachers who possess pedagogical content knowledge and knowledge of mathematics content have the potential to deliver mathematics instruction more effectively. Further, the study’s hypothesis suggests that teachers who effectively deliver mathematics instruction have the potential for increased MTE to impact changes in teachers’ instructional practice. Figure 1.1 displays useful concepts and their anticipated relationships into a conceptual framework to address the problem of practice in this research study. The framework is based on the theories discussed in this chapter and used by this researcher to argue for and justify the implementation of an intervention to support special education teachers in translating mathematics curriculum standards into aligned instruction for students with special needs.

![Figure 1.1. Conceptual Framework.](image)

**Self-Efficacy Theory**

There have been several studies over the past three decades that have revealed a positive correlation between teachers’ self-efficacy and student outcomes (Moore & Esselman, 1992; Swackhamer, Koellner, Basile & Kimbrough, 2009; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998; Watson, 1991). Further, studies have shown that teachers with higher levels of self-
efficacy possess greater work ethic and demonstrate more effective teaching practices than teachers with lower self-efficacy (Czerniak, 1990; Guskey, 1985; Swackhamer et al., 2009). Self-efficacy as a theory was presented in Bandura’s (1977) article *Toward a Unifying Theory of Behavioral Change*. According to Bandura (1977) self-efficacy is responsible for “changes achieved in fearful and avoidant behavior” (p. 193). Further, self-efficacy is enhanced when individuals experience performance accomplishments when faced with challenging circumstances (Bandura, 1977). As individual success increases with reliable experiences, greater changes are experienced in perceived self-efficacy (Bandura, 1977).

Bandura (1995) later defined self-efficacy as “beliefs in one’s capability to organize and execute the courses of action required to manage prospective situations” (p. 2). The belief that ‘I can’ or ‘I cannot’ has ramifications for student achievement because high levels of teachers’ self-efficacy has been associated with effective teaching and has correlated to positive outcomes for teachers and students (Swackhamer et al., 2009). Researchers have used Bandura’s self-efficacy theory and applied it to teacher self-efficacy in the field of education (Woolfork-Hoy & Burke-Spero, 2005). When efficacy is applied to teachers, teacher efficacy is defined as “judgment of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated” (Tschannen-Moran et al., 2001, p. 783). Additionally, teacher efficacy consists of personal teaching efficacy and teacher outcome efficacy. Personal teaching efficacy is “a teacher’s belief in his or her skills and abilities to positively impact student achievement, while teacher outcome efficacy is a teacher’s belief that the educational system can work for all students, regardless of outside influences” (Swackhamer et al., 2009, p. 64).
In a study conducted by Swackhamer et al. (2009) to measure the self-efficacy of middle school teachers in one Denver, CO school district, 88 participants were given the Science Teaching Efficacy Belief Instrument (STEBI-B). The STEBI-B was developed by Riggs and Enochs (1990) and was based on Bandura’s self-efficacy theory. Additionally, the researchers investigated whether personal teaching efficacy and teacher outcome efficacy changed because of completing mathematics content courses. The results of the study demonstrated that teachers with four or more science content courses reported higher levels of teacher outcome efficacy than those teachers who took three or less science content courses. These findings supported Palmer’s (2006) study with pre-service teachers who increased self-efficacy levels because of completing courses that focused on how to teach science content. Palmer’s findings are important to the present study because empirical research demonstrates that teacher efficacy affects teachers’ decision-making actions, motivations, persistence, and resilience when faced with challenges (Chang, 2015; Nurlu, 2015; Swackhamer et al., 2009). For special education teachers working with the lowest performing students, this internal belief to overcome challenges in meeting the diverse educational needs of students has the potential to impact student learning and achievement (Cantrell, Young & Moore, 2003; Chang, 2015; Ernest, Heckaman, Thompson, Hull, & Carter, 2011; Gibson & Dembo, 1984; Goddard & Goddard, 2001).

**Pedagogical Content Knowledge**

In addition to self-efficacy theory, pedagogical content knowledge has also been linked to effective teaching and student learning (Shulman, 1986). Shulman (1987) theorized that teachers with strong pedagogical content knowledge have a deep understanding of mathematics content and possess the ability to relate this subject matter knowledge to their pedagogical knowledge. Shulman (1987) expanded this theory by specifying seven categories of professional knowledge.
needed for teaching. The categories include: “content knowledge, general pedagogical knowledge, curricular knowledge, knowledge of learners, knowledge of educational contexts, knowledge of educational aims, goals and purposes, and pedagogical content knowledge” (p. 8). Pedagogical content knowledge is the combination of content and pedagogy that represents how topics, issues, or problems are organized and presented for instruction (Shulman, 1987). However, when presented in this way pedagogical content knowledge lacks clarity within mathematics education (Ball, Thames & Phelps, 2008; Depaepe, Verschaffel & Kelchtermans, 2013). Hill, Ball and Schilling (2008) provided greater specificity to Shulman’s (1986) construct by conceptualizing teachers’ pedagogical content knowledge into a valid measure of teachers’ MKT. This reconceptualization has provided empirical evidence of a positive relationship between student achievement and teachers’ pedagogical content knowledge (Baumert et al., 2010; Depaepe et al., 2013).

The relationship between teachers’ pedagogical content knowledge and student achievement was evident in a one-year study in Germany with 4,353 tenth grade students and their 181 teachers. Researchers hypothesized that pedagogical content knowledge and not content knowledge was more important to student learning and progress (Baumert et al., 2010). Content knowledge was measured using a paper and pencil assessment given to teachers consisting of 13 questions covering arithmetic, algebra, measurement, functions, and geometry (Baumert et al., 2010). Given that the assessment consisted of only 13 questions the test items “required complex mathematical argumentation or proofs of mathematical topics that were compulsory for Grades 5 to 10 and particularly appropriate for assessing the conceptual understanding of mathematical content” (Baumert et al., 2010, p. 148). Additionally, three facets of teachers’ pedagogical content knowledge were assessed through the completion of four
mathematical tasks, teachers’ recognition of students’ misconceptions, and teachers’ instructional knowledge based on responses from vignettes of classroom situations. The study linked pedagogical content knowledge to student assessment outcomes and determined that those teachers with the capacity to effectively communicate mathematics content demonstrated the greatest gains in their students’ performance (Baumert et al., 2010).

**Mathematical Knowledge for Teaching (MKT)**

Mathematical knowledge for teaching refers to the mathematical knowledge teachers need to effectively teach mathematics (Ball et al., 2008; Hill et al., 2005). MKT differs from Shulman’s concept of pedagogical content knowledge because MKT attempts to empirically validate pedagogical content knowledge and it combines pedagogy and content knowledge into one overarching category of knowledge (Ball et al., 2008). MKT can be measured by using an assessment developed by the Learning Mathematics for Teaching (LMT) project (Hill et al., 2004). The assessment measures teachers’ mathematical knowledge using multiple-choice questions based on classroom related scenarios. MKT includes two categories related to content knowledge: “common content knowledge; mathematical knowledge and skills used in settings other than teaching and specialized content knowledge, mathematical knowledge and skills unique to teaching mathematics” (p. 400). MKT also includes such categories as

- knowledge of content and students;
- knowledge of the interaction between mathematical understanding and students’ mathematical thinking;
- knowledge of content and teaching; and
- knowledge of the design of instruction (p. 401).
The concept of MKT serves three distinct purposes. First, MKT provides an empirical basis for pedagogical content knowledge (Depaepe et al., 2013). Second, MKT provides a valid measure of teachers’ mathematical knowledge for teaching. Third, the concept of MKT provides a positive correlation between pedagogical content knowledge and student learning outcomes (Depaepe et al., 2013). With the concept of MKT in place and the theoretical framework established, the structure of MKT can be defined through each of its four domains.

**Common content knowledge (CCK).** The first domain that helps teachers establish a perspective and appreciation for effective mathematics instruction is CCK. It is defined as the mathematical knowledge and skill “used in settings other than teaching” (Ball et al., 2008, p.399). Common content knowledge is the knowledge that is used in a variety of settings not unique to schools and teaching but not necessarily knowledge everyone possesses (Ball et al., 2008). CCK is the knowledge and skill needed to determine when students’ answers are incorrect or when textbooks provide inaccurate definitions. Teachers who possess CCK also have a firm grasp on the mathematics in the student curriculum to plan for and carry out effective instruction (Ball et al., 2008).

**Specialized content knowledge (SCK).** Specialized content knowledge is defined as the “mathematical knowledge and skill unique to teaching” (Ball et al., 2008, p. 400). Unlike CCK, SCK is specific for the purposes of teaching because it involves working with mathematics in ways that those outside of teaching typically do not, such as knowing alternative algorithms for 25-19 (Ball et al., 2008). For example, teachers employing SCK regularly respond to students’ “why” questions, modify tasks to make them harder or easier, or evaluate mathematical explanations. SCK requires that teachers unpack mathematics and make mathematics content visible and learnable by students (Ball et al., 2008). Thus, the work of teachers and the specific
Mathematical knowledge specialized to teaching highlight the importance of SCK on student learning.

**Knowledge of content and students (KCS).** Knowledge of content and students is defined as the “knowledge that combines knowing about students and knowing about mathematics” (Ball et al., 2008, p. 401). This domain calls for teachers to forecast what will motivate students to learn and how to use students’ thinking to drive future instruction. Teachers who possess knowledge of content and students understand the mathematical errors students will likely make and then plan accordingly. For example, Cognitively Guided Instruction (CGI) presents ideas in this area of literature by documenting common misconceptions of the equal sign or that comparison problems involving subtraction are more difficult than separate problems (Carpenter, Fennema, Franke, Levi, & Empson, 1998). What separates KCS from the first two domains is the familiarity with common errors and anticipating which of these common errors students will likely make (Ball et al., 2008).

**Knowledge of content and teaching (KCT).** Knowledge of content and teaching is the combination of “knowing about teaching and knowing about mathematics” (Ball et al., 2008, p. 401). KCT involves understanding the advantages of representing 25-19 in a variety of ways. Teachers who successfully sequence mathematical content select examples that develop students’ deeper understanding of content and evaluate the most effective representations used to teach an idea demonstrate KCT (Ball et al., 2008). These attributes describe an interaction between an understanding of content and pedagogy and the balance between the “mathematics at hand and the instructional options at play” (Ball et al., 2008 p. 401).

**Supporting the Use of MKT**
The mathematical knowledge of teachers and mathematical knowledge in teaching have gained the attention of researchers in mathematics education (Baumert et al., 2010; Depaepe et al., 2013; Zazkis & Mamolo, 2011). Baumert et al. (2010) conducted a one-year study in Germany with tenth grade students and their teachers. The study linked pedagogical content knowledge to student assessment outcomes and determined that those teachers with the capacity to effectively communicate mathematics content demonstrate the greatest gains in their students’ performance (Baumert et al., 2010). According to Baumert et al. (2010) the study results are significant because very few studies have successfully predicted student outcomes based on an assessment of teachers’ mathematics content knowledge.

Additionally, Faulkner and Cain (2013) conducted a professional development study that evaluated teacher knowledge specific to mathematics and its relationship to student achievement. Using Shulman’s (1985) conceptualization of MKT, researchers measured the effects of a 40-hour professional development course designed to increase educators’ mathematical knowledge (Faulkner & Cain, 2013). One hundred forty-six, K-12 general and special educators were administered the Content Knowledge for Teaching Mathematics (CKTM)-Number and Operations forms A and C. The CKTM measured teachers’ mathematical skills and knowledge needed to be effective in the classroom. The CKTM was given pre and post professional development. Those teachers selected as the treatment group and received professional development made significant gains in mathematical knowledge as compared to those teachers who received no mathematics training as measured by the CKTM (Faulkner & Cain, 2013).

**Effects of MKT on Student Achievement**

With the concept and structure of MKT established, Hill et al. (2005) explored whether and how teachers’ MKT contributed to gains in students’ mathematics achievement. In a mixed-
model methodology study including 1,190 first graders, 334 first grade teachers, 1,773 third graders, and 365 third grade teachers the researchers found that teachers’ mathematical knowledge was a significant predictor of achievement gains in both models at the first and third grade level. Student achievement was measured using the CTB/McGraw-Hill’s Terra Nova Battery, the basic battery, and the Survey (Hill et al., 2005). The scores were computed using item response theory. In the first grade study teachers’ MKT was distributed evenly across student socio-economic status (SES) levels. However, student minority status and teachers’ MKT revealed a negative relationship. The results from the third grade study revealed a significant relationship between teachers’ MKT and student SES. Additionally, the relationship between teachers’ level of MKT and minority student achievement in third grade students showed an increase in comparison to minority students in first grade. The difference in the findings between the two grades was not clear to the researchers but may be due to limitations such as small sample size of students, missing data, and “a lack of alignment between our measure of teachers’ mathematical knowledge and student achievement” (Hill et al., 2005, p. 399). Regardless, the study presents information relating to the importance of MKT development in teachers, especially those serving populations who traditionally underperform (Greer & Meyen, 2009).

The Role of MKT and Special Education Teachers

The concept of MKT is influential in the study of teaching and learning mathematics (Ball et al., 2008; Faulkner & Cain, 2013; Hill et al., 2005). Conceptual understanding consists of content knowledge including facts and concepts, transforming and delivering one’s own knowledge of content and pedagogy to meet the needs of diverse learners, and arranging mathematical concepts into a logical sequence to deliver instruction (Greer & Meyen, 2009; Hill
et al., 2005). Research shows that special education students benefit from explicit mathematics instruction as well (National Mathematics Advisory Panel, 2008). Explicit instruction consists of providing clear models to students for solving problems, allowing for extensive practice of new skills, having students share their steps for solving problems, and providing students frequent and immediate feedback (Greer & Meyen, 2009).

The strategies for explicit instruction were highlighted in the Institute of Education Sciences (IES) practice guide through a thorough review of the literature (Gersten, Chard, Jayanthi, Baker, Morphy, & Flojo, 2009). Gersten et al. (2009) recommends providing systematic, explicit instruction to students participating in tier two or tier three interventions. Tier two interventions provide struggling students the opportunity to work in a small group four or five times a week in 20- to 40-minute sessions. These interventions are designed to develop targeted mathematics proficiencies (Fuchs, Fuchs, & Vaughn, 2014). Tier three interventions usually include one-on-one tutoring and a variety of instructional interventions. One on one special education services are typically considered tier three supports (Fuchs et al., 2014). Recommendations for successfully executing explicit instruction with students with special needs consist of: (a) providing clear models for solving problems, (b) teacher think-alouds, (c) opportunities for students to solve problems in a group, and (d) access to regular cumulative review of skills (Gersten et al., 2009).

The combination of instructional methods listed above puts special education teachers in a situation of competing priorities. Special education teachers are responsible for translating curriculum standards into aligned instruction for special education students, so the development of MKT for pre-service and in-service special education teachers is needed (Depaepe, 2013; Hurrell, 2013; Greer & Meyen, 2009). Additionally, with special education teachers now
responsible for teaching grade-level curriculum to students who traditionally perform below
grade level, special education teachers are required to understand, teach, and assess special
education students according to general education curriculum standards (Greer & Meyen, 2009;
Kleickmann, Richter, Kunter, Elsner, Besser, Krauss, & Baumert, 2013; Mosvold & Fauskanger,
2014). However, if a child with a learning disability experiences a combination of teaching that
includes a conceptualization of MKT as defined by Ball and Hill (2008) and explicit instruction
as discussed by Gersten et al. (2009), one would expect a child with a learning disability to
experience successful academic outcomes.

Based on the gap in achievement between special education students and non-special
education students on the 2015 PARCC assessment in one mid-Atlantic school district, it is the
hope that special education teachers have an appropriate understanding of mathematics content,
pedagogical content knowledge, and possess the belief that their instruction will result in
successful translation of curriculum standards into aligned instruction (Hinton et al., 2015;
Kamil, 2003). Critics of MKT argue that this model ignores teachers’ beliefs about mathematics
teaching and that teachers’ mathematics knowledge can be tested independently from the context
of the classroom (Hurrell, 2013; Petrou & Goulding, 2011).

Mathematics Teacher Efficacy (MTE)

An examination of the research has determined that MTE accounts for individual
differences in teacher effectiveness and has a strong relationship to student mathematics
achievement (Cantrell et al., 2003; Gibson & Dembo, 1984). Teacher efficacy beliefs influence
teachers’ ability to: (a) persevere through challenges, (b) take responsibility for student success,
(c) adopt new strategies for teaching, and (d) dictate the amount of effort that goes into teaching
(Bandura, 1997; Takahashi, 2011). These four qualities highlight the importance of being able to
confidently translate curriculum into aligned instruction; a concept that some special education teachers struggle with when trying to provide specialized instruction to students with special needs within the general education classroom (Greer & Meyen, 2009; Hill et al., 2008; Swackhamer et al., 2009).

In a study conducted by Maccini et al. (2002) researchers shared concerns that special education teachers reported having limited knowledge and understanding of the goals of NCTM’s *Principles and Standards for School Mathematics* (2000) and aligning instruction for special needs students. Through the completion of a survey sent to 129 secondary general education mathematics teachers and special education teachers in Maryland, researchers determined that most of the special educators had not heard of the NCTM Standards nor were they confident in their ability to accommodate and adapt the Standards to individual learning needs (Maccini et al., 2002). Researchers also found a significant difference with general education teachers reporting more mathematics methods coursework (Maccini et al., 2002). These concerns have implications for special education teachers because of their responsibility for making grade-level mathematics curriculum accessible to students with special needs (Hinton et al., 2015). Considering that 55% of special educators in Maccini et al.’s (2002) study had not heard of the NCTM Standards signifies the need to further develop this knowledge in support of increasing student achievement for students with special needs.

As previously stated, MTE is associated with a teacher’s belief that their effort, perseverance, and success in conveying their mathematical content and pedagogical knowledge are directly related to gains in student achievement (Briley, 2012; Nurlu, 2015). Additionally, those teachers who exhibit high self-efficacy beliefs demonstrate characteristics such as believing in students’ achievement and taking responsibility for students’ success. Teachers who
report higher levels of MTE also have a higher level of persistence and effort with students and show greater tolerance towards students’ mistakes (Chang, 2015; Nurlu, 2015; Swackhamer et al., 2009). In a study conducted in Adana, Turkey during the 2011-2012 school year, researchers applied the *Self-Efficacy Beliefs toward Mathematics Teaching Scale* to 33 primary school teachers (Nurlu, 2015). The results demonstrated that teachers with high efficacy beliefs as measured with the scale had different characteristics than teachers with lower self-efficacy beliefs. The characteristics included greater effort, persistence with students, open-mindedness to new ideas and methods, and ownership of student achievement and success (Nurlu, 2015).

Not only did these teachers display highly-efficacious characteristics, they developed stronger relationships with students than teachers with lower self-efficacy (Nurlu, 2015). Highly efficacious teachers were also less critical of incorrect answers and showed tolerance towards students’ mistakes (Gibson & Dembo, 1984; Nurlu, 2015). In contrast, teachers with lower self-efficacy give up on lower achieving students, blame outside factors, and refer more students for special education (Gibson & Dembo, 1984). For special education students, the implications of having a highly efficacious teacher are self-confidence, less anxiety and fear with mathematics, a willingness to learn from mistakes, and increased academic achievement (Nurlu, 2015).

Conversely, the Nurlu (2015) study also determined that a negative attitude toward mathematics including fear, anxiety, and low self-confidence negatively impact student achievement. Teachers with low self-efficacy suggest that student characteristics such as inherited ability, fear of mathematics, interest, mathematical intelligence, motivation, and personal talent as reasons for low student achievement. Blaming students for low achievement translates to teachers’ taking no responsibility for improving their mathematics instruction which according to researchers could produce higher levels of student achievement (Gibson & Dembo,
These teachers also suggest that students’ low achievement is attributed to a lack of parental support (Nurlu, 2015). Conversely, Hoover-Dempsey, Bassler, and Brissie (1987, 1992) found a positive relationship between parental involvement and teachers’ self-efficacy. Highly efficacious teachers were more likely to encourage parent volunteers to come into the classroom to support the instructional program as well as increase involvement with at-home skill development. Similarly, Nurlu (2015) found that low level efficacy can be a cause of a weaker teacher-parent relationship.

Recent contributions to the literature further develop MTE by determining that successful teaching achievements foster positive beliefs in a teachers’ efficacy which subscribe to the expectation that positive attainments will likely reoccur (Chang, 2015, 2010). Researchers from one southern state within the United States conducted a five-week case study where one special education teacher in an inclusive first grade classroom consisting of both general and special education students used pre-assessment, self-assessment, and formative assessment to differentiate instruction to meet the needs of three students identified as special needs with an Individual Education Plan (IEP) (Ernest et al., 2011).

Using a systematic approach to individualization, the special education teacher used a variety of differentiated instruction strategies such as varying reading materials, providing rubrics, and varying time and support for specific tasks to make learning more accessible for the students with special needs (Tomlinson, 2000). Results of the study showed positive changes in the teacher’s planning and preparation, collaboration with the general education teacher, and assessment development and analysis. Because of the changes, this teacher focused on remediation of skills before moving on to other objectives, formed a stronger partnership with the general education teacher, and used assessment to determine content knowledge and drive
future instruction. These findings have important implications for classrooms where challenges and setbacks are common for those special education students who struggle conceptualizing mathematical concepts and strategies (Schulte & Stevens, 2015). With many school reform efforts focused on improving the quality of teaching and learning in the classroom, teacher efficacy beliefs are an important factor in school improvement efforts and in meeting the needs of all students in an inclusive school setting (Moolenaar, Sleegers & Daly, 2012).

**Pre-service Special Education Teachers’ Self-Efficacy**

Pre-service teachers enter teacher education programs with established ideas about how to teach mathematics based on prior experiences as students in mathematics classrooms (Briley, 2015; Cady & Rearden, 2007; Kamil, 2003). Students’ ability to solve problems, their disposition toward mathematics, and their confidence to persevere through mathematical challenges is affected by the teachers they encounter in school (NCTM, 2000). Teachers with lower self-efficacy who demonstrate limited understanding of mathematics content knowledge, are more likely to rely on whole group direct instruction (lecture-based), use worksheets, and lack the ability to effectively differentiate for the diverse needs of the students (Hinton et al., 2015; Swars, 2005; Wenta, 2000). Teacher education programs build foundations in pedagogical content knowledge and efficacy beliefs through course work designed to teach and learn mathematics content through critical thinking, reasoning, and problem-solving (Burton, 2015; Ma, 2010; Thames, 2006). The three attributes listed above are especially important for those teaching students with special needs because of the concern that a lack of conceptual understanding may interfere with students’ mathematical success at higher levels of mathematics such as pre-algebra or algebra I (Hinton et al., 2015). These factors stress the importance of having pre-service special education teacher candidates’ complete mathematics content and
methods coursework equivalent to that required of general education teachers, yet rarely are these mathematics content courses taken by pre-service special education teachers (Hinton et al., 2015; Kamil, 2003).

The Conference Board of the Mathematical Sciences (CBMS, 2012) document provides recommendations that mathematics teachers need to know to effectively instruct students across all school settings. These recommendations apply to teachers from early childhood to high school mathematics. The recommendations include the importance of pre-service teachers taking at least 12 semester-hours of mathematics content courses that will help them better understand the mathematics they will be teaching by engaging in reasoning, explaining, and sense-making. These recommendations hold true for those teaching students with special needs as well. Additionally, throughout their careers teachers need continued professional development opportunities to develop and strengthen their mathematical knowledge. In-service professional learning should include:

- content-based professional growth at levels appropriate for their experience, as they make the transition from new teacher, to mid-career professional, to master teacher.
- Opportunities for mathematical growth should include school- and district-based professional development, university-based graduate courses and “short courses” (e.g., one- or two-week intensive courses), teacher-driven professional experiences (e.g., lesson study), and teacher–mathematician partnerships (e.g., math teachers’ circles) (CBMS, 2012, p. 19).

In an investigation into pre-service special education teachers’ mathematical skills, self-efficacy, and teaching methodology Hinton et al. (2015) used a mixed-methods study involving problem-solving assessments, efficacy belief surveys, and open-ended questions administered to
33 pre-service special educators in one southeastern U.S. university during the final semester of their program. The purpose of the study was to investigate pre-service special education teachers’ preparation for effectively teaching mathematics. The researchers found that those teachers who classified their instruction as procedural in nature rated their outcome expectancy lower than those who classified their instruction as conceptual in nature. Despite the successful completion of an accredited teacher preparation program where all 33 pre-service special education teachers earned highly qualified special education teacher status with certification to teach at the elementary level and co-teach mathematics at the secondary level, 12 candidates exhibited limited content knowledge as well as deficits in their approach to mathematics instruction (Hinton et al., 2015). The implication of having 12 candidates demonstrate weakness in mathematics content and pedagogy is perhaps an indication of increased focus on skill within mathematics methodology coursework. Although no pre-test or formal intervention were administered in this study, content knowledge was measured near the end of students’ pre-service training using the Math Operations Test-Revised (MOT-R) (Fuchs, Hamlett, & Stecker, 1991) and the Math Concepts and Applications Test (MCAT) (Fuchs, Fuchs, Hamlett, Thompson, Roberts, & Kubek et al., 1994). The pre-service special educators in this study revealed strong beliefs in their effectiveness and students’ abilities to respond in a positive manner when exposed to effective instruction in the classroom (Hinton et al., 2015). This outcome is consistent with previous research, indicating optimism for future special education teachers’ self-efficacy beliefs when provided appropriate teacher preparation experiences (Flores, Patterson, Shippen, Hinton & Franklin, 2010; Hinton et al., 2015).

In-service Special Education Teachers’ Self-Efficacy
Teacher preparation programs are designed to develop pre-service teachers’ pedagogical content knowledge and increase mathematics teaching efficacy so that graduates entering the field of education are prepared to meet the needs of diverse learners (Briley, 2012; Hinton et al., 2015). Mathematics education instructors’ in education departments at the university level use instruments such as MTEBI to collect teacher efficacy data to provide insight into changes in pre-service teachers’ beliefs and attitudes about their ability to effectively deliver mathematics instruction (Hinton et al., 2015). On the other hand, research regarding in-service special education teachers’ mathematics teaching efficacy is limited because the concept of self-efficacy as developed by Bandura (1995) applied mostly to novice learners. Despite this limitation, MTE research conducted with pre-service teachers and the limited research done with in-service teachers applies to special educators as well (Flores et al., 2010; Swackhamer et al., 2009).

In a study to examine in-service teachers’ self-efficacy, Swackhamer et al. (2009) hypothesized that teachers enrolled in mathematics content courses that focus on how to teach mathematics content have higher mathematics teaching efficacy as a result. The study also investigated whether the characteristics of the teachers that participated in these courses were associated with high levels of efficacy. To test this hypothesis, the researchers administered the Science Teaching Efficacy Belief Instrument (STEBI-B) developed by Riggs and Enochs (1990) to 88 middle school teachers who had taken at least one of the 15 mathematics content courses offered to teachers over a four-year period in Denver, Colorado. The STEBI-B was based upon Bandura’s self-efficacy theory and consists of 23 items. Thirteen items measure teachers’ Personal Teaching Efficacy (PTE), or teachers’ belief in their ability to positively impact student achievement. Ten items measure teachers’ Teaching Outcome Expectancy (TOE), or teachers’
belief that the schools can have a positive impact on student achievement despite external factors (Swackhamer et al., 2009).

The researchers determined that in-service TOE was higher in those who had taken four or more mathematics content courses. Considering most teachers in the study were experienced (some with 15 or more years of teaching) it was not a surprise to researchers that the overall personal efficacy of the 88 teachers was relatively high even for those who had taken three or fewer content courses. Based on these findings, researchers were interested in why mathematics content courses increased TOE and not PTE. It was found that teachers who possessed greater content knowledge and had the confidence to convey this knowledge to all students contributed to higher levels of TOE (Swackhamer et al., 2009).

**Collective teacher efficacy.** Inclusive school settings where special educators and general educators share the responsibility for planning, teaching, and assessing students with special needs show promise for student achievement (Ernest et al., 2011). However, students’ academic struggles have researchers convinced that efficacy beliefs present a problem for schools where teachers and students are on “a self-perpetuating cycle in which teachers’ low efficacy beliefs and students’ low academic outcomes feed into each other” (Takahashi, 2011, p. 732). Based on Bandura’s (1997) findings, teachers’ low efficacy beliefs translate into lower student performance while at the same time, students’ low academic performance suppress teachers’ efficacy beliefs. This negative cycle not only presents a barrier to school improvement but reveals a problem that is grounded in teachers’ experiences working as a professional learning community with students who traditionally underperform. (Bandura, 1997; Caprara, Barbaranelli, & Steca, 2006, Takahashi, 2011).
In a study conducted in one urban Massachusetts junior high school where one-half of the students identified as Hispanic and one-third identified as African American; the expectation might be that teachers experience low efficacy beliefs given students’ academic performance and demographic characteristics (Takahashi, 2011). This school was selected for the study based on its demographics and its willingness to engage in evidenced-based decision making practices. The motivation behind the study was to examine the connection between these practices and teachers’ efficacy beliefs. The researcher focused on the experiences of four teachers through 13 interviews over a period of three months. The results of the study determined that communities of practice where teachers engage in dialogue about student achievement data, discuss and implement research based strategies, and receive feedback from administrators have positive implications for teacher efficacy beliefs (Takahashi, 2011). The findings of the study show promise for special educators working with students who exhibit lower levels of performance because communities of practice provide opportunities for teachers to co-construct efficacy beliefs and collectively negotiate the purpose of their work (Takahashi, 2011).

**Conclusion**

Special education teachers are faced with the challenge of translating grade level curriculum standards into aligned instruction for students with special needs often without formal teacher preparation or professional development opportunities (Greer & Meyen, 2009). Research shows that because of limitations to some special education teachers’ MKT and MTE the expectation to translate grade-level standards into aligned instruction can be a challenge, particularly in many elementary school classrooms (Chang, 2015; Greer & Meyen, 2009; Hill et al., 2005). Additionally, special educators in conjunction with their general education colleagues are expected to close the gap in achievement in mathematics even though some special education
teachers have expressed limited knowledge of important policy documents such as NCTM’s *Principles and Standards for School Mathematics* (2000). Despite these concerns, this review of the literature has revealed findings that support gains in student achievement through the development of teachers’ content knowledge, pedagogical content knowledge, MKT, and MTE (Ball et al., 2008; Swackhamer et al., 2009; Takahashi, 2011). These findings are encouraging and speak to providing special education teachers with formal opportunities to build their capacity in teaching mathematics and to gain confidence in meeting the needs of students who have traditionally underperformed or have demonstrated gaps in their mathematics learning.
Chapter 2

Needs Assessment

Goals and Objectives

The purpose for the needs assessment was to examine MKT and MTE of teachers of students with special needs in one mid-Atlantic district. Currently, elementary teachers of students with special needs deliver instructional services to students with disabilities in kindergarten through fifth grade. These individuals are responsible for translating curriculum standards into aligned instruction for students with learning disabilities (Greer & Meyen, 2009). The responsibility of a special educator is to collaborate with general education teachers to provide specialized instruction through supplementary aides and services and accommodations that modify and provide access to the general education mathematics curriculum. With the passage of No Child Left Behind (NCLB, 2002) and the Individuals with Disabilities Act (IDEA, 2004), students with special needs are held to the same grade-level standards in mathematics as their non-disabled peers. The implication of this change in instructional accountability is that teachers of students with special needs now must understand, teach, and align their instruction to general education standards (Greer & Meyen, 2009).

Context of Professional Practice

The context of professional practice was within a large suburban school system in one mid-Atlantic district. Specifically, this study focused on 11 elementary special education teachers who worked with a total of 258 students in grades kindergarten through grade five across four schools. Additionally, the gap in achievement in mathematics between students with special needs and their non-disabled peers at the four schools was considerable ranging on average from 70.1% (all students proficient or above) to 23.8% (students with special needs
proficient or above). The table below provides a comparison of proficiency levels in mathematics for all students and students with special needs in grades 3-5 at each of the four school sites represented in the needs assessment on the 2016 administration of the PARCC assessment.

Table 2.1

*2016 PARCC Proficient and Above Performance Level Grouping by School and Student Group*

<table>
<thead>
<tr>
<th>School</th>
<th>All Students</th>
<th>Special Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>86.4%</td>
<td>39.5%</td>
</tr>
<tr>
<td>B</td>
<td>82.9%</td>
<td>20.0%</td>
</tr>
<tr>
<td>C</td>
<td>60.0%</td>
<td>25.8%</td>
</tr>
<tr>
<td>D</td>
<td>53.8%</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

The four schools represented a combination of Title I and non-Title I, urban environments, as well as diversity in ethnicity, socio-economic status, and total school enrollment.

**Research Questions**

The purpose of the needs assessment study was to investigate the impact that pre-service training and previous in-service professional development has had on participants’ perceptions regarding their level of understanding of mathematics instructional strategies and their self-assessment of their ability to use instructional strategies to teach mathematics to students with special needs. To answer these questions, the following broader research questions were addressed:

1. What are the professional characteristics of the 11 special education teachers?
2. How do special education teachers describe the impact that mathematics professional development has had on their ability to teach mathematics?

3. What is special education teachers’ level of knowledge of instructional strategies in elementary mathematics?

4. What are special education teachers’ beliefs about their ability to increase the learning of students with special needs in mathematics?

Method

Participants

As of April 26, 2016, the school system in the study employed 292.5 special education teachers who provided services to 4,657 students (Retrieved from http://www.fcps.org/). The 11 special educators for this needs assessment were recruited and voluntarily participated. The teachers were recruited based on school demographics related to the fact that each school had a combination of new and veteran teachers. The 11 special educators were the only participants asked to take part in the study. This study included 11 female, certified elementary special education teachers across four schools in a single public school district in a mid-Atlantic state. The table below provides school demographic information (in percentages) for the four schools represented in the study. These 11 individuals provided special education services to a total of 258 students in kindergarten through fifth grade. Of the 11 participants, six taught at Title I schools and five taught at non-Title I schools. Four of the participants had 1-3 years of experience. Four of the participants had 4-8 years of experience. Three of the participants had more than eight years of experience.
Table 2.2

School Demographics

<table>
<thead>
<tr>
<th>Student Group</th>
<th>School A</th>
<th>School B</th>
<th>School C</th>
<th>School D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Education</td>
<td>10.6%</td>
<td>10.0%</td>
<td>11.5%</td>
<td>13.1%</td>
</tr>
<tr>
<td>ELL</td>
<td>3.6%</td>
<td>0.7%</td>
<td>14.4%</td>
<td>44.3%</td>
</tr>
<tr>
<td>African American</td>
<td>6.3%</td>
<td>2.1%</td>
<td>31.0%</td>
<td>17.5%</td>
</tr>
<tr>
<td>Free or Reduced Meals</td>
<td>9.8%</td>
<td>15.0%</td>
<td>57.5%</td>
<td>86.6%</td>
</tr>
</tbody>
</table>

Measures

After being recruited, participants voluntarily agreed to participate in this study by signing a consent form. A mixed-methods approach was used to determine special education teachers’ knowledge of instructional strategies in mathematics which is important to determining a teachers’ MKT. The reason MKT was not measured in the needs assessment was because the questions were written by the author and therefore not valid or reliable. Knowledge of instructional strategies in mathematics were determined by asking teachers the two scenario questions during the semi-structured interview.

Semi-structured interview. The 11 special education teachers participated in the semi-structured interview with questions developed by the researcher. The interview questions were based on this researcher’s observation of and assumption that professional development opportunities for special educators in mathematics were lacking. The development of the interview questions came from an assignment completed in the Research Methods and Systematic Inquiry I course taken by the author during the 2016 spring semester. Additionally, the researcher in this study decided to conduct group interviews by school based special education teams. The reason for doing group interviews was to avoid having participants feel
“under the microscope” and to provide a less threatening experience overall. This researcher’s experience as a principal has revealed that teachers are more willing to speak freely to an administrator when in the presence of a teammate. Also, the goal was to create a conversation in hopes of generating more of a free flow of ideas.

**Relationship between interview questions and research questions.** The semi-structured, group interview questions as seen in Table 2.3 were grouped in relationship to one of the four research questions. The first five questions were grouped in relationship to research question number one. Questions one and two were written to determine participants’ demographics, questions three and four determined participants’ frequency attending and type of professional development opportunities, and question five asked participants to describe the characteristics of quality professional development. Question six was written in relationship to research question number two to determine participants’ instructional shifts because of professional development experiences. Questions seven and eight were written in relationship to research question number three and presented scenarios asking teachers to describe their level of knowledge regarding resources and strategies they use with struggling learners. Teachers who possess knowledge of instructional strategies and use them well, develop students’ mathematical thinking and evaluate the most effective representations used to teach a mathematical idea (Ball et al., 2008). Questions nine and ten were written in relationship research question number four to assess potential professional development opportunities to be considered as an intervention to address the problem of practice.

Table 2.3

*Semi-Structured Interview Questions*

<table>
<thead>
<tr>
<th>Research Question One</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How many years have you been a special education teacher?</td>
</tr>
<tr>
<td>2. How many 3 or 4 credit mathematics methods courses have you taken?</td>
</tr>
</tbody>
</table>
3. How often do you participate in professional development related to teaching mathematics at your school?
4. What type of mathematics professional development have you participated in as a special educator?
5. What are the characteristics of the best professional development you have ever had?

Research Question Two
6. What changes have you made to your mathematics instruction as a result of professional development?

Research Question Three
7. When a third grade teacher comes to you to express concern about a student who is struggling with basic number sense of whole numbers, what core instructional strategies or tier 2 interventions do you recommend?
8. When a fifth grade teacher comes to you to express concerns about a student who is struggling with foundational fraction skills, what core instructional strategies or tier 2 interventions do you recommend?

Research Question Four
9. What domains of the Common Core mathematics curriculum are you most comfortable teaching to students? Why?
10. What domains of the Common Core mathematics curriculum are you least comfortable teaching to students? Why?

Mathematics Teaching Efficacy Beliefs Instrument. The teachers also completed the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs, Smith, & Huinker, 2000). Mathematics teaching efficacy was measured using the MTEBI and knowledge of instructional strategies was measured using a semi-structured interview with the special education teams at each of the four schools. Semi-structured interviews were audio recorded then transcribed onto an Excel spreadsheet and coded.

The quantitative data collection instrument used was the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs, et al., 2000). The MTEBI (see Appendix B) resulted from the modification of the Science Teaching Efficacy Belief Instrument STEBI-B (Riggs & Enochs, 1990). The MTEBI measures mathematics teaching efficacy beliefs and consists of 21 questions with two subscales, personal mathematics teaching efficacy (PMTE) and mathematics teaching outcome expectancy (MTOE). The PMTE consists of 13 items and the MTOE consists of eight items. The rating scale includes a 1 to 5 Likert scale with the anchors: strongly disagree, disagree, uncertain, agree, and strongly agree. Enochs et al. (2000) suggested reverse scoring the
seven negatively worded items on the PMTE to produce high scores for those who selected a one or two and lower scores for those who selected a four or five on the rating scale. See Table 2.4.

Using Cronbach’s alpha, researchers produced an alpha coefficient of 0.88 for the PMTE scale and an alpha coefficient of 0.75 for the MTOE scale. Confirmatory factor analysis revealed that both scales were independent, confirming the construct validity of the MTEBI (Enochs et al., 2000). Possible scores on the MTEBI ranged from 21 to 105. Higher scores indicated higher levels of mathematics teaching efficacy. Thirteen items on the MTEBI addressed teachers’ beliefs about personal mathematics teaching efficacy. These items made up the PMTE subscale. Scores on the PMTE subscale ranged from 13 to 65. Higher scores indicated higher levels of personal mathematics teaching efficacy. Eight items on the MTEBI addressed teachers’ beliefs about effective teaching and the connection to positive outcomes for students. These items made up the MTOE subscale. Scores on the MTOE subscale ranged from 8 to 40. Higher scores indicated higher levels of mathematics teaching outcome expectancy.

Data Analysis

When determining the response categories or codes for the semi-structured interview responses, organizing by research question provided a framework that made the most sense for this qualitative approach to data collection. The response category for years of experience was 1-3 years of teaching experience, 4-8 years of teaching experience, and 9+ years of teaching experience. The response categories for question number two and the number of mathematics methods courses taken during in-service training were zero courses taken, one course taken, or more than two courses taken. Regarding the frequency in which the special educators participated in mathematics professional development at their respective schools the categories were at least once a year, at least once a month, or at least once a week. Question four was
coded a priori as research-based interventions, response to intervention, mathematics problem-solving, and differentiation. After reviewing the data for question four, unpacking mathematics content standards was revealed as an emerging code. Question five was coded a priori as organized and applicable, knowledgeable instructor, and collaboration with colleagues. After reviewing the data for question five, integration of technology was revealed as an emergent code.

Coding for research questions two involved dividing the phrases into small parts, assigning a label to each part, and then grouping the codes into themes (Creswell & Clark, 2011). Semi-structured interview question six was coded a priori as use of higher-order teaching strategies. The emerging codes for question number six and the changes made to instruction because of professional development were unpacking standards and accounting for research-based interventions during instructional time.

The researcher in this study established a priori codes for research question three based on research specific to mathematics instruction for students with learning disabilities. Participants were asked to make recommendations to their general education colleagues when approached about those third grade students who were struggling with basic number sense of whole numbers and those fifth grade students struggling with foundational fraction skills. Question seven was coded a priori as explicit instruction, use of visuals, feedback, student verbalization, and working a peer. After reviewing the interview data, the emergent codes were research-based interventions, small group or one-on-one instruction, online resources, and the use of manipulatives. After a review of the interview data for question number eight the emergent codes were use of manipulatives, consultation with mathematics specialist, small group or one-on-one instruction, and research-based interventions.
The final research question was categorized according to the mathematics domains outlined in the Common Core State Standards (NGA, 2010) for the elementary grades (Retrieved from http://www.corestandards.org). The domains selected a priori were Counting and Cardinality, Operations and Algebraic Thinking, Number and Operations in Base Ten, Number and Operations in Fractions, Measurement and Data, and Geometry.

Following the semi-structured interview, participants were given the MTEBI to complete individually. The MTEBI took each participant approximately 10 minutes to complete. The completed MTEBI was placed into an envelope, sealed, and given to the researcher by a neutral party upon completion. MTEBI results were recorded on an Excel spreadsheet where regression analysis was performed to identify the relationship between years of experience and mathematics teaching efficacy.

Results

Research Question #1: What are the professional characteristics of the 11 special education teachers?

The first three semi-structured interview questions established the special education teachers’ background in terms of years of experience teaching special education, number of mathematics methodology courses each participant had taken during pre-service training, and participation in mathematics professional development. One participant had a minor in mathematics which meant that she had 12 credits of mathematics content coursework and a three credit mathematics methods course. All participants had one mathematics methods course during pre-service training however, the methods courses were not specific to teaching students with special needs.
When the participants were asked about the frequency of their participation in mathematics professional development at their home school they shared many insights. One veteran teacher from school B said, “Mathematics professional development for special education teachers is a school-based decision, so where you work really dictates how often or how much professional development you attend or receive. This year we have only gone twice to professional development and even then we felt it did not meet our needs. To be honest, we would rather be with our students.” Another teacher shared that she had professional development “Two or three times a year to specifically focus on mathematics instruction.” A special educator from one Title I school stated, “We have gone to two professional development sessions this year and they were during a staff meeting when we discussed data [about students’ mathematics performance] during SIOP [Sheltered Instruction Observation Protocol] training.” One veteran special education teacher from the other Title I school said, “What typically happens is that we have intentions of going to professional development but that plan usually disintegrates a few months into the school year because of our caseload responsibilities with students.” One teacher from a non-Title I school stated, “Because of our schedules and the history of not attending professional development at this school, we have not gone to any mathematics professional development this year.”

When asked about the content of the professional development these special education teachers have participated in, teachers from school A said, “we participated in one professional development session at the beginning of the year that reviewed the CCSS Standards of Mathematical Practice and how they could be developed in the classroom.” School A also said, “we received one professional development session about students’ mindset regarding mathematics.” The team did not elaborate on how the professional development specifically
related to mathematics instruction. School B described their mathematics professional
development as one session that covered how to use a published intervention program called
Math Navigator with their special education students (emerging code-targeted intervention).
Math Navigator is a targeted intervention composed of modules that help students in tier 2 and 3
interventions build foundational concepts. One teacher from school B said, “Using Math
Navigator helps to better prepare them [students] for understanding the grade level standards in
the Common Core.” The special education team leader from school C shared, “I attended one
mathematics intervention meeting to learn about how to use Math Navigator with my students
and one SIOP training that was specifically geared toward mathematics” (emerging code-
targeted intervention). School B participants also said, “We participated in one mathematics
professional development session with a grade level team to unpack one of the Operations and
Algebraic standards from the Common Core curriculum. The purpose was to better understand
the standard so that the team could create a common formative assessment” (emerging code-
unpacking standards).

Aside from the team leader at school C, the other two teachers from school C had only
been on the job for a few months and had neither attended mathematics professional
development at their school nor at the county level. School D special educators had not attended
mathematics professional development at all during the year so they had nothing to offer other
than one teacher’s prior experience attending the Math Navigator training (emerging code-
targeted intervention) at the district level. Another reason the participants from school D had not
attended professional development specific to mathematics was because up to that point one
teacher had only worked in a specialized program for students with severe special needs who
were non-verbal and the other special education teacher had just transitioned from special
education pre-kindergarten and had not attended mathematics professional development while in that role.

When analyzed by the coding for question number four and the content of professional development experiences, four participants discussed targeted interventions and six participants discussed unpacking standards.

Question five dealt with determining the characteristics of the most effective mathematics professional development these teachers had received as special educators. The teachers from school A had experienced mathematics professional development in the past that included collaboration between special and general educators (emerging code-collaboration) on how to make connections between the general education curriculum and best practice for students with special needs. One veteran teacher stated, “We become better co-teachers when we learn together.” These teachers also discussed how important it was for the person leading the professional development to understand special education (emerging code-knowledgeable instructor) and the challenges that accompany modifying grade level curriculum for students working one, two or more years below grade level. One teacher from school A said, “It makes the presenter credible and more interesting to learn from.”

School B described their best mathematics professional development experience as “organized” and “relevant to their work as special educators” (emerging code-organized). This professional development experience was previously described as the work that was done in collaboration with general educators when together, they unpacked a mathematics standard to better understand it and then wrote a common formative assessment to drive future instruction (Emerging code-collaboration). These teachers referred to the collaborative experience as the “data teams” process. One teacher from school B said, “Data teams allowed us the opportunity
to discuss the strategies for helping students make progress with the standard.” The experience mentioned by the teachers at school B provided them an opportunity to drill deeper into a standard and to use that information to make more informed instructional decisions.

The one teacher from school C who had been teaching longer than one year described the best mathematics professional development as “technology rich and applicable to teachers of students with special needs.” This teacher appreciated learning about a variety of iPad apps that could be used as independent practice with struggling learners. She viewed them to be “motivating and engaging for students” (emerging code-technology). The other two new teachers had not received mathematics professional development to date so they had nothing to offer in response to this question. The characteristics of the best professional development that teachers from school D experienced were well organized, detailed, applicable to special educators, included hand-outs for future reference, and provided opportunities to collaborate with colleagues (emerging codes-organized, collaboration). These teachers did not mention one professional development opportunity, just the characteristics of what they believed to be the best experience across multiple sessions.

When analyzed by the coding for interview question number five and the characteristics of the most effective mathematics professional development these teachers had received as special educators, five participants mentioned organized and applicable as effective professional development characteristics, two teachers mentioned collaboration, two teachers discussed having a knowledgeable instructor as important, and one teacher mentioned that professional development that incorporates technology as an effective approach.

Research Question #2: How do special education teachers describe the impact that mathematics professional development has had on their ability to teach mathematics?
Interview question number six asked teachers to discuss the changes they had made to their mathematics instruction because of mathematics professional development. Schools A, B, and C discussed that they made some changes to their instruction because of learning how to dissect a standard as part of the data teams process. The team leader at school B described the unpacking of a standard as “It [data teams] provided a deeper understanding of the standard being analyzed for the purpose of discussing and implementing common instructional strategies and for creating common formative assessments.” The instructional strategies varied depending on how far the students were from the benchmark but some instructional strategies included the use of specific manipulatives as appropriate for the standard, explicit instruction, or expecting students to justify solutions in words or visuals.

Teachers at all four schools discussed how the state now requires all students working two years or more below grade level in mathematics to participate in research-based interventions. Placing students in research-based interventions has shifted some of their instructional time from using a co-teaching model to delivering small group or one-on-one interventions to students with special needs. The two commercial intervention programs that were mentioned were Math Navigator and Connecting Math Concepts. One teacher mentioned the Educator Effectiveness Academy (EEA) as one other professional development opportunity specifically focused on mathematics. EEA occurred at the district level three times a year over a five-year span. The purpose of EEA was to educate staff about the roll-out of the Common Core State Standards and help schools’ transition from the old curriculum to the new. The training was Common Core mathematics and English language arts content aligned during the first three years of EEA.
When analyzed by the coding for question number six, five teachers mentioned the unpacking of standards as an impactful strategy learned during professional development, four teachers discussed researched-based interventions as a focus of professional development.

**Research Question #3:** What is the special education teachers’ level of knowledge of instructional strategies in elementary mathematics?

When given an authentic scenario and asked about effective instructional strategies or tier 2 interventions to support a third grade student lacking basic number sense of whole numbers, the special education teachers offered the following strategies included in Table 2.4.

**Table 2.4**

*Individual Teacher Responses for Knowledge of Content and Teaching*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Years of Experience</th>
<th>Responses to Question Seven</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 months</td>
<td>“I don’t really have any recommendations for this teacher because I am so new to special education teaching and I do not have any third graders on my caseload so far.”</td>
</tr>
<tr>
<td>2</td>
<td>4 months</td>
<td>“Provide an assessment to determine where the gaps are and then consult with the math specialist in the building to find the resources to best meet the students’ needs. I would also recommend using Dream Box or Front Row, the online math resources for independent practice. This student could also benefit from small group instruction as well.”</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>“I would recommend small group instruction or one-on-one tutoring using the Math Navigator module that focuses on number sense, so that the intervention is specifically addressing the area of need.”</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>“I would recommend using a hundreds chart, dice, or even a regular deck of playing cards. The teacher could also use a calendar or ask the parents to help with number sense at home. I would also recommend flashcards.”</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>“Sum Sense is a good online website to practice with flashcards but using the computer.”</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>“I would recommend that the teacher incorporate some small guided group instruction after consulting with the math specialist in the building for some ideas. I would also recommend the use of visuals.”</td>
</tr>
<tr>
<td>7</td>
<td>18</td>
<td>“My recommendation to this teacher would be to provide some one-on-one support each day in the areas of number sense that are lacking. I would also recommend some specific Math Navigator activities that specifically address the areas of weakness.”</td>
</tr>
</tbody>
</table>
“I would ask the teacher what data was used to support the idea that this child lacks number sense. I would then recommend that they incorporate daily explicit instruction from the Math Navigator modules that deal with number sense.”

“My recommendation would be the use of manipulatives and visuals. If it is number sense, then I would use things like base ten blocks and have the students build numbers and then discuss with the teacher their understanding of the number built.”

“Yes, I would also use manipulatives and spend time getting to know the student’s data to make an informed decision.”

“At this point because this is my first year teaching something other than special education pre-kindergarten, I would have a hard time recommending anything useful at this time.”

Teachers two and six mentioned consulting with the school-based mathematics specialist as one core instructional strategy to address weaknesses with number sense. The school-based mathematics specialist serves as a resource for teachers who are seeking support with materials of instruction, data analysis, planning and preparation, and knowledge of instructional strategies. When analyzed by the coding for question number seven, three teachers mentioned using research-based interventions, three discussed small group or one-on-one instruction, two teachers thought that online resources were effective, and three teachers mentioned the use of manipulatives or pictorial representations to develop number sense of whole numbers in a struggling third grade student. The participants’ responses demonstrated limited understanding of how to specifically assist a teacher seeking guidance on how to respond to a struggling third grade student. Not one participant said specifically what small group instruction should entail or the most effective manipulatives to use in a scenario like the one mentioned above. Teacher 11 went as far to say that she has not been teaching long enough to make a recommendation whereas the 24 year veteran mentioned the use of a calendar to help build number sense.
When asked about effective instructional strategies or tier 2 interventions to support a fifth grade student struggling with foundational fraction skills, the special education teachers offered the following strategies included in Table 2.5.

Table 2.5

*Individual Teacher Responses for Knowledge of Instructional Strategies*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Years of Experience</th>
<th>Responses to Question Eight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 months</td>
<td>“I would first have the teacher consult with the math specialist in the building to see what they think. I would recommend using something like Cuisenaire Rods or base ten blocks and have the teacher work in a small group or one-on-one with the student.”</td>
</tr>
<tr>
<td>2</td>
<td>4 months</td>
<td>“My recommendation would be for this teacher to work with this student in a small group and review many of the basic fraction concepts taught in third and fourth grade.”</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>“I am having that teacher get out the manipulatives and get the student to build basic fractions using fraction bars or fraction circles. We would discuss the basics such as one-half and one-fourth, etc. We would be doing a lot of manipulation of materials.”</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>“I would recommend using manipulatives such as fraction bars and a multiplication chart to help with reducing fractions. I would emphasize fraction vocabulary and getting the child to understand what it means to reduce fractions.”</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>“I would offer after school support to the student like I have done in the past with language arts.”</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>“My thoughts would be small group instruction, consult with the math leader for support, and use lots of visuals with the student. I would also ask the teacher what data they used to determine the gaps and deficiencies.”</td>
</tr>
<tr>
<td>7</td>
<td>18</td>
<td>“I would use the fraction module of Math Navigator and encourage mastery of multiplication facts because they are the foundation to helping students understand fractions.”</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>This teacher offered no response.</td>
</tr>
<tr>
<td>9</td>
<td>7</td>
<td>“My recommendation would be to use manipulatives to help them understand basic fractions and to help them find that one strategy that works well for them.”</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>“I would have them use visuals and use real world application of knowledge. I would have them draw pictures of fractions and use some of the really good apps we have for the iPad. Just five or 10 minutes of individual practice is good.”</td>
</tr>
</tbody>
</table>
When analyzed by the coding for question number eight where $N = 11$, two teachers mentioned consultation with the mathematics specialist in the school, six teachers discussed the use of manipulatives or visual representations, four respondents mentioned small group or one-on-one instruction, one teacher added research-based interventions, and one teacher discussed online resources.

When asked about the Common Core mathematics domain they are most comfortable teaching to special needs students all 11 special education teachers answered with Counting and Cardinality and Number and Operations in Base Ten. The reason according to one teacher at school D was because “these are the strands that we most often write IEP goals for and in most cases, these are the strands that our students need the most support with.” A teacher from school B said, “Most of the goals I write have to do with the four operations of addition, subtraction, multiplication, and division and right now I am working primarily with the primary grades so Counting and Cardinality drives many of my students’ goals.”

When asked about the common core mathematics domain they had the most difficulty teaching to students with special needs all 11 special education teachers answered with Operations and Algebraic Thinking. The reason this choice was unanimous was because they each suggested it was also on many of their students’ IEPs and a real struggle for students to grasp because of the problem-solving involved. This domain was described by one teacher at school D as too “abstract for the students with special needs.” The special education team leader at school C said, “Our students, especially the non-English speakers have difficulty solving
problems in context because the comprehension of the mathematics problems gets in the way of the students doing the mathematics involved in the problems.”

**Research Question #4:** What are special education teachers’ beliefs about their ability to increase the learning of students with special needs in mathematics?

Regression analysis as seen in Table 2.6 was used to determine whether years of experience affected mathematics teaching efficacy beliefs for the 11 needs assessment participants. No teacher in the study scored higher than a 91 out of a possible 105 points on the MTEBI. Six out of 11 teachers scored between 57 and 72. The special education teacher with the least amount of teaching experience scored the lowest with 57 on the MTEBI. Five out of 11 special education teachers scored between 75 and 91. The special education teacher with the mathematics minor and 18 years of teaching experience scored the highest with 91 on the MTEBI. Further, this participant scored the highest with 61 out of a possible 65 points on the PTME subscale. The participant with 24 years of experience scored the second highest with 52 points on the PMTE subscale.

Ten out of 11 special education teachers scored between 22 and 30 on the Mathematics Teaching Outcome Expectancy (MTOE) subscale. The special education teacher with the mathematics minor and 18 years’ teaching experience scored on the higher end of the scoring range with a 30 out of a possible 40 points on the MTOE subscale. The special education teacher with the fewest years of teaching experience scored the lowest with a 22 on the MTOE subscale. Six out of 11 special education teachers scored between 35 and 61 on the Personal Mathematics Teaching Efficacy (PTME) subscale. The special education teacher with the least experience scored the lowest with a 35 on the PTME subscale.

Table 2.6
Correlation between Years of Experience and Teacher Efficacy Beliefs

<table>
<thead>
<tr>
<th>Participant</th>
<th>Years of Experience</th>
<th>MTOE</th>
<th>PMTE</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 months</td>
<td>22</td>
<td>35</td>
<td>57</td>
</tr>
<tr>
<td>2</td>
<td>4 months</td>
<td>24</td>
<td>44</td>
<td>68</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>27</td>
<td>49</td>
<td>76</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>28</td>
<td>52</td>
<td>80</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>25</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>25</td>
<td>44</td>
<td>69</td>
</tr>
<tr>
<td>7</td>
<td>18</td>
<td>30</td>
<td>61</td>
<td>91</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>28</td>
<td>44</td>
<td>72</td>
</tr>
<tr>
<td>9</td>
<td>7</td>
<td>27</td>
<td>50</td>
<td>77</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>26</td>
<td>43</td>
<td>69</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>25</td>
<td>44</td>
<td>69</td>
</tr>
</tbody>
</table>

Analysis of the data showed that five of the six participants with five or less years of teaching experience had the lowest overall scores on the MTEBI of the 11 participants. Conversely, veteran teachers with the most experience scored highest. These individuals were the special education team leaders at each school and made the greatest contributions to the semi-structured interviews as well. The regression analysis shown in Table 2.7 demonstrates statistically significant results between participants’ years of experience and overall teacher efficacy scores ($p = .01$).

Table 2.7

Results of Regression Analysis of Teacher Self-Efficacy and Years of Teaching Experience

<table>
<thead>
<tr>
<th>Variable</th>
<th>df</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years teaching</td>
<td>10</td>
<td>9.76</td>
<td>.012</td>
</tr>
</tbody>
</table>
Discussion

The data from the semi-structured interviews revealed that some special education teachers lack appropriate knowledge of instructional strategies to translate curriculum standards into aligned instruction (Greer & Meyen, 2009). When participants were asked to discuss those instructional strategies that support third grade students with number sense deficiencies, teacher one said, “I don’t really have any recommendations for this teacher because I am so new to special education teaching and I do not have any third graders on my caseload so far.” Teacher 11 said, “At this point because this is my first year teaching something other than special education pre-kindergarten, I would have a hard time recommending anything useful at this time.” Teacher four with 24 years of teaching experience said, “I would recommend using a hundreds chart, dice, or even a regular deck of playing cards. The teacher could also use a calendar or ask the parents to help with number sense at home. I would also recommend flashcards.” These data revealed that special education teachers in this school district align with the findings that teachers of special education are ill-prepared to meet the needs of students with special needs in mathematics at the elementary level (Greer & Meyen, 2009; Hill et al., 2008; Swackhamer et al., 2009).

The interview results showed that teachers with less than three years of experience teaching special education made recommendations such as consulting with the mathematics specialist, offering after school support, using manipulatives, using online games or resources, or made no recommendations at all when asked how to support struggling learners. The veteran teachers recommended research based interventions, small group or one-on-one instruction, and manipulatives as ways to support struggling leaners develop number sense or build foundational fraction skills.
Additionally, the interviews determined that the special education teachers’ lack of knowledge of instructional strategies as evidenced by their recommendations for supporting students struggling with basic number sense and foundational fraction skills. Nowhere in the discussion about developing foundational fraction skills did teachers discuss helping students see fractions as numbers, extend students’ understanding of fraction equivalence or ordering, or building fractions from unit fractions. Common responses included the use of manipulatives, small group instruction, iPad apps, consultation with mathematics specialist, the use of assessment to determine gaps, and the use of visuals. Teachers made no mention of mathematical practices such as understanding the ways students think, evaluating the thinking behind students’ problem-solving methods, effective questioning, reviewing previous learning, providing model responses for students, providing adequate time for practice, high expectations for student achievement, providing feedback to students in a timely manner, goal-setting, and differentiation of instruction based on formative assessments.

The special education teachers also discussed their struggle to help students with special needs understand and grasp the concepts involved in the Operations and Algebraic Thinking strand of the Common Core State Standards. This struggle was supported by all 11 participants in this study. The special education teachers felt that this strand was the one that most of their students struggled with as well. One teacher from one of the Title I schools said the intersection of reading in word problems had an influence when she stated, “It is the comprehension of the problem more than the math sometimes that trips my kids up.” Problem-solving and comprehending problems in context were topics that all the teachers emphasized as a weakness for special education students in mathematics. A teacher from school D shared, “My kids don’t even read the problem sometimes; they just look for the numbers and start adding or
subtracting!” This concern was felt by one teacher at school A when she said, “We try to teach problem-solving strategies that help the students dissect the problem, but they still struggle to understand what the problem is asking them to do.”

**Limitations**

After conducting the needs assessment, the study revealed several limitations. One of the limitations was the team approach used in the semi-structured interview. In some cases, this format allowed for one individual to dominate the discussion and to make the results more difficult to generalize to the larger population. The drawback of using the group interview approach was that an individuals’ knowledge may not be easily identifiable or be overshadowed by the ideas of the group. Group interviews also provided individuals the opportunity to blend in with the group and not voice thoughts or opinions with as much confidence. The group format or dynamic may have inhibited individuals from saying exactly what they thought or knew about the topic. Another limitation in this study was the reliability and validity of the interview questions. The interview questions were created by the author who does not classify them as either reliable or valid. Additionally, during the semi-structured interviews, teachers were only asked about mathematics methods coursework and not mathematics content courses. This limited teachers’ responses and ignored an important aspect of their pre-service training. As the researcher is a principal working in the district, teachers may also have been concerned about sharing limitations and instructional deficiencies openly with the interviewer.

**Conclusion**

The findings from the needs assessment interviews and self-efficacy scores support the implementation of an intervention for special education teachers that will increase the level of content and pedagogical knowledge. The need to implement an intervention to address limited
pedagogical content knowledge in mathematics was supported by teachers’ responses when asked about core instructional strategies to support struggling learners. Statements such as, “I would offer after school support to the student like I have done in the past with language arts” or “Sum Sense is a good online website to practice with flashcards but using the computer” speaks to the need to provide special educators with the capacity to develop and use their mathematical knowledge for teaching and to rely on a high sense of self-efficacy to make appropriate instructional decisions. Getting special education teachers to refer to practices such as data driven decision-making, effective questioning, increased expectations for students, and systematic, explicit instruction may provide students with special needs the opportunity for greater progress and increased student achievement. The needs assessment also supports the need to address special education teachers’ mathematics teaching efficacy so that students with special needs can learn from an individual who possesses the confidence to plan and implement mathematics content in a manner suitable for students with special needs.
Chapter 3

Synthesis of Intervention Research Literature

As the literature revealed, some elementary special education teachers struggle to translate curriculum standards into aligned instruction for students with special needs (Greer & Meyen, 2009). These findings were supported during the needs assessment when participants struggled to explain those instructional strategies that they have tried and found to be effective for students who struggle to learn mathematics. Researchers suggest that teachers’ mathematical knowledge has been linked to student performance in mathematics (Ball et al., 2008; Faulkner & Cain, 2013). To support special education teachers faced with closing the achievement gap for students with special needs, a logical next step that emerges from the data would be to implement an intervention designed to improve teachers’ pedagogical content knowledge and MTE. Potential interventions to address these concerns are, Professional Learning Communities (PLCs), face-to-face mathematics professional development, one-on-one instructional coaching, a focus on a research-based practice such as Cognitively Guided Instruction (CGI) (Carpenter et al., 1998) and the use of Data Teams (DT) (Reeves, 2006). These interventions have the potential to address factors in the conceptual framework included in Figure 3.1 and discussed in chapter one.

Figure 3.1. Conceptual Framework.

---

Professional Development
Researchers posit that teachers with strong pedagogical content knowledge and knowledge of mathematics content demonstrate MKT which could potentially lead to increased MTE (Floyd & Rice, 2009; Greer & Meyen, 2009; Hill et al., 2008; Stigler & Hiebert, 2004). The absence of effective professional development opportunities in one mid-Atlantic district for special education teachers in mathematics as evident in the needs assessment (Watkins, 2016) supports the need to implement professional development that will increase teachers’ capacity to confidently plan for and deliver effective mathematics instruction. With the adoption of the No Child Left Behind Act of 2001, schools have felt pressure to close the gap in mathematics achievement for all students. There is an expectation that all teachers possess the knowledge and confidence to deliver mathematics content standards to a diverse student population in a manner that is unique to differentiated learning styles and levels of development (Sowder, 2007). This increased emphasis on meeting state standards has made the professional development of all teachers a matter of concern for many districts across the country (Telese, 2016). Dever and Lash (2013) support these findings and emphasized the importance of attending to the role of the teacher as an active learner and willing participant in true professional growth. Further, Dever and Lash (2013) contend that professional development should be delivered with the expectation that it is relevant, effective, and easily translatable to daily classroom instruction.

Many models of professional development have been considered and implemented since the No Child Left Behind Act of 2002 that have delivered some results for teacher learning and student outcomes in general, however the gap in achievement for students with special needs remains. Telese (2016) contends that certain factors must be present in the development and implementation of effective professional development to have an impact on teachers’ ability to “develop knowledge, skills, and dispositions so that they can teach mathematics well” (p. 617).
Key factors in effective professional development include collaboration among peers, active learning, participating in activities linked to relevant content, extended over a period, job-embedded, sandwiched with assignments carried out in classrooms, and administrator support and feedback (Dever & Lash, 2013; Darling-Hammond & McLaughlin, 1995; DuFour, 2004; Sparks & Hirsh, 1997). Guskey (2000) contributed five critical components for evaluating professional development to assist researchers and practitioners in determining participants’ reactions to the professional development. The components include participants’ learning, organization support and change, participants’ use of new knowledge and skills, and student learning outcomes. This review of the literature addresses some of the professional development models that possess these factors and contribute to the professional growth of teachers and increase teacher efficacy in the process.

**Professional Learning Communities**

The practice of using professional learning communities (PLC) has been instrumental in leading school reform efforts for more than 20 years (Bloom & Vitcov, 2010; Dufour, 2004). When a school team functions as a PLC each member of the team is responsible for: (a) planning and implementing high levels of learning for all students, (b) assuming collective responsibility to ensure learning takes place, and (c) constantly seeking evidence of student learning to improve instructional practices in the classroom (Bloom & Vitcov, 2010; DuFour, 2004). For the purpose of addressing the problem of practice in this study, PLCs show promise for teacher development by increasing: (a) content knowledge, (b) the ability to meet diverse learning needs, and (c) teachers’ confidence in tackling gaps in achievement for all students (Caskey & Carpenter, 2012; Protheroe, 2004).
In schools where PLCs are implemented with fidelity, teams of teachers create lessons, develop common assessments, share and discuss curriculum resources, and openly dialogue about the most effective instructional strategies. The focus is on a proactive approach to improving instruction through collaboration with colleagues and school administrators. PLCs provide autonomy to school teams because they are teacher led and subject specific (Dever & Lash, 2013). For special education teachers seeking to develop more effective instructional strategies and become more confident in their ability to meet the needs of students with special needs, a model of professional development that encourages collaboration and the translation of curriculum standards into aligned instruction are what the teachers in the needs assessment expressed as missing from their professional development experiences (Watkins, 2016).

Educators have expressed concern over the number of job responsibilities that monopolize teachers’ planning time. The responsibilities include parent communication, grading, email, team meetings, creating assessments, and so on. With very little time to plan instruction and gather resources, teachers appreciate productive professional development that is relevant to their needs and job-embedded (Dever & Lash, 2013). More importantly, teachers desire opportunities to reflect on their own practice and impact student achievement (Xu, 2016). Dever and Lash (2013) conducted an in-depth observational case study to determine the effectiveness of PLCs at a middle school in the Midwest. The study’s focus was on the professional growth of a five-member, eighth grade team over the course of one school year. This team met twice a week during their common planning time to participate in an embedded professional development model specific to students’ mathematics achievement. Researchers revealed emerging themes related to an effective learning community such as: (a) the team’s understanding of their primary purpose for meeting as a group, (b) teachers’ desire to impact
student learning, (c) unit planning involving content-specific conversations, (d) and academic-specific talk only. These behaviors produced promising results for teachers who desired a proactive approach to improving instructional practice and were seeking a direct link to student learning (Dever & Lash, 2013). Collectively, these individuals were autonomous within the PLC to make decisions about student learning objectives based on the results of common formative assessments and were driven to improve preparation practices.

When implemented to fidelity, PLCs can have a positive influence on the culture and direction of a school community. The impact of the PLCs as an embedded professional development model was described by the teachers in (Mundschenk & Fuchs (2016) as culture changing and empowering because teachers were continuously engaging in a practice of “knowledge sharing and innovation” (p. 59). According to Mundschenk and Fuchs (2016), of the 84 teacher participants, most viewed the experience of implementing PLCs as part of an embedded professional development model as a highly acceptable way to accelerate professional growth. Participants who valued data driven decision-making and saw growth in their students felt more efficacious and focused less on what students could not do and more on what they as teachers could control; namely effective instructional practices. However, researchers caution against forced collaboration among teachers within a community of learners where working in isolation and a lack of administrator support has been the norm (Dufour, Dufour, & Eaker, 2008; Vescio, Ross, & Adams, 2008). The idea of teachers learning together to improve student achievement and instructional strategies is not a new practice in the United States however, collaboration can be met with resistance if not managed effectively as in the case where administrative support is lacking (Dufour et al., 2008; Vescio, Ross, & Adams, 2008).

**Sustained Mathematics Professional Development**
Professional development has been the hallmark of many districts across the country as a means of building capacity in teachers and improving instruction in the classroom (Zambo & Zambo, 2008). Professional development has been delivered using a variety of formats with mixed reviews from educators however, studies have shown when delivered effectively, professional development has the potential to positively affect teachers’ outlook on the mathematics instruction they provide to students (Vacc, Bright, & Bowman, 1998; Zambo & Zambo, 2008). As discussed in the problem of practice, some special education teachers lack MKT and MTE to translate curriculum standards into aligned instruction for students with special needs (Greer & Meyen, 2009). One way to address this concern is through offering professional development opportunities that allow teachers to develop content knowledge and increase confidence in their ability to deliver content to students with special needs. Additionally, researchers found that professional development delivered over the course of at least six months and includes no less than 14 hours of direct teacher learning is positively correlated to increased student achievement in mathematics however, correlational evidence recommends 20 hours or more (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007).

**The effects of professional development on MTE.** Teachers who possess a high level of self-efficacy demonstrate intrinsic motivation to “spend more time planning, designing, and organizing what they teach” (Zambo & Zambo, 2008, p. 159). Additionally, these teachers possess the attitude that they can overcome any obstacle and have high expectations for their own learning (Goddard, Hoy, & Woolfolk, 2000). Zambo and Zambo (2008) contend that workshops that offer opportunities for “mastery experiences or direct experiences” (p. 160) lead teachers to a sense of accomplishment and an increased level of self-confidence. Increased teacher efficacy was evident in a study conducted in a school district in the United States with a
high incidence of underperforming schools. Researchers recruited 63 fourth through tenth grade teachers to attend a two-week, summer professional development workshop designed to increase teachers’ own knowledge of problem-solving and improve teachers’ problem-solving instruction in the classroom (Zambo & Zambo, 2008). Thirty-two teachers were from schools with a low incidence of underperformance in mathematics achievement, while 31 teachers were from schools with a high incidence of underperformance in mathematics achievement. Researchers hypothesized that: (a) the individual efficacy of both groups would increase pre-to post-intervention (b) scores for personal competence would be higher than scores for group competence pre to posttest for both groups, and (c) the teachers in higher performing schools would outperform those in lower performing schools pre to posttest in group competence upon completion of PD (Zambo & Zambo, 2008).

Using a 21-item Likert scale Collective Efficacy Questionnaire (Goddard, Hoy, & Woolfolk-Hoy, 2000) and adapting the questionnaire by adding the word” mathematics” to each question as appropriate, researchers measured pre and post workshop collective teacher efficacy. In addition, researchers used a 10-item teacher efficacy measure developed by Bandura (2000) and found that collective teacher efficacy and individual teacher efficacy were positively related (Goddard, Hoy, & Woolfolk-Hoy, 2000). The researchers also administered an adapted version of the Elementary Science Efficacy Questionnaire (Enochs & Riggs, 1990) to determine whether the participants increased their level of personal competence, or “a teacher’s perception of his or her ability to operate at a high level of proficiency in a specific domain” (Zambo & Zambo, 2008, p. 160). This 25-item, Likert scale questionnaire was also “adapted for mathematics instruction by replacing the word ‘science’ with the word ‘mathematics’ as necessary” (Zambo & Zambo, 2008).
Regarding the first hypothesis, Zambo and Zambo (2008) used a paired-sample $t$-test to determine that the teachers in the low group showed a significant increase from pre to posttest on personal competence while teachers in the high group also had significant gains for personal competence from pre to posttest. However, only teachers in the low group had significant gains pre to posttest on group competence. There were no significant pre to posttest differences by groups for any other variables (p. 163).

Regarding the second hypothesis, Zambo and Zambo (2008) again used a paired-sample $t$-test and found that teachers in the low group scored significantly higher on personal competence than on group competence on both pretest and posttest. Teachers in the high group also scored significantly higher on personal competence than on group competence on both pretest and posttest. When determining between group comparisons Zambo and Zambo (2008) used an analysis of variance and found a significant effect for group on group competence both pretest and posttest. This study highlights the potential for professional development involving mathematics problem-solving to increase teachers’ knowledge of content and have a positive effect on teachers’ self-efficacy in mathematics.

The notion that mathematics professional development directly translates to increased teacher efficacy was realized in a study conducted by Telese (2016). Using the Mathematics Teaching Efficacy Belief Instrument (MTEBI), 140 participants who taught grades kindergarten-12 completed the 21-item efficacy survey to determine whether participation in a three-credit graduate course in mathematics education resulted in increased mathematics teaching efficacy. Information pertaining to survey scores, reliability, and validity were discussed in the needs assessment. Data were collected pre and post professional development and revealed a statistically significant change in mathematics teaching efficacy. Researchers believe the change
was prompted by the opportunity to participate in sustained mathematics professional development where teachers received “feedback about the learning and teaching of mathematics concepts” (Telese, 2016, p. 625). These results coincide with Bandura’s (1997) belief about positive changes in self-efficacy due to “compelling feedback that forcefully disrupts the preexisting disbeliefs in one’s capabilities” (p. 82). Based on the results in this study, teachers’ response on the MTEBI supported the notion that sustained mathematics coursework resulted in a disruption in preexisting beliefs regarding teaching efficacy beliefs and teaching outcome expectations (Telese, 2016).

The results of Telese’s study support other empirical research demonstrating that teacher efficacy affects teachers’ decision-making actions, motivations, persistence, and resilience when faced with challenges (Chang, 2015; Nurlu, 2015; Swackhamer et al., 2009). For special education teachers working with the lowest performing students, this internal belief to overcome challenges in meeting diverse educational needs of students, preparing differentiated instruction, and aligning instruction to curriculum standards strongly influences a teacher’s performance, which has positive implications for student learning and achievement (Cantrell et al., 2003; Chang, 2015; Ernest et al., 2011; Gibson & Dembo, 1984; Goddard & Goddard, 2001).

**The effects of professional development on MKT.** Professional development has been one of the components used to strengthen teachers’ knowledge of content and develop effective teaching practices. Longitudinal studies have revealed that professional development focused on specific instructional strategies increases teachers’ use of those practices within the classroom. Additionally, studies have also determined specific features of professional development that increase its effect on teacher’s instruction (Desimone, Porter, Garet, Yoon, & Birman, 2002). In a national, cross-sectional study of nearly 93% of all K-12 public school districts in the U.S.
Desimone et al., (2002) gathered data for a longitudinal study on teacher change. The results of the cross-sectional study were based on the feedback from a national probability sample of 1,027 elementary public school teachers. Researchers used teacher responses and prior research to determine those features of professional development related to changes in teachers’ knowledge of skills, content, and practice (Desimone et al., 2002). The key features include: (a) reform type or non-traditional approaches to professional development, such as internships or individual research projects, (b) duration or contact hours spent in the activity, (c) collective participation such as a school team working on a professional development activity as opposed to the participation of individual teachers from various schools, (d) active learning, (e) coherence, and (f) content focus or activities focused on increasing teachers’ knowledge of content in mathematics (Desimone et al., 2002).

Researchers gathered data at three points in time over the course of three years from 430 mathematics and science teachers in grades K-12 from districts and schools considered to have taken a diverse approach to professional development. Diversity in approach was characterized as providing teachers with opportunities for feedback on teaching or analyzing student work samples. A diverse professional development approach also included collective participation by teachers in the same school working together as a cohort of learners. The results correlated to the national, cross-sectional findings that specific teaching practices used in professional development translated to the use of those same strategies in the classroom (Desimone et al., 2002).

The relationship between characteristics of professional development and change in teaching practices were validated by Boyle, Lamprianou, and Boyle (2005) in a two-year longitudinal study on those features that make professional development effective. Of the 854
participants at the primary and secondary levels, most of the mathematics and science teachers participating in longer term professional development (i.e., longer than a 1-day workshop) reported changes in teaching practices. The changes came because of teacher preferred professional development activities such as observation of colleagues, collaboration among peers, and coaching. Gee and Whaley (2016) confirmed these findings in a study of practice-centered professional development in mathematics where 16 elementary teachers indicated a change in teacher practice because of collaboration within a community of learners. Case study methodology was used to demonstrate change in teachers’ practice through a focus on questioning and discussion techniques, student discourse, and student thinking via video recorded classroom observations (Gee & Whaley, 2016). Gee and Whaley (2016) used the three criteria for characterizing teacher discussion of student mathematical thinking developed by Sherin, Linsenmeier, and van Es (2009) as the guide to code students’ thinking. The criteria included, “(a) understanding student thinking, (b) examining student ideas and content knowledge, and (c) teacher collaboration and sharing knowledge” (p. 94). Teachers in this study emphasized the importance of collaboration among peers focused on students’ responses to mathematics lessons as “beneficial to their professional growth” (p. 94).

Mathematics Instructional Coaching

The professional growth of elementary special education teachers through opportunities such as PLCs, lesson study, and sustained mathematics professional development have the potential to effectively address the problem of practice in this study. Special education teachers in the needs assessment reiterated the desire to be included in regularly scheduled opportunities of professional learning focused on the translation of grade-level mathematics curriculum into meaningful learning for students working below grade level. One potential professional
development approach to achieve this goal is the introduction of mathematics instructional coaching. This job-embedded professional development approach has been effective in the successful implementation of response-to-intervention (RtI) models, a multi-tiered system of support for students with special needs, enacted under the Individuals with Disabilities Education Act of 2004 (Individuals with Disabilities Education Act, 2004). Research supports instructional coaching’s effectiveness in areas of classroom management, literacy, mathematics, school culture, and teacher collaboration (Desimone & Pak, 2017). Mathematics instructional coaching as a job-embedded approach to professional development for special education teachers assists in helping teachers translate curriculum standards into aligned instruction and “reflects foundational ideas about what makes teacher learning effective” (Desimone & Pak, 2017, p. 4).

Using the research-based ideas for effective professional development, researchers have determined that instructional coaching when implemented effectively provides the teacher with clear direction on how to engage deeply into subject matter content and classroom pedagogical approaches (Desimone & Pak, 2017). When teachers are provided the opportunity to focus on how students learn content and plan activities that align with a teacher’s knowledge and needs of students, the result is a deeper understanding of mathematics pedagogy, content, and student understanding (Desimone & Pak, 2017). Further, researchers believe teachers impact student achievement more than any other feature of schooling and report a strong connection between students’ academic success and high-quality teachers (Darling-Hammond, 2000; Goldhaber, 2002; Gomez Johnson, 2016; Guskey, 2002; Kinkead, 2007). Although many diverse models of instructional coaching exist, researchers believe “that the conceptual foundation of the model embodies content focus, active learning, coherence, and collective participation in ways that meaningfully bolster teacher and student learning” (Desimone & Pak, 2017, p. 5).
Evidence to support instructional coaching as an effective job-embedded professional development model was revealed in a qualitative study to determine teachers’ confidence in increasing mathematics achievement for students in grades three and six (Bruce & Ross, 2008). Eight teachers from grade three and four teachers from grade six participated in four face-to-face professional development sessions focused on pedagogical content knowledge, reform-based mathematics teaching, and familiarizing teachers with the coaching process. All 12 teachers were observed pre and post professional development regarding three elements included in the professional development experience. Five observers recorded observations of: (a) selection of mathematical tasks, (b) student construction of mathematical knowledge, and (c) support for student-student interaction (Bruce & Ross, 2008, p. 354). Bruce and Ross (2008) established a formal observation protocol based on research literature, several observations from traditional and innovative teachers NCTM policy statements, and classroom teacher interviews.

Researchers determined that teachers were more willing to adopt a more constructivist approach to mathematics instruction and that they were more likely to offer students open-ended mathematical tasks to students. The study also determined that the opportunity to engage with an instructional coach led teachers to be more reflective about their instructional practices and positively impacted teachers’ implementation of standards-based teaching (Bruce & Ross, 2008). The results of Bruce and Ross’ study are aligned with the idea that a quality instructional coach can have a tremendous impact on raising teachers’ awareness of best practice in mathematics instruction (Saphier & West, 2010). The instructional coaching model demonstrated in Bruce and Ross’ study of these 12 elementary teachers also revealed through pre and post professional development interviews, increased mathematics teaching efficacy because of the partnership.
between coach and teacher as well as, positive beliefs that students performed better based on the coach-teacher relationship.

Not only is it important to examine studies that demonstrated the impact that instructional coaches have on classroom instruction and student achievement, it is also important to discuss those best practices for successful classroom implementation of instructional coaching from the perspective of teachers, administrators, and instructional coaches. Tanner, Quintis, and Gamboa (2017) shared their experience and perspective as practitioners and key players in the planning and implementation of instructional coaching in a school setting. These three individuals also discussed the priorities that stakeholders such as teachers, administrators, and coaches must possess to make instructional coaching a viable intervention to impact instruction, student achievement, and teacher efficacy.

**Administrative perspective.** Researchers contend that an effective school administrator can have a positive impact on student achievement and teacher change (Cotton, 2003; Hall & Simeral, 2008; Tanner et al., 2017). In the case of implementing instructional coaches as a form of school improvement efforts, administrator support plays an important role in determining an instructional coach’s success. From the perspective of a school administrator, Tanner et al. (2017) described successful instructional coaches as those individuals that foster productive, positive relationships with staff, are instructional leaders in the building, and spend ample time in classrooms. Effective coaches from these researchers’ perspective are available to observe, model, and plan instruction and provide teachers with support to improve teaching practices. Ineffective coaches on the other hand, are reluctant participants in the school improvement process, have strained or contentious relationships with staff, and provide little support in terms of modeling, observing and planning instruction (Tanner et al., 2017).
In situations as described in Tanner et al. (2017) where instructional coaching was an effective model for the professional learning of teachers, the instructional coach and administrator used student work samples and data to engage teachers in courageous conversations about student achievement. Together, the coach and administrator met with teachers to analyze student misconceptions and unpack content standards to develop a common understanding of effective instructional strategies. The administrator also understood that the selection of an effective instructional coach and administrator support of the instructional coaching model were two of the most important components when evaluating the success of this specific reform model of school improvement. Further, when administrators allow coaches direct access to teachers and classrooms on a regular basis, the model is viewed by all stakeholders as more effective and impactful (Tanner et al., 2017).

**Cognitively Guided Instruction (CGI)**

Cognitively Guided Instruction (CGI) is a research-based program in mathematics instruction developed at the University of Wisconsin-Madison that is based on constructivist principles (Carpenter et al., 1998). This program is an example of how research and theory have informed teaching and learning mathematics with kindergarten through fifth grade teachers for more than 30 years. The initial project introduced first grade teachers to research-based knowledge about the development of children’s mathematical thinking (Carpenter et al., 1998). Researchers examined how teachers use this knowledge in classroom practice and examined its impact on teachers’ beliefs and knowledge (Behrend, 2003; Franke & Kazemi, 2001; Moscardini, 2014).

CGI uses word problems within a set of frameworks to promote learning computational operations with understanding. The frameworks provide the foundation for teacher professional
development in problem types within content domains and an understanding of strategies children instinctively use to solve the problems (Carpenter et al., 2000). This approach to mathematics instruction is not a prescriptive pedagogy or a limited set of knowledge but a way of thinking about teaching and learning mathematics (Franke & Kazemi, 2001; Moscardini, 2010). Teachers engage in a continuous process of reflection on students’ thinking and build on this knowledge to make use of it in the context of ongoing practice in the classroom.

Teachers who instruct using the CGI approach, present word problems and encourage students to solve them individually using a variety of instinctive solution strategies. The word problems are used to develop mathematical concepts, rather than as a means of assessing existing abstract number knowledge (Moscardini, 2010). Two examples of problem types include: (a) Allie had 22 books. His grandma gave him 8 books for his birthday. How many books does he have now? (Result Unknown) or (b) Mr. Watkins’ class has 139 fossils. We have 206 fossils. How many fewer fossils does Mr. Watkins’ class have than we do? (Comparison). Students are encouraged to use strategies that involve the use of manipulatives such as counters, drawings, or known number facts. The teacher acts as a facilitator of learning, encouraging students to share their strategies through visuals or classroom discussions. The strategies include: (a) physically representing the numbers using manipulatives, fingers, or drawings, (b) keeping track of numbers using tally marks, fingers, or manipulatives, (c) using known facts to solve problems involving unknown facts, and (d) knowing the fact without representing the action (Carpenter et al., 2000). Building on children’s instinctive problem-solving strategies and mathematical knowledge, students begin to construct concepts of place value and computational procedures for addition, subtraction, multiplication, and division. Students then replace direct modeling with
more efficient counting strategies and build an understanding of the relationships between numbers (Behrend, 2003; Moscardini, 2014).

Studies on the effectiveness of CGI Professional Development. For more than 30 years, teachers have used CGI as an approach to increase their knowledge of student’s thinking and to raise student achievement (Moscardini, 2014; Smith & Smith, 2006). Steinberg et al. (2004) conducted a study to determine the effectiveness of CGI professional development in one teacher’s classroom over the period of several years. Prior to this study, the teacher had already received direct professional development regarding the CGI approach and was using research-based knowledge about children’s thinking to inform instructional decisions. This teacher was familiar with the problem-type framework and solution strategy hierarchies after learning about these components during undergraduate training (Steinberg et al., 2004). This teacher agreed to be observed 34 times during a five-month period. Lessons were video recorded and transcribed. The researcher completed field notes and identified nine target students. These students’ solution strategies were monitored closely over the course of the five months. The teacher was interviewed by researchers at various points over the course of the study. The purpose of the study was to evaluate the growth in this teacher’s engagement with children’s thinking and to determine the sustainability of CGI over time. The results suggested that mathematics conversations between the teacher and students during instruction served as both an index of change and a catalyst for additional change (Steinberg et al., 2004).

The study also revealed that the teacher’s engagement with students’ thinking changed dramatically in a short time period, and interviews several years later confirmed the sustainability of the change in practice. Using CGI as a potential approach to professional development would provide more opportunities for students to engage in conversations about
their thinking that may lead to the development of mathematical ideas as well as opportunities for the teacher to use students’ mathematical knowledge to drive future instruction (Steinberg et al., 2004). This study confirms CGI’s impact on one fourth grade teacher’s instructional practice with general education students but failed to address its effectiveness with special education teachers working with students with special needs. This limitation does not discount CGI as an appropriate instructional approach but confirms the need for further research in the field of study.

This limitation was addressed in a CGI professional development study that included 12 special education teachers who provided direct instruction to students with learning difficulties (Moscardini, 2015). Prior to professional development, the teachers had limited understanding of children’s mathematical thinking and had low expectations for students with special needs. Phase one of the three-phase study included semi-structured interviews and an analysis of current planning and assessment practices. The second phase involved two, eight-hour professional development sessions focused on developing teachers’ knowledge of the CGI framework and problem types for addition and subtraction. Teachers then conducted 10 CGI sessions and recorded their teaching and learning observations to measure their understanding of the framework. The third phase consisted of post-intervention interviews and an analysis of video recorded classroom observations (Moscardini, 2015).

Post-intervention results were consistent with a previous study (Carpenter et al., 2000) in that CGI professional development affirmed teachers’ deeper understanding of children’s mathematical thinking, knowledge of learners, pedagogical knowledge, and increased expectations for students with LD. These findings suggest that the growth in knowledge by teachers reflected a change in beliefs about learners’ capabilities. The change in teacher’s expectations for student learning suggests the potential for students with special needs to benefit
from an inclusive pedagogy that offers a balanced approach to teaching and learning mathematics (Greer & Meyen, 2009; Moscardini, 2015).

Researchers confirmed these findings in a study that compared CGI in one classroom to a more traditional approach to instruction with students in another classroom (Smith & Smith, 2006). Ten fourth grade students in the control group were taught multiplication facts using a traditional approach of memorization. Fifteen third grade students in the experimental group were taught using cognitively guided instructional approach that emphasized conceptual understanding. The study concluded that memorizing multiplication facts was not an indication of understanding basic multiplication concepts for those fourth graders receiving traditional instruction. When presented with multiplication problems in context, the control group produced acceptable answers 27% of the time whereas the experimental group produced acceptable answers 96% of the time. These findings are consistent with the broader claim that learning is a sense-making activity and emphasizes the importance of creating meaning related to the learning activities of students (Stylianides, 2007).

Additionally, these findings revealed the need for a fundamental shift in teachers’ thinking from computational proficiency as the reason for using word problems to mathematical sense-making (Smith & Smith, 2006). This shift in thinking is consistent with earlier studies (Baroody, 1996; Behrend, 2003) in that students, even those with learning disabilities, were able to invent, use, and retain strategies for solving mathematical problems. Moscardini (2010) confirmed these findings in a study that involved 12 primary teachers and 24 special education students with moderate learning disabilities. The teachers were introduced to CGI principles through an eight-hour professional development session. The teachers developed CGI activities for the whole class but gathered data on two focus students identified at the outset of the study.
The study found that the sample group was “able to implement problem-solving strategies and develop mathematical understanding without prior explicit instruction” (Moscardini, 2010, p. 1). These results do not necessarily contradict those studies that suggest that students with special needs benefit from explicit instruction but support the need to provide a variety of instructional approaches to problem-solving. These strategies include chunking problems into smaller parts, modeling procedures, having students verbalize solution strategies, teaching students to visually represent the information, and monitoring for understanding (Greer & Meyen, 2009; Jayanthi, Gersten, & Baker, 2008).

Researchers also determined that the opportunity for direct-modeling needs to be encouraged in an authentic constructivist manner (Moscardini, 2010). Constructivism refers to a contextualized process of constructing knowledge rather than acquiring it (Jonassen, 1992a). Special educators should practice caution when using materials and resources for direct modeling, as the use of manipulatives that mimic a taught procedure will not help students with special needs develop conceptual understanding (Baroody, 1989). One potential way for special education teachers to avoid teaching procedures as the primary means of instruction is to engage in a continuous teaching-learning cycle where teachers and administrators collaboratively plan and prepare for the learning of all students (Schwanenberger & Ahearn, 2013). For those elementary schools who seek to engage in professional learning communities where the implementation of best practice research and formative assessments are the priority, the Data Teams (DTs) process may be appropriate

### The Data Teams’ Process

The Data Teams’ (DT) process (Reeves, 2004) as shown in Figure 3.2 is an example of a professional learning community where classroom teachers, special educators, and
administrators prioritize needs within the curriculum and engage in a six-step process of continuous improvement.

Figure 3.2. Data teams process and the cycle of continuous improvement.

DTs “provide the structures, processes, procedures and protocols for education teams wishing to implement whole school reform and operate effectively and efficiently” (Schwanenberger & Ahearn, 2013, p. 151). Developed by Reeves (2004), DTs are:

one form of a professional learning community. The data team process, in the context of the teaching-learning cycle, is a vehicle by which teachers and administrators can collaboratively plan for the learning of all students. Data teams and the data teams process provide the structures, processes, procedures and protocols for education teams wishing to implement whole school reform and operate effectively and efficiently. Districts and schools can be professional learning communities, and data teams are how they can implement the best practices research and experience offer (Schwanenberger & Ahearn, 2013, p. 151).

The needs assessment revealed that teachers had not been given the opportunity to participate in regular professional development where they were included in instructional
strategy conversations grounded in student achievement outcomes. Providing special education teachers, the opportunity to participate in the DTs process as an intervention to address the problem of practice enhances teachers’ professional practice because of the strategic, systematic, and diagnostic nature of the process. DTs provide special educators the opportunity to prioritize standards, unpack the curriculum, make connections between IEP goals and grade level content, and discuss effective strategies for moving students along the continuum of learning (Reeves, 2006).

When implemented with fidelity, DTs require a 60-90 minute meeting typically held when formative assessment data are available. DTs are most effective when meetings are regular and on-going over the course of the school year (Reeves, 2006). As shown in Fig. 3, teachers submit formative assessment results to a team leader prior to the meeting and come prepared with their student assessments in hand. The assessment results are organized into four categories from highest level of proficiency to least proficient then analyzed in step two for strengths and obstacles for each proficiency level. The team examines student work samples for trends, patterns, and underlying misconceptions. The team then discusses and records inferences to determine reasons for student successes and struggles. In step three, teachers create a short-term Specific, Measurable, Agreed Upon, Realistic, Time-based (SMART) goal that is attainable, yet challenging, to address the needs of all learners. Step four of the process is a time for educators to participate in a conversation about research-based strategies shared amongst teammates and to make decisions for how to best address the obstacles and achieve mastery of the SMART goal. Step five, the team determines the results indicators. Step five is an important aspect of the DTs process because teacher and student success criteria are established for each proficiency group. Step six includes monitoring and evaluating results and adjusting the process as needed.
(Reeves, 2004). The DTs process shows promise for the problem of practice and addresses the needs assessment results that special education teachers have not been given regular, on-going opportunities to participate in conversations around standardizing instructional practices across teams.

**Studies on the effectiveness of the DTs process.** Special education teachers are accustomed to using data to develop the goals on a student’s IEP. IEP goals are monitored for progress and then modified based on actual student achievement. The goals on the IEP are written to help students with special needs access grade level curriculum and to gain exposure to content that would have otherwise been challenging or even unattainable. Studies have shown that the effective use of student achievement data can result in successful school reform efforts (Campbell & Levin, 2009; Carlson, Borman, & Robinson, 2011); however, the needs assessment in this study revealed that special education teachers in one mid-Atlantic school district are often absent from those professional learning opportunities where data-driven decision making is the focus. When schools make DTs a priority, general and special education teachers, along with school-based administrators, make instructional decisions based on student performance data measured against a SMART goal that was written and agreed upon by the team (Reeves, 2006). When performed with fidelity, DTs have proven to be an effective tool for those schools faced with closing gaps in achievement (Reeves, 2006; Schildkamp, Poortman, & Handelzalts, 2016).

Research shows that school systems that adopt the DTs process to address low academic achievement and school improvement have found success (Mandinach, 2012; Reeves, 2004). In a study conducted in the Netherlands, researchers identified four secondary schools that were characterized by a high percentage of grade repeaters, poor mathematics achievement in the lower grades of secondary education, and lower performance of pre-vocational education
students entering senior general secondary education (Schildkamp et al., 2015). The goal was to determine the level of fidelity to which the teams implemented the DTs process. The researchers first focused on the six-step process to address data-based decision making. Depth of inquiry was determined by the degree to which team conversations expressed higher level thinking skills. Attribution focused on “whether teams attributed problems to causes outside the school, to causes at the level of the school, at the level of the students, or at the level of their own functioning” (Schildkamp et al., p. 234).

Researchers determined that each of the four schools showed improvements in data driven decision-making and were more capable of solving their educational problems. These schools also increased student achievement over time. Teachers at these four schools also improved their depth of inquiry and became less reliant on seeking causes to problems or blaming personal experiences and more proficient with using the data to drive discussions. These teachers became more analytical, developed more in-depth comparisons and conclusions about student outcomes which resulted in higher levels of depth of inquiry. Remarkably, attribution was the greatest strength among the teachers at each of the four schools. The teachers in these four schools did mention several causes for low student performance related to school factors from the start (Schildkamp et al., 2015). Reeves (2004) argued that the acknowledgement of in-school factors early in the DTs process would move teams further along in the process. Attribution has implications for schools serving underserved populations because of the number of external factors that can overwhelm schools and be used as an excuse for poor performance. Furthermore, this research demonstrates that starting with a problem and clear goals is essential (Reeves, 2006). Participating in the DTs process with fidelity, including shared cognition and collective efficacy results in “teachers and school leaders feeling empowered by
data use because they are actually able to solve the problem they are investigating” (Schildkamp et al., 2015, p. 248).

The importance of implementing DTs with fidelity was realized in a K-12 public school study in one mid-Western school district composed of one pre-school, four elementary schools, two middle schools, and one high school. Total enrollment for the district was 5,170 students, and 100% of its teachers were considered highly qualified with 55% having more than 10 years of teaching experience and 26% having less than five years of teaching experience. During the 2011-2012 academic year, the district’s schools participated in the DTs process. The purpose of the study was to determine teacher assessment of the DTs process (Reeves, 2004) on curricular, instructional, assessment, and leadership practices in pursuit of improved student achievement (Schwanenberger & Ahearn, 2013). One research question that supported the problem of practice and DTs as a potential intervention addressed teachers’ assessments of how the DTs process impacted instructional practices. With special education teachers’ instructional practices at the center of the problem of practice, this study provided justification for the DTs process to be considered as one approach to address low MKT and MTE.

The study determined that teachers at all levels of K-12 schooling reported positive feedback on the DTs process. Teachers used DTs to engage in conversations about core instructional strategies as well as explicit causal connections between strategies and student achievement. Data also showed that “school-based administrators significantly improved student achievement and teaching quality by establishing and systematically supporting a schoolwide DTs as the primary means by which educators improved their craft and focused on student achievement” (Schwanenberger & Ahearn, 2013). These findings supported the implementation of the DTs process as an opportunity for the special education teachers to receive professional
learning that was both systematic and holds its participants accountable to students and to one another as professionals.

**Overview of Proposed Intervention**

Researchers have determined that teachers who have a deeper understanding of the content and are confident in their ability to deliver instruction to students are more likely to positively impact student achievement (Bruce & Ross, 2008; Hartman, 2013). For special education teachers, the impact of sustained mathematics professional development over the course of several months with a component of instructional coaching to provide on-going support and feedback has potential to significantly impact the problem of practice. The needs assessment results revealed that special education teachers in one mid-Atlantic district have been largely absent from opportunities of professional growth in mathematics which may be one of the major contributing factors to the gap in achievement for students with special needs (Watkins, 2016).

The intervention in this study included the participation of 13 special education teachers in face-to-face, sustained mathematics professional development over the course of five months. The goal however was to include up to 25 participants in hopes of generating greater reliability to the intervention results. Five, three-hour professional development sessions were held to provide direction for unpacking curriculum standards so that teachers fully understood what should be taught, lesson planning in collaboration with colleagues, and analysis of students’ mathematical thinking through the investigation of student work samples and teacher anecdotal notes (Desimone et al., 2002; Desimone & Pak, 2017; Reeves, 2004; Steinberg et al., 2004). Additionally, participants were reintroduced to and/or reminded of those mathematics instructional practices that are effective for students with special needs as discussed earlier in
chapter three. The strategies include: (a) explicit instruction, (b) using multiple instructional examples, (c) having students think-aloud their problem-solving strategies, and (d) having students use visual representations of solution strategies (Jayanthi et al., 2008). Also, included in the intervention was bi-weekly instructional coaching. The instructional coaching included collaborative planning and teaching between a coach and a teacher. Additionally, the mathematics coach observed teachers and provided feedback about lesson execution and student engagement (Desimone & Pak, 2017). Intervention participants took pre- and post-intervention surveys and an assessment as introduced in chapter four to gather data regarding teacher efficacy and mathematics knowledge for teaching as well as participated in semi-structured interviews to provide feedback to the researcher about the value of the intervention experience (Desimone & Pak, 2017).

**Conclusion**

This review of the literature has determined that professional growth for special educators may be achieved by participating in opportunities of on-going professional learning. The goal is to increase special education teachers’ MKT and MTE to help them translate curriculum standards to aligned instruction for students with special needs (Greer & Meyen, 2009). These potential interventions may allow teachers to strengthen their mathematics content knowledge, pedagogical content knowledge, and increase teacher efficacy in teaching mathematics through face-to-face, sustained mathematics professional development, lesson study, instructional coaching, CGI, and data teams. Professional development opportunities in mathematics have proven to effectively engage teachers and school teams in a process of continuous improvement and have provided opportunities for teacher growth and reflection on instructional practices. The potential interventions discussed in this review of the literature provide promise for elementary
special education teachers who expressed in the needs assessment that their needs have been largely overlooked.
Chapter 4

Elementary Special Education Teacher Cohort

A review of the intervention literature and the results of the needs assessment revealed that some elementary special education teachers are limited in their ability to translate curriculum standards into aligned instruction for students with special needs (Greer & Meyen, 2009). The teachers that participated in the needs assessment discussed that some special educators have not had the number of professional development opportunities as compared to their general education teacher counterparts due to a variety of case management responsibilities but welcome the opportunity to become more effective mathematics instructors. Based on the needs assessment results and the literature to support these findings, the Elementary Special Education Teacher Cohort (ESETC) intervention was designed to include a component of sustained mathematics professional development to increase teachers’ mathematics content knowledge, pedagogical content knowledge, and mathematics teaching efficacy. Additionally, instructional coaching provided guidance in lesson planning, delivery, and data analysis. With the responsibility of writing standards-based Individualized Education Plan (IEP) goals, closing the gap in achievement in mathematics for students with special needs, and differentiating instruction for students in kindergarten through fifth grade, elementary special educators required professional development to develop their capacity in mathematics instruction. The ESETC intervention was designed based on the relationship between perceived self-efficacy and behavioral changes (Bandura, 1997), effective professional development (Desimone et al., 2002; Guskey, 2003), instructional coaching as high-quality professional development (Desimone & Pak, 2017), and the effects of subject matter knowledge and pedagogical content knowledge on teachers’ MKT (Ball & Hill, 2008).
Through face-to-face mathematics professional development and one-on-one instructional coaching over several months, the ESETC intervention focused on lesson design and delivery aligned to standards-based IEP goals in Operations and Algebraic Thinking (OA), Number & Operations in Base Ten (NBT), and Number & Operations-Fractions (NF) (Common Core State Standards for Mathematics, 2010). Participating in direct mathematics professional development allowed this cohort of learners to strengthen their understanding of the OA, NBT, and NF standards to develop content knowledge and pedagogical content knowledge with the four operations for whole numbers and fractions, analyze student work samples, and dialogue with colleagues regarding students’ mathematical thinking. Instructional coaching provided an opportunity for participants to apply new learning and focus on effective lesson delivery specific to students with special needs. The ESETC intervention included 13 special education teachers whose years of experience ranged from one to 20 years, from three of the five Title I schools and four non-Title I schools in one mid-Atlantic public school district. This chapter includes an overview of the intervention, purpose of the study, research design, and methodology.

**Intervention Framework**

The ESETC design was based on this researcher’s conceptual framework (Figure 4.1) and supported by the research literature regarding effective professional development implementation practices (Desimone et al., 2002; Guskey, 2003), instructional coaching (Desimone & Pak, 2017), and Ball’s (2011) research regarding MKT. This intervention design developed special education teachers’ knowledge of content and pedagogy to increase teachers’ MKT by offering opportunities to learn mathematics methodology, participate in discussions about effective instructional strategies, and share students’ mathematical thinking to help increase teachers’ efficacy in mathematics. Participants brought student work samples to
professional development sessions for analysis and reflected on students’ mathematical strategies and lesson components that needed to be strengthened or modified. These conversations were continued and supported during instructional coaching sessions to develop instructional strategies to address students’ struggles, misconceptions, and gaps in learning. With this conceptual framework in mind, this researcher engaged participants in a learning community that promoted teacher change through what Desimone et al. (2002) and Desimone and Pak (2017) referred to as reform type (or mentoring relationship), collective participation, active learning, duration, coherence, and activities focused on increasing teachers’ knowledge of content and pedagogy in mathematics.

![Figure 4.1. Conceptual Framework.](image)

Researchers have determined that instructional coaching provides the teacher with clear direction on how to engage deeply into subject matter content and classroom pedagogical approaches (Desimone & Pak, 2017; Hall & Simeral, 2008; Tanner et al., 2017). Although many derivations of professional development and instructional coaching exist (Kretlow, Cooke, & Wood, 2012), researchers believe “that the conceptual foundation of the model embodies content focus, active learning, coherence, and collective participation in ways that meaningfully bolster teachers’ capacity and increase student learning” (Desimone & Pak, 2017, p. 5). This framework allows special education teachers the time to engage in professional dialogue with colleagues, develop a firm understanding of content and pedagogy and design lessons that translate
curriculum standards into aligned instruction for students with special needs. This model also supports the findings of the needs assessment that special education teachers in this mid-Atlantic district have limited opportunities to engage in professional learning with colleagues who share similar goals, case management responsibilities, and the burden of closing the gap in achievement for students with special needs.

**Purpose of the Study**

The purpose of this study was to determine whether sustained mathematics professional development with a component of one-on-one instructional coaching would increase participants’ MKT and have a positive impact on participants’ MTE. Additionally, this study assisted special educators in developing standards-based IEP goals, taught participants mathematics methodology, and greater developed educator’s pedagogical content knowledge through more effective lesson planning, assessment practices, and data driven decision-making. Specifically, participants: (a) engaged in direct, sustained mathematics professional development over the course of several months, (b) received bi-weekly, one-on-one mathematics instructional coaching, and (c) dialogued with colleagues about the mathematical learning and thinking of students within a professional learning community. The hypothesis was that special education teachers would develop greater content knowledge and pedagogical content knowledge and increase MTE within the elementary special education teacher cohort. The research questions in this study included:

RQ1: How does special education teachers’ mathematics teaching efficacy change through participation in the elementary special education teacher cohort?

RQ2: How does special education teachers’ mathematics knowledge for teaching change through participation in the elementary special education teacher cohort?
RQ3: To what extent does participation in the elementary special education teacher cohort increase teachers’ confidence in using the reformed teaching instructional strategies?

**Research Design**

The ESETC addressed the need for special education teachers in one mid-Atlantic school district to receive professional development in mathematics. Ideally, participants would become proficient in the OA, NBT, and NF domains of the CCSSM (2010). To that end, a one-group pretest-posttest design was implemented to determine this intervention’s effectiveness (Campbell & Stanley, 1963; Shadish, Cook, & Campbell, 2002). The ESETC was conducted during the 2017-2018 school-year and included 13 voluntary, elementary special education teacher participants who represented a non-random sample of the greater district special education teacher population. The purposive, non-random sample approach in this study was selected with the goal of representativeness in mind and because the non-random sample matched the larger population characteristics (O’Leary, 2017).

**Process evaluation design.** Conceptualizing fidelity within the context of this study and in accordance with Berman and McLaughlin (1976) began with the alignment between the proposed professional development and the logic model as presented in Appendix A. The logic model included the necessary components for implementing the intervention with fidelity. These components included that all 13 participants completed five, three-hour professional development sessions and the completion of bi-weekly one-on-one instructional coaching sessions for seven identified participants. The seven coaching participants were identified by the pre-intervention MTEBI scores. The researcher selected the seven candidates with scores that fell in the middle to lower end of the scoring range. In addition, when the seven instructional
coaching participants were observed demonstrating new learning into classroom instruction as designed per the logic model, evidence of a high fidelity intervention could be determined as well (O’Donnell, 2008). If a teacher was unable to attend a face-to-face professional development session, she had the option of meeting with the researcher later to review the content of the unattended session.

**Outcome evaluation design.** The outcome evaluation design in this study was a one-group pretest-posttest design. In a one-group pretest-posttest design, a pretest was followed by a treatment and posttest where the difference between the pretest outcome and the posttest outcome was presumably explained by participation in the ESETC. This one-group pretest-posttest design supported the use of the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs et al., 2000). Outcomes were measured on the same targets prior to participation and following an appropriate amount of professional development for effects to be determined (Enochs et al., 2000). This design allowed the researcher to compare pre- and post-intervention efficacy ratings as a means of determining the program’s effect. Outcome evaluation was also measured using the Reformed Teaching Observation Protocol (RTOP) (Piburn & Sawada (2000). This observation protocol instrument was used to document all teacher observations to measure “reformed” teaching practices. This protocol is discussed in detail in the methods section below. The Diagnostic Mathematics Assessment for Elementary School Teachers (DTAMS) Whole Number & Computation Assessment (WNC) 2.3 and 4.3 (Saderholm, Ronau, Brown, & Collins, 2010) were also used to determine changes in teachers’ knowledge of content as it relates to whole number concepts. Lastly, semi-structured interviews were transcribed and coded to provide qualitative data of teachers’ change in teaching efficacy
and knowledge of the content and the appropriate ways to deliver it to students with special needs.

**Method**

**Participants**

The 13 participants in this study were recruited from the four lowest achieving elementary Title I schools and from the six lowest achieving non-Title I schools in the district with low achieving special education students as measured by PARCC. The special education students in these 10 schools had a proficiency score less than 30% on the 2017 PARCC in mathematics. There were currently 37 elementary special education teachers at the 10 schools, but the goal was to secure at least 25 voluntary participants for the study. All 10 schools had a Free and Reduced Meal (FARM) percentage that exceeded the overall district percentage of 26%. The 10 participants came from schools with a FARM rate of at least 33% with one school as high as 91%. Of the 37 potential participants, 10 had between 15-20 years of special education teaching experience, five had between 10-14 years of special education teaching experience, 13 had between 5-9 years of special education teaching experience, and the remaining nine potential participants had less than five years of special education teaching experience. The special educators from these 10 schools were targeted for recruitment because the student achievement in the OA, NBT, and NF domains on local and state assessments were the lowest among the district’s 36 elementary schools. Additionally, the lack of experience teaching special education among the 10 schools was also cause for concern and indication that face-to-face mathematics PD and instructional coaching was warranted.

Following the recruitment efforts described above, 11 individuals from the 10 schools agreed to participate in the study. Considering that the goal was to recruit 25 participants, a
second recruitment effort was conducted. This researcher met with the special educators at five schools where the special education subgroup at each site scored below 40% on the 2017 PARCC in mathematics. The second round of recruitment efforts resulted in two additional participants. The two additional participants were from some of the highest achieving schools in the district, but with a major discrepancy between how all students and special needs students performed on PARCC. With the intervention start date approaching, this researcher made the decision to proceed with the 13 identified participants.

Of the 13 participants, three had more than 10 years of teaching experience, seven had between six and nine years of teaching experience, and three participants had between one and three years of teaching experience. Eleven of the 13 participants were elementary and special education certified and two of the participants were K-12 and special education certified.

Instruments

Five instruments were used to collect data in this study. The first was a Likert-scale survey called the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs et al., 2000; see Appendix B). The second data collection tool was the Reformed Teaching Observation Protocol (RTOP) (Piburn & Sawada (2000); see Appendix E). The third data collection instrument was the Professional Development Feedback Form (Ross & Morrison, 2017), administered in December, February, and March at the completion of each mathematics professional development sessions (see Appendix C). The fourth data collection instrument was the Diagnostic Mathematics Assessment for Elementary School Teachers (DTAMS) (Saderholm et al., 2010; see Appendix F). Whole Number & Computation Assessment-Version 2.3 was administered in November 2017 and the equivalent test Whole Number & Computation Assessment-Version 4.3 which was administered in March 2018. Finally, author constructed
questions for the semi-structured interview to determine mathematics planning and instruction beliefs and professional learning needs were asked to the seven participants with relatively high (three individuals) and low (four individuals) combined pre-intervention MTEBI scores (Appendix B). The semi-structured interviews provided qualitative data to triangulate with the quantitative data produced by the MTEBI and RTOP. The triangulation of the data helped determine whether teachers increased mathematics teaching efficacy and mathematics knowledge for teaching because of participation in the ESETC.

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI). This data collection instrument was discussed in chapter two (see Appendix B). The first version of the MTEBI consisted of 23 items like the STEBI-B; however, subsequent analysis in this validation required two items to be removed. Reliability analysis produced an alpha coefficient of 0.88 for the PMTE scale and an alpha coefficient of 0.75 for the MTOE scale. Confirmatory factor analysis reveals that both scales are independent, confirming the construct validity of the MTEBI (Enochs et al., 2000). Possible scores on the MTEBI range from 21 to 105. Higher scores indicate higher levels of mathematics teaching efficacy. Thirteen items on the MTEBI address teachers’ beliefs about personal mathematics teaching efficacy. These items make up the PMTE subscale. Scores on the PMTE subscale range from 13 to 65. Higher scores indicate higher levels of personal mathematics teaching efficacy. Eight items on the MTEBI address teachers’ beliefs about effective teaching and the connection to positive outcomes for students. These items make up the MTOE subscale. Scores on the MTOE subscale range from 8 to 40. Higher scores indicate higher levels of mathematics teaching outcome expectancy.

Reformed Teaching Observation Protocol (RTOP). The RTOP (see Appendix E) is an observation instrument used in the study of mathematics and science to measure “reformed”
teaching practices. This measure was developed by the Evaluation Group of the Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT) and has shown to predict student learning outcomes in mathematics and science (Piburn & Sawada, 2000). The RTOP includes 25 items measuring observation evidence in three categories (a) lesson design and implementation, (b) content, and (c) classroom culture. A Likert-type rating scale is used to record observations from zero (never occurred) to four (very descriptive). Reliability was determined by analyzing a database of 153 classroom observations. Reliability was determined by using a best-fit linear regression of one set of observations on the other (Piburn & Sawada, 2000). Additionally, the RTOP possesses strong construct and predictive validity through the collection of evidence in four different instructional settings.

**Professional Development Feedback Form.** The 8-statement Professional Development Feedback Form (Ross & Morrison, 2017) (see Appendix C) was used to indicate participants’ confidence in their skills for using each of the following instructional strategies: (a) ability to plan and design effective instruction, (b) ability to make learning engaging, (c) ability to create a positive learning environment, (d) promote students’ higher order thinking, (e) helping students to become more self-directed learners, (f) offering feedback to help students improve, (g) ability to present material in an engaging way, and (h) ability to stimulate productive class discussion through questioning. The feedback form was a Likert-type scale from 1 (very doubtful) to 5 (very confident).

**Diagnostic Mathematics Assessment for Elementary School Teachers (DTAMS).** The DTAMS (Saderholm et al., 2010) (see Appendix F) is a measure of teachers’ depth and breadth of mathematics content knowledge and mathematics pedagogical content knowledge and to identify strengths and weaknesses in teachers’ knowledge to inform professional learning.
The assessment consists of four domains including (a) whole number/computation, (b) rational number/computation, (c) geometry/measurement, and (d) probability/statistics/algebra. Each assessment consists of 20 items, 10 multiple choice and 10 open-response. Validity was established by putting the DTAMS through a stringent review process by some of the nation’s leading educators and mathematicians.

**Special education teacher interview questions.** The special education teacher interview consisted of 15 questions. The first three questions focused on participants’ background information. Ten questions pertained to mathematics planning, teaching, professional development experiences, and teachers’ efficacy in teaching mathematics (see Appendix D). These 10 questions were adapted from the MTEBI, RTOP, and *The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5* (Gojak & Harbin-Miles, 2013) to provide the researcher in this study with greater specificity regarding teachers’ pedagogical content knowledge and to further explain teachers’ change in efficacy pre- to post-intervention. Additionally, the qualitative data that the interview provided allowed for the triangulation of three data points: (a) the MTEBI, (b) the RTOP, and (c) the interview.

**Procedure**

This section presents an overview of the ESETC intervention, data collection, and data analysis methods to show the alignment between the research questions, measures used to operationalize the variables of interest, data collection, and data analysis. The ESETC intervention will be described in detail including timeline for implementation, professional development activities, instructional coaching components, and complete descriptions of data collection and analysis methods for the qualitative and quantitative measures included in this study.
**ESETC intervention.** This intervention consisted of three components: (a) face-to-face mathematics professional development, (b) trials within the classroom, and (c) instructional coaching. Direct mathematics professional development included monthly, face-to-face professional learning sessions from November to March. The mathematics instructional coaching included the opportunity for participants to receive two, one-on-one coaching session per month as a follow-up to the monthly face-to-face professional learning sessions. The intervention was designed to provide voluntary participants with the capacity to design mathematics lessons that align mathematics content and pedagogy to IEP goals and objectives. This section will describe the (a) face-to-face mathematics professional development, (b) instructional coaching, and (c) ESETC instructional resources (Table 4.1).

Table 4.1

<table>
<thead>
<tr>
<th>ESETC Component, Timeframe, Duration, Activity, and Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Component</strong></td>
</tr>
<tr>
<td>PD Session 1</td>
</tr>
<tr>
<td>PD Session 2</td>
</tr>
<tr>
<td>PD Session 3</td>
</tr>
<tr>
<td>PD Session 4</td>
</tr>
<tr>
<td>PD Session 5</td>
</tr>
</tbody>
</table>
**Instructional Coaching**

On-going November 2017 to March 2018

Bi-weekly-40 minute sessions

One-on-One Coaching

---

*Note.* PD = professional development; DTAMS WNC 2.3 = Diagnostic Mathematics Assessment for Elementary School Teachers: Whole Number Concepts Versions 2.3 and 4.3 (Saderholm et al., 2010).

**Face-to-face professional development.** The face-to-face ESETC professional development sessions consisted of five components as displayed in the table above and explained with greater specificity in chapter five. Component one was designed to lay the foundation for the importance of the work that took place over the course of the five professional development sessions. Participants were introduced to fellow cohort members, resources (see Table 4.1), and professional learning goals and objectives. The initial session included the administration of the DTAMS WNC 2.3 pre-intervention assessment, identifying high quality mathematical tasks, discussion around articles that addressed concepts such as effective pedagogy in mathematics, strategies for teaching students with special needs, and the importance of teaching with problem-solving. Additionally, component one began the work of developing teachers’ knowledge of content and pedagogy in OA-Grades 3-5. The guiding question for this component was, “What do students and teachers look like when engaged in a rich OA task?”

Components two through five followed the sequence provided in Table 4.2. Each component consisted of a review of the standard, activities that include participants’ solving mathematics problems specific to the standard for each session, discussion about how to teach the standard, and lesson development to translate the standard into aligned instruction for students with special needs. Teachers were provided with homework to complete between each session that included the implementation of instructional strategies, recording of students’ mathematical thinking, and returning with student work samples to discuss with colleagues.

Table 4.2
### Outline for Professional Learning-Sessions One through Five

<table>
<thead>
<tr>
<th>Session</th>
<th>Face-to-Face Professional Development Agenda</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>DTAMS WNC 2.3 pre-intervention assessment. Reviewed the guiding question to establish the purpose for professional learning. Participants unpacked the OA standards to become familiar with “what” and “how” of the standards. Participants engaged in problem-solving as if they were students trying to find solutions to a variety of problems in grades three-five within the OA domain. Participants shared solution strategies with the group and discussed where students may potentially struggle with the standards. Participants learned how to design lesson plans that were specific to students with special needs.</td>
</tr>
<tr>
<td>Two</td>
<td>DTAMS WNC 4.3 post-intervention assessment (session five only). Reviewed the guiding question to establish the purpose for professional learning. Participants unpacked the NBT and NF standards to become familiar with “what” and “how” of the standards. Participants engaged in problem-solving as if they were students trying to find solutions to a variety of problems in grades three-five within the NBT and NF domains. Participants shared solution strategies with the group and discussed where students may potentially struggle with the standards. Participants learned how to design lesson plans that were specific to students with special needs.</td>
</tr>
</tbody>
</table>

*Note.* DTAMS WNC 2.3 = Diagnostic Mathematics Assessment for Elementary School Teachers: Whole Number Concepts Versions 2.3 and 4.3 (Saderholm et al., 2010); OA = operations and algebraic thinking; NBT = number and operations in base ten; NF = number and operations: fractions.

**Instructional coaching.** This aspect of the ESETC intervention was conducted on a bi-weekly, one-on-one basis at each participant’s school site. This researcher worked collaboratively with seven voluntary participants to review mathematics standards, students’ problem-solving strategies, next steps for students who have or have not achieved the standard, and to create lesson plans for a future mathematics lesson. These sessions also served as post-observation conferences where coach and teacher debriefed about mathematics lessons. The coaching model aligned with Desimone and Pak’s (2017) approach to teacher learning. The model included the five features of effective professional development as discussed in chapter three and included in Table 4.3 below: (a) content focus, (b) active learning, (c) coherence, (d)
sustained duration, and (e) collective participation. The instructional coaching model also included the work of Guskey (2003, 2002, 1985) and the idea that teacher change comes because of professional development focused on changes in classroom practice that lead to changes in learning outcomes and teachers’ beliefs and attitudes. The instructional coach also conducted classroom observations using the RTOP to provide feedback to study participants prior to monthly, face-to-face professional development sessions. The observations were used to drive professional development instruction and determine changes in teachers’ knowledge of the content and teaching efficacy in mathematics.

Table 4.3

*Instructional Coaching and the Five Features of Effective Professional Development*

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Focus</td>
<td>Activities that are focused on subject matter content and how students learn the content.</td>
</tr>
<tr>
<td>Active Learning</td>
<td>Opportunities for teachers to observe, receive feedback, or analyze student work.</td>
</tr>
<tr>
<td>Coherence</td>
<td>Content, goals and activities are consistent with the school’s curriculum and goals, teacher knowledge and beliefs, students’ needs, and school, district, state policies.</td>
</tr>
<tr>
<td>Duration</td>
<td>Professional development opportunities that are ongoing throughout the year and include 20 hours or more of contact time.</td>
</tr>
<tr>
<td>Collective Participation</td>
<td>Groups of teachers from the same grade, subject, or school participate in professional development activities together.</td>
</tr>
</tbody>
</table>


*Instructional resources.* The ESETC intervention utilized resources such as, *The Common Core Math Companion, Grade, 3-5: The Standards Decoded* (Gojak & Harbin-Miles, 2015), *Teaching Student-Centered Mathematics: Developmentally Appropriate Instruction for*

The Common Core Mathematics Companion, Grade, 3-5: The Standards Decoded was used to assist teachers in understanding the mathematics embedded in each standard, provide examples of effective teaching, connecting standards within each domain, priorities within clusters, rigor, and common student misconceptions (Gojak & Harbin-Miles, 2015). Teaching Student-Centered Mathematics: Developmentally Appropriate Instruction for Grades 3-5 was used to illustrate what it means to teach student-centered, problem-based mathematics, serve as a reference for the mathematics content and research-based instructional strategies suggested for grades three to five, and present a large collection of high quality tasks and activities that engage students in the mathematics that is important for them to learn (Van de Walle et al., 2013). Visible Learning for Mathematics provided teachers with online video clips, planning tools, rubrics, and templates to assist in making the appropriate instructional decisions at each phase of the learning cycle (Hattie et al., 2017). Mine the Gap for Mathematical Understanding, Grades 3-5 introduced 180 high-quality tasks aligned to the standards and big ideas in grades 3-5 mathematics. This resource explained common misconceptions, instructional “next steps”, and how to identify the gaps in students’ learning (SanGiovanni, 2017). Extending Children’s
Mathematics Fractions and Decimals: Innovations in Cognitively Guided Instruction helped teachers extend students’ intuitive problem-solving strategies with whole numbers to fractions and decimals and built meaning for fractions through discussing and solving word problems (Empson & Levi, 2011).

Data Collection

The ESETC intervention study was a mixed-methods convergent design. Creswell and Clark (2011) describe this type of design as a concurrent collection of qualitative and quantitative data that are analyzed separately then merged together. The data was collected using four methods: (a) surveys, (b) interviews, (c) the DTAMS, and (d) the RTOP (Table 4.4). Each participant was assigned a confidential personal identification number and pseudonym prior to data collection.

Survey. The Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) was administered via paper-pencil, pre-and post-intervention (November 2017 and March 2018). The Professional Development Feedback Form was administered via paper-pencil after the December, February, and March professional development sessions.

Interviews. One-on-one interviews were conducted in April and May of 2018 at each participant’s home school site. Interviews were audio recorded and transcribed.

Participants’ attendance. Participant’s completion of The Professional Development Feedback Form indicated attendance at face-to-face professional development sessions and the completion of the Instructional Coaching log indicated attendance at the one-on-one coaching sessions.

Instructional coaching log. The purpose of maintaining this coaching log was to informally document one-on-one coaching sessions with each teacher. The coaching log served
as documentation of attendance and informed professional development activities. This log was an anecdotal record of conversations between the teacher and instructional coach.

**Reformed Teaching Observation Protocol (RTOP).** The RTOP was used pre- and post-intervention to determine the change in participants’ mathematics knowledge for teaching. The instructional coach used the observation protocol during classroom observations to document teachers’ instructional practices related to reformed teaching.

**Diagnostic Teaching Assessment for Mathematics and Science (DTAMS).** The DTAMS was used pre- and post-intervention to determine the change in participants’ knowledge of mathematics content.

Table 4.4

<table>
<thead>
<tr>
<th>Measure</th>
<th>Method</th>
<th>Data-Type</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTEBI</td>
<td>Quantitative</td>
<td>Paper-Pencil</td>
<td>Pre- and Post-Intervention</td>
</tr>
<tr>
<td>PD Feedback Form</td>
<td>Quantitative</td>
<td>Paper-Pencil</td>
<td>December 2017, February, and March 2018</td>
</tr>
<tr>
<td>(Ross &amp; Morrison, 2017)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview</td>
<td>Qualitative</td>
<td>Audio Recorded</td>
<td>April and May 2018</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transcripts</td>
<td></td>
</tr>
<tr>
<td>RTOP</td>
<td>Quantitative</td>
<td>Paper-Pencil</td>
<td>November 2017 and March 2018</td>
</tr>
<tr>
<td>DTAMS WNC</td>
<td>Quantitative</td>
<td>Paper-Pencil</td>
<td>Pre- and Post-Intervention</td>
</tr>
<tr>
<td>Anecdotal Coaching Notes</td>
<td>Qualitative</td>
<td>Paper-Pencil</td>
<td>On-going-November 2017 to March 2018</td>
</tr>
</tbody>
</table>

*Note.* MTEBI = Mathematics Teaching Efficacy Beliefs Instrument (Enochs et al., 2000); PD = professional development; RTOP = Reformed Teaching Observation Protocol (Piburn & Sawada, 2000); DTAMS = Diagnostic Mathematics Assessment for Elementary School Teachers: Whole Number Concepts 2.3 and 4.3 (Saderholm et al., 2010).

**Data Analysis**
The data analysis section consists of the qualitative and quantitative coding and statistical tests used in response to the research questions in this study (Creswell & Clark, 2011). Table 4.5 outlines the research questions, measure, timeframe, and analysis.

**Table 4.5**

*Research Question, Measure, Timeframe, and Analysis*

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Measure</th>
<th>Timeframe</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>How does special education teachers’ MTE change through participation in the ESETC?</td>
<td>MTEBI</td>
<td>November 2017 and March 2018; December 2017, February 2018, and March 2018</td>
<td>t-test; Cronbach’s alpha; Chi square; Inductive and deductive thematic coding</td>
</tr>
<tr>
<td></td>
<td>PD Feedback Form</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interviews</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How does special education teachers’ MKT change through participation in the ESETC?</td>
<td>DTAMS WNC</td>
<td>November 2017 and March 2018</td>
<td>t-test</td>
</tr>
<tr>
<td></td>
<td>RTOP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To what extent does participation in the ESETC increase teachers’ confidence in using reformed teaching instructional strategies?</td>
<td>PD Feedback Form</td>
<td>December 2017, February 2018, and March 2018</td>
<td>Cronbach’s alpha; Chi square; t-test</td>
</tr>
<tr>
<td></td>
<td>RTOP</td>
<td>November 2017 and March 2018</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* MKT = Mathematics Knowledge for Teaching; MTE = Mathematics Teaching Efficacy; ESETC = Elementary Special Education Teacher Coho; MTEBI = Mathematics Teaching Efficacy Beliefs Instrument (Enochs et al., 2000); PD = professional development; RTOP = Reformed Teaching Observation Protocol (Piburn & Sawada, 2000); DTAMS = Diagnostic Mathematics Assessment for Elementary School Teachers: Whole Number Concepts 2.3 and 4.3 (Saderholm et al., 2010)

**Statistical tests.** The MTEBI was scored to assign a numerical value to each response. The MTEBI consisted of 21 questions with two subscales, personal mathematics teaching efficacy (PMTE) and mathematics teaching outcome expectancy (MTOE). The PMTE consists of 13 items and the MTOE consists of eight items. The rating scale included a 1 to 5 Likert-type scale with the anchors: strongly disagree, disagree, uncertain, agree, and strongly agree. Enochs et al. (2000) suggest reverse scoring the seven negatively worded items on the PMTE to produce higher scores for those who selected a one or two and lower scores for those who selected a four
or five on the rating scale. Paired sample $t$-tests was performed to analyze participants’ pre- and post-intervention mean self-efficacy ratings.

The RTOP was scored to assign a numerical value to each response. Paired sample $t$-tests were performed to analyze participants’ pre- and post-intervention changes among the three categories of (a) lesson design and implementation, (b) content, and (c) classroom culture. The DTAMS was scored to assign a numerical value to each response. Paired sample $t$-tests were performed to analyze participants’ pre- and post-intervention changes. The Professional Development Feedback Form was scored to assign a numerical value to each response. Cronbach’s alpha was used to determine internal consistency and Chi square was used to find the $p$ value of specific statements to determine statistical significance between what was learned during professional development and the reform strategies listed on the feedback form.

**Qualitative data coding.** Qualitative data in the form of semi-structured interviews were collected, read, and reread to develop a general understanding of the database. Initial thoughts and memos were written in the margins of interview transcripts. These data were analyzed using a deductive and inductive coding processes (Creswell & Clark, 2011). As discussed in chapter five, a priori and emerging codes were established based on the literature review for chapters one and three. These initial steps were the basis for establishing broad categories, such as themes or codes. In vivo codes were established based on participants’ interview responses conducted during the needs assessment and at the end of the intervention. At this time, a coding notebook was established. The coding notebook included a priori codes from the literature, codes that emerged during analysis, and codes that emerged from the semi-structured interviews.

**Conclusion**
The ESTEC intervention was designed to increase special education teachers’ MTE and MKT by participating in face-to-face mathematics professional development and one-on-one instructional coaching. Designing and conducting a mixed methods approach supported the research questions in this study. Chapter four provided a review of the ESTC intervention including the intervention framework, purpose, research design, method, procedures, data collection, and data analysis. Measures included interview responses, surveys, an instructional coaching/observation tool, observations, assessments, and participation to determine teachers’ pedagogical content knowledge and teachers’ confidence delivering mathematics instruction to students with special needs.
Chapter 5

Results and Discussion

The purpose of this dissertation was to examine elementary special education teachers’ MTE and MKT through participation in the Elementary Special Education Teacher Cohort (ESETC). The ESETC consisted of five face-to-face professional development sessions for the 13 participants and bi-weekly one-on-one instructional coaching sessions for a subset of seven participants. Chapter 3 discussed possible interventions to support the problem of practice (PoP) that some special education teachers struggle to translate mathematics curriculum standards into aligned instruction for students with special needs (Greer & Meyen, 2009). This researcher decided to address the PoP and the following research questions through face-to-face professional development and one-on-one instructional coaching. The goal of this chapter is to present the research findings and discuss the implications of the results for future practice. As previously stated, the following research questions are the basis for analyses within chapter five.

RQ1: How does special education teachers’ mathematics teaching efficacy change through participation in the elementary special education teacher cohort?

RQ2: How does special education teachers’ mathematics knowledge for teaching change through participation in the elementary special education teacher cohort?

RQ3: To what extent does participation in the elementary special education teacher cohort increase teachers’ confidence in using the reformed teaching instructional strategies?

Elementary Special Education Teacher Cohort

To truly understand the importance of the work of the participants, it is helpful to provide a brief history of professional learning opportunities afforded to these individuals outside
of the ESETC. As elementary special education teachers in this mid-Atlantic district, professional development has been traditionally offered either at the individual school level under the discretion of the principal or during designated professional development days executed by central office professionals across the district. In the situation where, professional development was a school-based experience, special educators usually found themselves joining general education grade-level teams to have conversations about strategies for instruction that satisfy the needs of students in general. When given the opportunity for district-wide professional development, often the conversations centered on issues of compliance or topics that do not apply to all participants. These two professional development approaches are practiced in many districts across the country with little success because of the logistics involved in scheduling, planning, and executing learning opportunities that are meaningful for all participants.

The ESETC was developed with special educators in mind based on the feedback from the needs assessment and through this researcher’s experience as a classroom teacher, mathematics specialist, and principal. The primary goal of the ESTEC professional development was to provide elementary special education teachers with an opportunity to develop a deeper understanding of mathematics content knowledge and learn how to more effectively plan and implement instruction for students below grade level in mathematics. The challenges that special education teachers in this district face are understanding the K-5 mathematics curriculum, planning small group instruction that allows for effective progress monitoring of IEP goals and grade-level material, having knowledge of instructional strategies that are effective for students with large instructional gaps, and having the confidence to step out of their comfort zone to try new instructional methods. As stated in chapter four, the ESTEC included a component of
monthly, face-to-face professional development for all 13 participants and bi-weekly, one-on-one instructional coaching for seven volunteers.

In the pages to follow, research question number one was answered using quantitative data from the MTEBI and Professional Development Feedback Form. The data were analyzed to support teachers’ changes in mathematics teaching efficacy and supported by qualitative analysis of semi-structured interview responses adapted from the MTEBI to provide further insight and clarification to survey responses. Research question number two was answered using quantitative data from the RTOP and DTAMS. Data were analyzed to support changes in teachers’ MKT and supported by semi-structured interview responses adapted from the RTOP and The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5 (Gojak & Harbin-Miles, 2013) to provide further insight into participants’ approach to student misconceptions, developing conceptual understanding, and knowledge of the relationship between multiplying and dividing whole numbers and multiplying and dividing fractions.

**Face-to-Face Professional Development**

The five, three-hour professional development sessions were designed so that participants had opportunities to read and discuss featured articles, unpack specific Common Core mathematics standards, solve mathematics problems using a variety of strategies and manipulatives, plan lessons with colleagues, and translate curriculum standards into aligned instruction for students with special needs.

**Professional development session one.** Session one began with the introduction of three articles that were used to begin the conversation about how teachers unintentionally or unknowingly contribute to students’ misconceptions or gaps in achievement. Through strategic planning and some simple adjustments, it was discussed that strategic planning could go a long
way to building students’ confidence and capacity in mathematics problem-solving. The articles were, “Never Say Anything a Kid Can Say” (Reinhart, 2000), “13 Rules That Expire” (Karp, Bush, & Dougherty, 2014), and “Mathematical Lies We Tell Students” (Graybeal, 2014). These three articles proved to be influential and impactful with the ESETC participants because time and again, the feedback to instructional coaching participants was to keep in mind how much teachers talk and how little students talk during small group instruction. These three articles also provided reminders about the impact of teachers’ words and why we as teachers should always think before speaking to students.

Session one also was an introduction to Visible Learning for Mathematics (Hattie et al., 2017). As a cohort, we discussed the effect sizes for strategies like self-reported grades, teacher clarity, classroom discussion, and direct instruction. These four strategies were selected because of their ease of implementation and applicability to small group instruction, even for students with special needs. Direct instruction was highlighted because of this researcher wanted to provide clarity to what direct instruction is and that the components of direct instruction translate well to working with students with special needs. According to Hattie et al. (2017) direct instruction:

“conveys an intentional, well-planned, and student-centered guided approach to teaching. The teacher decides the learning intentions and success criteria, makes them transparent to the students, demonstrates them by modeling, evaluates if they understand what they have been told by tying it all together with closure” (p. 206).

The remainder of session one was devoted to problem-solving with multiplication and division using tasks from Mine the Gap for Mathematical Understanding: Common Holes and Misconceptions and What to do About Them (SanGiovanni, 2017). Participants were introduced
to a template for identifying high-quality tasks SanGiovanni (2017) and then asked to compare the two mathematics problems against the components of a high quality task. The components include the alignment of standards, multiple entry points, authentic, encourages multiple strategies, encourages the use of representations, and communication of reasoning. It was emphasized that high quality tasks help promote rigor and address student misconceptions. In closing, the participants completed the pre-intervention DTAMS.

Professional development session two. Session two was comprised of a look at one district resource, the unpacking of 4.OA.A.3, and reading and discussion the article, “Effective Strategies for Teaching Students with Difficulties in Mathematics” (Gersten & Clark, 2007). The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5 (Gojak & Harbin Miles, 2016) was purchased for teachers at every elementary in the district and regarded as a useful resource for helping teachers understand mathematics standards. The first 30 minutes of session two were devoted to helping participants understand how to use the resource and why it is an important companion to decoding standards. Next, standard 4.OA.A.3 was unpacked. The standard reads:

Solve multistep word problems posed with whole numbers and having whole number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding (Gojak & Harbin Miles, 2016, p. 36).

Participants were asked to solve the following two problems and discuss how to interpret the remainders. “Eric bought a package of 18 batteries. Each toy robot uses 4 batteries. How
many toy robots can be filled with batteries?” “Alyssa has a new bookcase with 4 shelves. Each shelf holds 9 books. If Alyssa had 38 books, how many books will not fit in the bookcase?”

Next, participants read the article “Effective Strategies for Teaching Students with Difficulties in Mathematics” (Gersten & Clark, 2007) and discussed the importance of student think-alouds and the large effect size associated with this instructional practice. Student think-alouds have an effect size of 0.98, which is considered very large by Gersten and Clark (2007). According to Gersten & Clark (2007), student think-alouds address the sometimes impulsive approach that students with disabilities take when solving problems. Following the session, participants were asked to incorporate more opportunities for student think-alouds and to video record a portion of a lesson to show evidence of the think-alouds in action.

**Professional development session three.** The purpose of session three was to develop a deep understanding of 4.NBT.B.6: Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. The unpacking of this standard was accomplished by using a planning and preparation template from *Mathematics Coaching: Resources and Tools for Coaches and Leaders* (Bay-Williams & McGatha, 2014, p. 28). As depicted on the planning template, teachers were encouraged to (a) articulate the learning intentions for the lesson, (b) identify the success criteria, (c) determine how to assess students’ understanding of the standard, (d) list the explicit mathematics vocabulary, (e) discuss anticipated student responses, and (f) identify student misconceptions. These first six criteria were explained to participants as the “unpacking” of the standard.

Next, participants were asked to complete the planning template using the activity from *The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5* (Gojak &
The remaining components of the template include (a) describing the task, (b) listing the SMPs involved in the lesson, (c) explaining how to ensure student understanding without interfering with students’ thinking, (d) listing content related questions to ask students as they complete the mathematical task, (e) identifying those discussion questions to determine who learned what, and (f) evaluating the effectiveness of the lesson. The goal of the mathematics activity was to provide students with the opportunity to find estimated quotients of a three- or four-digit number divided by a one-digit divisor. Following the planning and preparation of the lesson participants were asked to complete the mathematics activity with a partner.

**Professional development session four.** The purpose of session four was to develop and strengthen foundational concepts of fractions. John SanGiovanni, elementary mathematics supervisor in Howard County, Maryland presented to the cohort. SanGiovanni used his experience as an adjunct instructor and coordinator of the Elementary Mathematics Instructional Leader graduate program at McDaniel College, as well as a national consultant for curriculum and professional development to send a strong message of the importance of foundational concepts when teaching fractions. The session was led by three guiding questions.

1. What is one thing students must understand about fractions?
2. What is a misconception students have about fractions?
3. What is a challenge you have with fractions?

SanGiovanni engaged participants in a discussion about developing students’ understanding of fractions beyond identifying the shaded part of a circle. SanGiovanni had participants use the fraction bar for one-half (red bar) and the fraction bar for three-fourths (blue bar) to answer the question, “what fraction is the red bar if the blue bar is the whole?” Having
teachers see the whole as something other than one, helped them to think about how children would respond when forced to see a whole as representing different amounts. SanGiovanni then introduced pattern blocks, Cuisenaire rods, color tiles, and number lines as possible models to use with students when deepening students’ understanding of fractions through multiple representations (i.e., area, length, set).

Participants were also introduced to foundations for fraction equivalency and comparison through a discussion and activities involving unit fractions. SanGiovanni asked participants to show a unit fraction with Cuisenaire rods, color tiles, pattern blocks, and a number line and to discuss the justification for using each representation. Next, participants used Cuisenaire rods to demonstrate how three-fourths and six-eights were equivalent. Participants discussed how the two fractions were the same and different. Finally, participants engaged in a conversation using representations to compare fractions. SanGiovanni took the approach of having participants make assumptions of how students would respond when asked to compare two fractions like the ones shown in Figure 5.1.

![Comparison of Fractions](image)

*Figure 5.1. Comparing Fractions.*

**Professional development session five.** The purpose of session five was to develop participants’ understanding of operations with fractions for addition, subtraction, and multiplication. Session five was inspired by the big ideas from chapter 13 of *Teaching Student-
centered Mathematics: Developmentally Appropriate Instruction for Grades 3-5 (Vol. 2) (Van de Walle et al., 2014). The big ideas include:

1. The meaning of the operations on fractions are the same as the meanings for the operations on whole numbers. Operations with fractions should begin by applying these same meanings to fractional parts.

2. For addition and subtraction, an essential understanding is that the numerator tells the number of parts and the denominator the type of part (what unit is being used). When denominators are different, an adaptation of the problem takes place.

3. For multiplication by a fraction, an essential understanding is that the denominator is a divisor. This idea allows us to find parts of the other factor.

4. Estimation should be an integral part of computation development to keep students’ attention on the meanings of the operations and the expected size of the results (Van de Walle et al., 2014, p. 231).

Participants were reminded of the importance of taking a problem-based approach with students by providing meaningful contexts, a variety of models, using estimation, and addressing misconceptions (Van de Walle et al., 2014). Further, it was reiterated that due to the nature of students’ disabilities and difficulties learning mathematics, participants were encouraged to allow for the necessary time to develop students’ fraction number sense prior to moving forward with operations with fractions.

Participants were reminded of the importance of taking a problem-based approach with students by providing meaningful contexts, a variety of models, using estimation, and addressing students’ misconceptions (Van de Walle et al., 2014). Further, it was reiterated that due to the nature of students’ disabilities and difficulties learning mathematics, participants were
encouraged to allow for the necessary time to develop students’ fraction number sense prior to moving forward with operations with fractions.

The agenda for session five consisted of first having participants estimate sums and differences of fractions and justifying their answers to a partner. Next, participants were given two addition with fractions word problems to solve using two strategies. The manipulatives used in session four were available for participants to use when solving. Participants discussed problem solutions and strategies with the entire group. Participants then solved a subtraction word problem and were asked to anticipate students’ responses, decide what would be counted as evidence of understanding, determine the misconceptions that could arise, and how they as teachers would respond.

The final topic for session five included multiplication of fractions. Participants were asked to think about situations that require multiplication of whole numbers. Next, participants were asked to think about and share out situations that require multiplication of fractions. The participants were then provided with contextual examples of three multiplication with fractions problems and provided with manipulatives and asked to solve each of the three problems. Once the problems were solved using the manipulatives provided, participants were asked to solve three additional problems using numbers, pictures, and words. In closing, the cohort solved $\frac{3}{5} \times \frac{3}{4}$ and used only a picture model to justify their response.

One-on-One Instructional Mathematics Coaching

The inspiration behind instructional mathematics coaching as one aspect of the ESETC came from *Mathematics Coaching: Resources and Tools for Coaches and Leaders, K-12* (Bay-Williams, & McGatha, 2014). Researchers and practitioners contend that the role of the instructional coach is to support teachers in developing greater knowledge of mathematics
content, strengthen students’ mathematical thinking, and increase mathematics teacher efficacy (Bay-Williams, & McGatha, 2014; Hartman, 2013; Obra, 2010). This researcher selected seven of the 13 participants for instructional coaching because their pre-intervention MTEBI scores ranged from the middle to lower end of the scoring range which allowed for an opportunity for considerable growth in MTE and MKT. The instructional coach met with each of the seven teachers on a bi-weekly basis during a time that was convenient for the teacher. The coach met with each teacher at her respective school in the teacher’s office. The one-on-one meeting provided the teacher and coach an opportunity for undivided attention on each teachers’ instructional concerns, shifts in classroom practice, and RTOP feedback.

Among the seven participants, the grade-level caseloads spanned kindergarten through fifth grade. All seven participants worked with students with special needs who had IEP goals that included mathematics calculation and mathematics problem-solving. Additionally, all seven special education teachers had students on their caseloads with IEP goals that represented the domains of (a) Operations and Algebraic Thinking, (b) Number and Operations in Base Ten, and (c) Number and Operations-Fractions. This researcher also used Bay-Williams and McGatha’s (2014) Leading for Mathematical Proficiency (LMP) Framework. The framework includes the Standards for Mathematical Practice (SMP) (CCSSO, 2010), instructional shifts, and mathematics knowledge for teaching. The recommendation to participants was a focus on one of the Shifts in Classroom Practice (Bay-Williams & McGatha, 2014) over the five-month intervention to provide direction during coaching sessions and to avoid having participants feel overwhelmed by having to address multiple areas of need.

**Shifts in classroom practice.** Researchers agree that the SMPs (CCSSO, 2010) are “a description of what a mathematically proficient students are able to do” (Bay-Williams &
McGatha, 2014, p. 2). As an instructional coach, the work with teachers involves helping them make the SMPs actionable in the classroom. For this researcher, it became evident that pre-intervention RTOP results for the seven instructional coaching participants supported the need to assist each one in identifying instructional practices that maximized opportunities to learn (OTL) for the students on their identified special education caseloads. OTL refers to the alignment of what students are taught to the assessment by which they are measured (Banicky, 2000). OTL also encompasses the quality of instructional resources and teaching practices. The pre-intervention RTOP results revealed the need to address OTL for all seven instructional coaching participants in some way which is why the decision to focus on the Shifts in Classroom Practice (Bay-Williams & McGatha, 2014) was made. Additionally, the decision to focus on instructional shifts helped narrow the focus of the coaching sessions and gave participants the opportunity to move along a continuum of professional growth. The instructional shifts include:

1. Same instruction toward differentiated instruction
2. Students working individually toward a community of learners
3. Mathematical authority coming from the teacher or textbook toward mathematical authority coming from sound student reasoning
4. Teacher demonstrating “how to” toward teacher communicating “expectations” for learning
5. Content taught in isolation toward content connected to prior knowledge
6. Focus on correct answer toward focus on explanation and understanding
7. Mathematics-made-easy for students toward engaging students in productive struggle (Bay-Williams & McGatha, 2014, p. 3)
Later in chapter five, two instructional coaching participants will be highlighted, an explanation of how their instructional shift will be shared, and the specific actions that moved them along the continuum will be discussed. Additionally, their own words will be revealed to support why they believe their change in MTE was significant.

**Mathematics Teaching Efficacy**

The first research question focused on changes in participants’ mathematics teaching efficacy as a participant in the ESETC. Researchers contend that teachers with high teacher efficacy invest more time planning, have higher levels of persistence with students, are open to new ideas, and take responsibility for student success (Guskey, 1988; Nurlu, 2015). These characteristics were significant in this study because one goal of this research was to help participants approach mathematics instruction from a new perspective that involved taking risks, accepting challenges, and reflecting on their instructional practice.

In this section I provide quantitative data using the MTEBI to support changes in the 13 participants’ mathematics teaching efficacy. Further, I make comparisons between those participants who received only professional development to those who received professional development and instructional coaching. I also used process evaluation data provided by the Professional Development Feedback Form administered at the end of three of the five face-to-face professional development sessions to reflect upon participants’ confidence in their skills for using each of the instructional strategies listed on the feedback form (see Appendix C). As a companion to the quantitative data, I provide qualitative data from the semi-structured interviews to further explain participants’ reasoning behind their responses on the MTEBI and the Professional Development Feedback Form.

**Mathematics Instructional Coaching Matters**
One quantitative measure used to determine changes in participants’ mathematics teaching efficacy was the MTEBI. This section reveals changes in mathematics teaching efficacy for three scenarios: (a) all participants, (b) participants who received only professional development, and (c) participants who received professional development and instructional coaching. The MTEBI was administered pre and post intervention to all 13 participants. These data support the effectiveness of ESETC, especially for those participants who received professional development and one-on-one instructional coaching.

**All participants.** A paired sample t-test revealed a significant difference between pre-intervention mathematics teaching efficacy ($M = 74.85$, $SD = 7.01$) and post-intervention mathematics teaching efficacy ($M = 80.54$, $SD = 6.77$; $t = 2.18$, $p = .01$, $d = 0.8$) for the 13 participants. November mathematics teaching efficacy scores ranged from 63 to 89, while March mathematics teaching efficacy scores ranged from 68 to 96. Eleven participants increased their mathematics teaching efficacy from November to March with a mean increase of 7.63 ($SD = 5.16$) while two participants decreased their mathematics teaching efficacy score with a mean decrease of 5.0 ($SD = 5.65$) during that same period.

**Professional development only participants.** A paired sample t-test for those six participants receiving only professional development revealed no significant difference between pre-intervention mathematics teaching efficacy ($M = 81.60$, $SD = 5.13$) and post-intervention mathematics teaching efficacy ($M = 82.20$, $SD = 9.26$; $t = 2.45$, $p = 0.91$, $d = 0.8$). November mathematics teaching efficacy scores ranged from 74 to 89, while March mathematics teaching efficacy scores ranged from 68 to 96. Four participants increased their mathematics teaching efficacy from November to March with a mean increase of 3.75 ($SD = 2.22$) while two
participants decreased their mathematics teaching efficacy score with a mean decrease of 5.0 (SD = 5.65) during that same period.

**Professional development and coaching participants.** A paired sample t-test for those seven participants receiving professional development and instructional coaching revealed a significant difference between pre-intervention mathematics teaching efficacy ($M = 70.14$, $SD = 4.81$) and post-intervention mathematics teaching efficacy ($M = 80.00$, $SD = 4.40$; $t = 2.18$, $p = 0.001$, $d = 1.98$). November mathematics teaching efficacy scores ranged from 63 to 78, while March mathematics teaching efficacy scores ranged from 75 to 89. All seven participants increased their mathematics teaching efficacy from November to March with a mean increase of 9.85 ($SD = 5.11$).

**A Look Behind the Numbers**

At the end of the ESETC, the seven participants who received instructional coaching were interviewed by individuals not associated with the study to encourage candid feedback about participants’ experience in the five-month research study. The first three interview questions provided information about participants’ caseloads. Participants were asked to discuss the grade levels they service, whether students on their caseloads had goals specific to mathematics problem-solving and calculation, and whether students’ IEP goals represented the OA, NBT, and NF domains of the CCSS-M. Table 5.1 displays the findings.

**Table 5.1**

*Background Information Regarding Participants’ Special Education Caseloads*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Grade Levels</th>
<th>Mathematics Problem-Solving</th>
<th>Mathematics Calculation</th>
<th>OA</th>
<th>NBT</th>
<th>NF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1st-5th</td>
<td>All students</td>
<td>All students</td>
<td>1st</td>
<td>2nd-3rd</td>
<td>4th-5th</td>
</tr>
<tr>
<td>2</td>
<td>1st-3rd</td>
<td>All students</td>
<td>All students</td>
<td>1st-2nd</td>
<td>2nd-3rd</td>
<td>3rd</td>
</tr>
<tr>
<td>3</td>
<td>K and 3rd-5th</td>
<td>3rd-5th only</td>
<td>3rd-5th only</td>
<td>None</td>
<td>3rd-5th</td>
<td>4th-5th</td>
</tr>
</tbody>
</table>
Additionally, three questions were adapted from the MTEBI to allow for further clarification of survey responses and to provide themes for topics such as “ineffective” and “good” teaching and what it means to provide extra attention to those students struggling with mathematics.

**Extra attention.** Based on the responses, the themes that emerged when discussing what extra attention looks like when carried out in their instruction were (a) the importance of planning and preparation, (b) making data-driven instructional decisions, and (c) providing the appropriate levels of support in either small groups or one-on-one. Extra attention refers to support given to students based on an identified need. Identification of needs are a result of data from teacher anecdotal notes, formal or informal assessments, or observations of students who express confusion or frustration with learning new material. During the interview with Participant 9 she stated,

In terms of what extra attention looks like for me, I think planning and preparation is extremely important for student success. One of the things that I have learned through as a member of the ESETC is how to plan more appropriately and how to utilize different resources and tools. *The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5* has been a good resource for identifying students’ misconceptions, but I have also been using the website Learn Zillion which walks me through steps for
teaching from the concrete to abstract and it helps me with concepts I am struggling to teach. So, I feel like I have spent a lot more time with preparation. That goes back to the question the extra attention on my part which I think carries over into the instruction and helps my students to understand mathematics better.

This response was that it is came from a 19-year veteran teacher who experienced the largest increase in mathematics teaching efficacy on the MTEBI from pre-intervention to post-intervention ($\Delta = 18$). Participant 9 was also a special education teacher who was teaching in one of the lowest achieving, highest poverty elementary schools in the district. Participant nine’s change in teacher efficacy may begin to align with the characteristics of highly efficacious teachers. This shift may lead to an increased likelihood that she will invest more time planning, be more persistent when helping students overcome learning challenges, and accept greater responsibility for student learning (Nurlu, 2015).

During the semi-structured interview with Participant 3, extra attention by the teacher also included the idea of first understanding where students are in relation to the standards and then moving forward with planning and preparation to meet students’ needs. Specifically, Participant 3 said,

Extra attention on my part means collecting enough data to know where the students are as far as current abilities, understanding, and foundations. Then looking at the standards and goals and determining where the students should be and then moving forward from that. It also includes reviewing for the students, so they remember what has already been taught. So, I guess the extra attention would be preparing for the lessons and thinking through what they really need behind the scenes and then making sure they have enough
information and manipulatives during instruction. At the end, making sure I know what they’ve gotten out of the lesson, so I know what to prepare moving forward.

In contrast to the 19 year veteran described above, Participant 3 is in her second year of teaching and is working in the second lowest achieving elementary school in the district in terms of mathematics proficiency on PARCC. Participant 3 also works in a school with a high concentration of English Language Learners (ELLs) in a densely populated, low socio-economic neighborhood.

**Ineffective instructional practices.** Based on interview responses, the themes that emerged when defining ineffective instruction were (a) lack of content knowledge, (b) not understanding students’ needs, and (c) lacking appropriate support to students. During the semi-structured interview with Participant 3 she stated, “Ineffective teaching means not understanding who your students are. Not having a clear understanding of what they need. It also involves not understanding the curriculum, standards, and best practice.” She also mentioned that ineffective teachers in her opinion hesitate to seek out support when it is needed.

Participant 13 had a different interpretation of the question about what whether ineffective teaching is to blame for underachieving students. She stated,

This one was tricky for me because I don’t know if it is totally related to ineffective teaching. I feel like there could be gaps in the students’ learning from early on which is why they could be struggling with a concept. One of the biggest things for me is really understanding how a student learns and trying to provide students’ instruction in that way. For example, there are those students that really need manipulatives so incorporating them into instruction when you know they need it. I guess ineffective means not knowing how to reach each individual student.
On the other hand, Participant 13 did agree with the statement on the MTEBI that said, “Students’ achievement in mathematics is directly related to their teachers’ effectiveness in mathematics teaching.” She also agreed with the statement, “The teacher is generally responsible for the achievement of students in mathematics.” It is also worth noting that Participant 13 was uncertain about those statements on the MTEBI that credited teachers’ efforts with student success signifying that she has doubts about the impact that teachers can have on low-achieving students. This participant went onto say, “I feel like there could be gaps in students’ learning from early on that effective teaching cannot always overcome.” Interestingly Participant 13 was willing to approach small group mathematics instruction in a different way from one who shows and tells students how to “do mathematics” to one who facilitates learning by asking questions and planning for diverse learning styles. The change in this Participant 13’s mindset was a result of the instructional coaching conversations that occurred during the first two months of the instructional coaching relationship. The instructional shift also was linked to the professional learning that occurred during session two when “Effective Strategies for Teaching Students with Difficulties in Mathematics” (Gersten & Clark, 2007) was discussed. Lastly, of the seven participants who received instructional coaching, Participant 13 demonstrated the lowest overall initial score and only increased two points on the MTEBI from pre-intervention to post-intervention.

During several conversations with Participant 13, she mentioned that she had spent most of her teaching career working in suburban school settings with populations categorized as predominantly white, middle-class, and higher achieving. It was not until the 2017-2018 school year that she transferred to a high poverty, ethnically diverse school setting where she encountered students with larger gaps in achievement who did not always respond favorably to
her instructional strategies. With two months remaining in the research study, Participant 13 became more comfortable with planning for diverse learning styles and levels and started to hold students more accountable for their own learning. Even though she was a risk-taker and made major adjustments to her instructional approach, perhaps she did not have enough time to fully understand and appreciate how her new approach to teaching would impact student learning.

Participant 1 took a different approach when discussing ineffective teaching when she said,

Now, I think that ineffective teaching means doing more of the work for the students. It means not scaffolding the work so that kids have an access point. I also think that ineffectiveness leads to jumping too quickly to the abstract or not giving students the opportunity to move into the abstract at all. And it means not giving students time to think on their own.

Participant 1 prioritized high expectations for students’ performance as a factor in whether teachers are effective or ineffective. Throughout her work with the instructional coach, Participant 1 was concerned with making sure she understood the curriculum, students’ IEP goals, and that she was prepared for her small group instruction. However, this participant was particularly concerned with placing more of the responsibility for learning on the students by trying to provide instruction that encouraged critical thinking, problem-solving, and justifying students’ thinking through words, pictures, and symbols. Later in the chapter, Participant 1 will be introduced and her work with the instructional coach will be discussed in further detail as part of a case study.

**Effective teaching practices.** The final statement adapted from the MTEBI to provide qualitative data to support changes in participants’ mathematics teaching efficacy involved
having each participant define effective teaching practices. This interview question was asked because one statement on the MTEBI asked participants whether they agree, disagree, or are uncertain about the following statement, “The inadequacy of a student’s mathematics background can be overcome by good teaching. The themes that emerged from participants’ responses included (a) knowing what works best for students, (b) differentiation, (c) having high expectations for students, and (d) supporting students with special needs through collaboration with general education colleagues. In terms of knowing what works best for students, participants mentioned instructional practices such as (a) modeling, (b) scaffolding, (c) feedback, (d) small group and one-on-one instruction, and (e) providing opportunities for critical thinking through problem-solving.

When Participant 2 was asked to define effective teaching practices she said,

I have seen a lot of good improvements in my students this year through my work with the instructional coach. So, for me, good teaching looks like small group instruction that is differentiated for each individual student in the group. It involves giving students independent practice to work on skills that need to be strengthened. It means providing modeling and extra support and building upon previous knowledge to build confidence. It also means having high expectations and holding students to a high standard. Even though my students have special needs it is important to hold them to a high standard because they can rise to the challenge.

This post intervention response is in stark contrast to what this teacher demonstrated during her pre-intervention observation as we will see later in this chapter when the results of the RTOP are shared. This participant is also introduced in greater detail later in the chapter as we follow her through her journey with the instructional coach. In her second year of teaching,
Participant 2 was observed by the instructional coach on several occasions working with two fifth grade students with severe cognitive disabilities. The students were working far below grade level in mathematics, had the support of an instructional assistant, and at this point were considered for placement on an alternative curriculum. In this case, alternative curriculum means being non-diploma bound. By the time the post intervention observation using the RTOP was conducted, Participant 2 practiced what she preached in her response to the interview question about effective teaching practices. She explained,

Good teaching means knowing your students and mathematical practices, principles, curriculum, and standards. It means making sure students are engaged. It involves knowing how they learn. Effective teachers provide the appropriate resources to engage students in learning and not spending time lecturing and assigning worksheets. It also involves engagement and scaffolding for those that need it. It also means differentiating instruction for all students. Good teaching also involves collaborating with colleagues especially as special educators who need to be able to collaborate with classroom teachers and specialists.

Participant 2 and the instructional coach also conducted a visit to a specialized program in one of the district’s other elementary schools to observe teachers and students using instructional resources to engage students with severe communication, vision, and cognitive disabilities. The motivation behind this arranged observation was to provide Participant 2 with a first-hand look at how teachers integrated supplementary aides and services, so students could access the curriculum and communicate what they had learned. Additionally, Participants 2 was able to observe teachers who were differentiating instruction not just for a small group, but for every individual within the small group. Seeing the teachers in the specialized program
differentiate for diverse learners aligned with Participant 2’s goal of becoming more skilled and confident differentiating for her students who in many ways mirrored those in the specialized program.

Following the visit, Participant 2 shared that she began to use some of the recommended online resources with her students and that she saw greater value in the use of visual cues and visual models when working with her students not only in mathematics but other subjects as well. The most important “take-away” from the classroom observation was the comfort in knowing that Participant 2’s challenges to meet her student’s needs were experienced by other teachers in the district and a network of support exists beyond the walls of Participant 2’s school.

**Mathematics Knowledge for Teaching**

The second research question focused on changes in participants’ mathematics knowledge for teaching (MKT) as a member of the ESETC. As discussed in chapter one of this dissertation, mathematics knowledge for teaching refers to the mathematical knowledge needed to do the work of teaching (Hill et al., 2003). In other words, teachers who possess MKT can explain concepts and terms, interpret students’ mathematical thinking, and use representations accurately (Hill et al., 2003). To better understand changes in participants’ MKT we examine the results of the DTAMS WNC 4.3 administered to all 13 participants and the RTOP administered to the seven participants who received instructional coaching.

In this section I provide quantitative data using the DTAMS WNC 2.3 and 4.3 to support changes in the 13 participants’ mathematics knowledge for teaching. Further, I make comparisons between those participants who received only professional development to those who received professional development and instructional coaching. Next, I discuss the results of the pre intervention and post intervention observations using the RTOP to highlight changes in
teachers’ instructional approach to teaching mathematics. Then, I provide qualitative data from the semi-structured interviews to provide insight into the “work of teaching” for those participants who received instructional coaching. Finally, I highlight two participants’ instructional coaching journeys to gather additional data for explaining the implications of instructional coaching and professional development for changes in teachers’ instructional practices.

**Diagnostic Teacher Assessments in Mathematics and Science**

The first quantitative measure used to determine changes in participants’ mathematics content knowledge is the DTAMS WNC 4.3 (Saderholm et al., 2010). This section will reveal changes in mathematics content knowledge for three scenarios: (a) all participants, (b) participants who received only professional development, and (c) participants who received professional development and instructional coaching. The DTAMS WNC was administered pre- and post-intervention to all 13 participants.

A paired sample t-test revealed a significant difference between pre-intervention ($M = 21.08, SD = 5.26$) and post-intervention DTAMS WNC scores ($M = 26.53, SD = 5.52$; $t = 2.06, p = 0.02, d = 1.00$) for the 13 participants. November DTAMS scores ranged from 14 to 32, while March DTAMS scores ranged from 16 to 33. Twelve participants increased their DTAMS WNC score from November to March with a mean increase of 5.38 ($SD = 3.54$) while one participant scored 19 on the pre- and post-intervention DTAMS.

A paired sample t-test for the subset of participants who only received professional development also revealed a significant difference between pre intervention ($M = 23.83, SD = 4.71$) and post intervention DTAMS WNC scores ($M = 29.50, SD = 2.94$; $t = 2.31, p = 0.04, d = 2.00$). November DTAMS WNC 2.3 scores ranged from 19 to 32, while March DTAMS
WNC 4.3 scores ranged from 26 to 33. All six participants increased their DTAMS WNC scores from November to March with a mean increase of 5.66 ($SD = 3.77$).

A paired sample $t$-test for the subset of participants who received professional development and instructional coaching revealed no significant difference between pre-intervention ($M = 18.71$, $SD = 4.79$) and post-intervention DTAMS WNC scores ($M = 23.86$, $SD = 6.41$; $t = 2.20$, $p = 0.11$, $d = 0.8$). November DTAMS WNC 2.3 scores ranged from 14 to 27, while March DTAMS WNC 4.3 scores ranged from 16 to 35. Six out of seven participants increased their DTAMS WNC scores from November to March with a mean increase of 5.14 ($SD = 3.63$).

**Qualitative data to support the DTAMS results.** The results of the DTAMS WNC for those participants who received both professional development and instructional coaching revealed no significant difference in teacher’s knowledge of whole number/computation from pre-intervention to post-intervention. There are some limitations that may have contributed to this outcome that are discussed in the limitations section at the end of chapter five. The following interview question was adapted from *The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5* (Gojak & Harbin-Miles, 2013) and asked to those who received instructional coaching. Participants were asked to explain how understanding the meaning of multiplication and division of whole numbers relates to understanding the meaning of multiplication of fractions. Participant 9 said, “They must understand the difference between multiplying and dividing a whole versus parts of a whole.” Participant 12 said, “First they need to understand what it is they are doing. I feel like we get stuck in the steps or this is what you need to do, but they really need to understand what I need to do to the first number I have. I feel like they need to know what it means to multiply and what it means to divide before they can
understand what that means with fractions.” Participant 4 said, “In order to multiply and divide fractions you must know how to do it with whole numbers first.” Participant 11 said, “Students must have a basic foundation of math skills when you're getting into higher level skills like multiplying fractions.”

The four responses to the questions above were representative of the entire group of seven participants. On the other hand, when participants were asked to discuss concrete models that students could use to develop conceptual understanding of a multiplication or division problem they were accurate in their responses. Participants discussed the use of the area model, linear model, and the set model.

**Reformed Teaching Observation Protocol**

The second quantitative measure used to determine changes in participants’ mathematics knowledge for teaching was the RTOP used to capture actual teaching performance in the classrooms. The RTOP consists of four sections (a) Contextual Information, (b) Lesson Design and Implementation, (c) Content, and (d) Classroom Culture. The RTOP is scored using a Likert-type rating scale from zero to four, with zero being “never occurred” during the lesson to four being “very descriptive.” The RTOP was administered pre- and post-intervention to seven participants. This section will reveal changes in MKT for participants who received professional development and instructional coaching. Following the pre-intervention observation, the researcher met with each of the seven participants to (a) review the findings of the RTOP observation, (b) establish bi-weekly coaching meeting times, (c) discuss one instructional shift that would become the focus of the instructional coaching sessions moving forward, (d) and review participants’ special education caseloads. These data support the effectiveness of
ESETC, especially for those participants who received professional development and one-on-one instructional coaching.

A paired sample $t$-test revealed a significant difference between pre-intervention ($M = 38.71, SD = 14.09$) and post-intervention ($M = 68, SD = 9.18; t = 2.23, p = .0009$) overall RTOP scores for the seven participants. November 2017 RTOP scores ranged from 20 to 59, while April 2018 RTOP scores ranged from 52 to 79. The seven participants increased their RTOP performance from November to April with a mean increase of 29.00 ($SD = 9.81$). It should be noted that the increase from pre-intervention to post-intervention for the seven instructional coaching participants may be explained by the frequency of the coaching visits, the fact that the instructional coach planned with each participant and modeled instructional strategies based on the methods from *Teaching Student-Centered Mathematics: Developmentally Appropriate Instruction for Grades 3-5* (Van de Walle et al., 2014) and *Mine the Gap for Mathematical Understanding: Common Holes and Misconceptions and What to do About Them* (SanGiovanni, 2017). The instructional coach provided on-going feedback specific to the components of the RTOP and used *The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5* (Gojak & Harbin-Miles, 2013) to support participants in unpacking standards.

Prior to revealing the results of the RTOP observations, a description of the contextual information as seen in Table 5.2 will be discussed. With each observation, the researcher in this study made note of the classroom setting and any relevant details about the students and teacher. All seven participants were observed working with students in small groups. Some participants were observed working with students in a small group in the general education classroom while others worked with students outside of the general education classroom. In those instances
where a participant was observed working one-on-one with a student as was the case in two pre-intervention RTOP observations, ratings in the Classroom Culture section were significantly impacted. The reason for low ratings in this section of the RTOP was because of the Communicative Interactions subsection where ratings on five “look-fors” were determined by opportunities for engagement with others. During the pre-intervention RTOP observation post-conference, the instructional coach encouraged the two teachers who worked one-on-one to consider opportunities to include these students with others when appropriate.

Table 5.2

**RTOP Contextual Information for Pre- and Post-Intervention Observations**

<table>
<thead>
<tr>
<th>Participant</th>
<th>RTOP Pre-Observation Context</th>
<th>RTOP Post-Observation Context</th>
</tr>
</thead>
</table>
| 1           | 7 students (4 boys and 3 girls)  
• Teacher and students sitting around a table in a special education resource room  
• Same tasks for all students | 3 students (2 boys and 1 girl)  
• Teacher and students sitting around a table in a general education classroom  
• Differentiated tasks based on students’ needs |
| 2           | 5 students (3 boys and 2 girls)  
• Teacher and students sitting around a table in a special education resource room  
• Same tasks for all students  
• Teacher directed for 45 minutes | 7 students (4 boys and 3 girls)  
• Balance between explicit instruction and independent problem-solving  
• Differentiated tasks based on students’ needs |
| 3           | 1 student  
• Teacher directed | 1 student  
• Teacher directed  
• “Teacher as listener” |
| 4           | 1 student  
• Teacher directed | 4 students (3 boys and 1 girl)  
• Balance between explicit instruction and independent problem-solving  
• Differentiated tasks based on students’ needs |
| 9           | 4 students (2 boys and 2 girls)  
• Teacher and students sitting around a table in a general education classroom  
• Teacher directed | 7 students (3 boys and 4 girls)  
• Teacher and students sitting around a table in special education resource room  
• Community of learners  
• “Teacher as listener” |
Based on the contextual information shared in Table 5.3, instructional shifts were made from instruction that was predominantly teacher directed and a “one size fits all” approach to instruction that was rigorous, student-centered, and differentiated based on students’ needs. Post-intervention RTOP results also showed that some participants displayed a balance of explicit instruction and independent problem-solving.

A look at the performance of participants on the RTOP section of Lesson Design and Delivery revealed a significant difference between pre-intervention (\(M = 8.00, SD = 4.08\)) and post-intervention (\(M = 13.14, SD = 2.67; t = 2.23, p = 0.02\)). This section of the RTOP helps the observer determine whether teachers (a) supported students’ prior knowledge, (b) engaged students as members of a learning community, (c) encouraged exploration prior to formal presentation, (d) promoted problem-solving, and (e) allowed students’ ideas to guide instruction.

When looking at the performance of participants in the Content section, participants revealed a significant difference between pre-intervention (\(M = 15.28, SD = 5.85\)) and post-intervention (\(M = 28.71, SD = 4.39; t = 2.20, p = 0.0005\)). The Content section is divided into subsections called Propositional Knowledge and Procedural Knowledge with each consisting of five components. The components addressed whether teachers possessed a solid grasp of the content therein and delivered instruction that promoted coherent conceptual understanding. The
Content section also provided teachers feedback regarding instruction that promoted student reflection, rigor, and use of a variety of means to represent phenomena. Post-intervention results revealed that each participant included fundamental concepts of the subject being taught, five of the seven participants taught a lesson that promoted strongly coherent conceptual understanding while two lacked conceptual understanding to some degree. All seven teachers had a solid grasp of the subject matter and five out of the seven participants included elements of abstraction when it was important to do so. Lastly, six out of seven participants made connections with other content disciplines and/or real-world phenomena while one participant did not.

Performance of participants in the subsection on Classroom Culture revealed a significant difference between pre-intervention ($M = 15.57$, $SD = 5.09$) and post-intervention ($M = 26.29$, $SD = 3.86$; $t = 2.20$, $p = 0.001$). This section of the RTOP is subdivided into Communicative Interactions and Student/Teacher Relationships with each subsection consisting of four components. The components are (a) communication, (b) collaboration, (c) respect, and (d) active listening by both students and teachers.

The data revealed significant shifts from pre-intervention ($M = 15.57$, $SD = 5.09$) to post-intervention ($M = 26.28$, $SD = 3.86$; $t = 2.20$, $p = 0.001$) in terms of Classroom Culture because the feedback to all seven participants after the pre-intervention RTOP was that teachers were doing most of the talking during small group instruction leaving students with few opportunities to ask questions and to work collaboratively with others. As a result of the feedback from the RTOP and the five months of instructional coaching built around the pre-intervention RTOP results, participants demonstrated the capability to play the role of “teacher as listener” rather than monopolizing classroom discussion. Additionally, students were not encouraged to generate multiple solution strategies, nor were they given time to determine the focus of
classroom discourse. Throughout the instructional coaching experience all seven participants focused on becoming more of a resource to support and enhance student investigations and became more adept at being a listener and more effective at asking questions.

**Qualitative data to support RTOP results.** Two questions were adapted from the RTOP to allow participants the opportunity to discuss their thinking in detail during the interview. One question asked participants to describe a lesson(s) that prompted strong, coherent conceptual knowledge and knowledge of content and the other question asked participants to describe a lesson that encouraged students to show evidence of their thinking using a variety of means and/or strategies. The two interview questions allowed for further investigation of participants’ propositional knowledge and procedural knowledge because the researcher in this study was focused on the changes participants were making to instructional practices used with the students with special needs. The information gathered from these two questions provided insight into participants’ approach to translating curriculum standards into aligned instruction for their students. These two interview questions also supported the work that was done throughout the five months of instructional coaching with special education teachers who were doing most of the talking during small group discussions with students and substituting small group instruction for supplementary aides and services and accommodations. Coding transcripts of the question concerning a lesson that encouraged students to solve problems using a variety of means revealed that all seven participants discussed using problems in context as the vehicle for encouraging alternative strategies and assessing students’ conceptual understanding. Participants discussed the instructional decisions that were made in terms of choosing the appropriate manipulatives or having students demonstrate multiple solution strategies. Participants also
provided examples of those lessons that encouraged students to take ownership of their learning and justify their thinking to others.

*Encouraging alternative strategies.* Participant 9 discussed a lesson that involved small group rotations where her students were encouraged to take a more active role in their learning, to collaborate with peers, and to be reflective about their learning. She stated,

This year I noticed that my students really struggled with the vocabulary, so I planned rotations and grouped students in threes. The first rotation was to get them to understand the vocabulary. Students worked together to complete a Frayer Model to define what the words meant. The second rotation had students use fraction tiles and fraction rods to represent fractions. The third rotation asked students to represent fractions and equivalent fractions on a number line. The final rotation asked students to solve a fraction problem in context. I observed and took notes on students' performance and tried to not intervene much while they worked together finding their solutions. At the end of the rotations we came back together and discussed the solutions and strategies at each rotation, so the kids could look at what the other groups accomplished and learned. The lesson took a lot of time and planning, but it helped me see where kids were and where I needed to go next (Participant 9, May, 2018).

The small group rotation lesson was the result of Participant 9 coming to an instructional coaching meeting early in the intervention and seeking reassurance that trying an approach that she had adapted from a language arts lesson was appropriate for her students in mathematics. The use of fraction tiles and Cuisenaire rods was a direct result of participation in the ESETC and the use of the Frayer Model was a direct result of an instructional coaching conversation about having evidence of students’ understanding of mathematics vocabulary. Participant 9 and
the instructional coach discussed the format for the lesson and from there; Participant 9 planned, prepared, and executed the lesson as described above.

On a different topic, one participant discussed her approach to encouraging alternative problem-solving strategies with her group of second graders. She stated,

This question has me thinking about my second graders and exposing them to strategies outside of the “tens and ones” strategy. It is now my expectation that they use an alternative strategy to become more confident in other strategies. I have given them many problems in context where they have to justify their thinking by using pictures and words to prove they are correct (Participant 2, May, 2018).

Participant 2’s approach to problem-solving was based on the feedback she received from the pre-intervention RTOP where she presented the same instruction to all students and expected similar solutions strategies from each member of the small group. Once the instructional coach and Participant 2 had multiple conversations about anticipated student responses and the misconceptions students may have, it became evident that a “one-size fits all” approach would not meet the diverse needs of her students. Also, when Participant 2 embraced the notion that small group instruction was not a substitute for the accommodations and supplementary aides and services on the IEP, she began to see her students as individuals with very specific needs.

Participant 1 discussed her approach to problem-solving that was developed over the five-month period working with the instructional coach. She followed a consistent formula for encouraging students to try alternative strategies and to justify their thinking. Participant 1 embraced the planning tool from *Mathematics Coaching: Resources and Tools for Coaches and Leaders, K-12* (Bay-Williams & McGatha, 2014). The planning tool helped Participant 1 plan her lessons by focusing on content standards, objectives, anticipated student responses, and the
appropriate resources needed for her diverse learners. She explained, “My third grade group manipulates a resource prior to solving. I then have them move to drawing it out and discussing it with a partner prior to solving the problem on paper. This approach helped their reasoning skills” (Participant 1, May, 2018). For Participant 1, her goal with each small group lesson was to have students own their learning by providing a rich mathematical task that encouraged the use of multiple strategies and a justification of students’ thinking both orally and in writing. Participant 1 became a true believer in not saying things that students should say by asking questions to assess understanding. In the end, Participant 1 was “telling” less and listening more. Becoming a more active listener and question asker was connected to an article that was shared with participants during session one. The article was called, “Never Say Anything a Kid Can Say” (Reinhart, 2000).

Approach to addressing fraction misconceptions. Question seven from the semi-structured interview was adapted from The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5 (Gojak & Harbin-Miles, 2013). Participants were asked to share one common misconception that students demonstrate with fractions and then discuss their approach to addressing the misconception. This researcher was particularly interested in participants’ approach to addressing the misconceptions because the responses supported whether participants possessed the knowledge to address certain misconceptions and if participants were confident in their approach to supporting struggling learners. Participant 9 said, “Adding the denominators is a major misconception. Other than telling students not to do it, I bring out the visual models to show them that the size of the whole does not change” (May, 2018). Participant 4 said, “When students add or subtract fractions some want to add or subtract the denominator. So, I use a visual model to show that the denominator is the whole. The
picture model seems to help my students more, based on what I have observed of them” (May, 2018).

Participant 3 selected a misconception that was addressed in professional development during session four.

One misconception that I have seen is getting kids to understand that the size of the whole can change based on the circumstance. For example, when using fraction bars the kids typically see the longest bar as the whole and the other bars as part of the whole. So, when they are given something like Cuisenaire rods which are not labeled, they immediately think the biggest piece must be the whole. So, I have a conversation about finding ways to prove that other rods can also be the whole and have the kids show me or prove that there are other possibilities for one whole (Participant 1, May, 2018).

During session four, SanGiovanni addressed fraction foundations with the ESETC and explained the purpose for using Cuisenaire rods with students who struggle with the size of one-whole changing based on the circumstances. Session four also included the use of visual models to demonstrate that when adding and subtracting fractions the whole (denominator) does not change. The responses from the three participants discussed above represent what the other four participants shared, demonstrating that each participant had an appropriate approach to addressing a misconception with fractions.

Conceptual understanding. The second question that was adapted from the RTOP involved a discussion about a lesson the teachers presented that promoted strongly coherent conceptual understanding. The researcher was also interested in hearing what participants had to say about the evidence that supports their rationale for why the lesson promoted conceptual understanding. The participants discussed how they began with a mathematics concept like
counting money, solving division problems, or the relationship between customary and metric units of measure. From there, participants discussed how they took a concept and had students apply their understanding of the concept to problems in context. Participants also included in their answers those opportunities where students were asked to justify their thinking with peers. For example, Participant 1 said, “I started a lesson by having students simply manipulate color tiles into equal groups to develop the idea of dividing. From there we moved to division word problems in context with the use of manipulatives to demonstrate their answers” (May, 2018).

Participant 2 discussed a lesson she taught to her first graders that encouraged the use of familiar resources such as base ten blocks to develop students’ knowledge of ten more and ten less. Participant 2 said,

I am thinking about a plus ten, minus ten lesson with my first graders. They were using their tens and ones t-chart. We built 25 with tens and ones and then had them add a tens rod to show what ten more would be. We would have them skip count, 10, 20, 30, 35 and then go back to the 100s chart to show how this applies to understanding how numbers work on a hundreds chart (Participant 2, May, 2018).

Participant 2 discussed how she puts students’ knowledge of coin values to the test in a lesson that had students plan a party on a budget. Participant 2 said,

We put their knowledge of money into context by having students plan a party based on a budget and a certain number of guests. It was interesting to see them think about something like $5.00 as 500 cents and then being able to subtract from that amount as they "bought" supplies for the party. When it came time to take the benchmark assessment, they were prepared to solve money problems by using a model to show their thinking (Participant 2, May, 2018).
Question 11 from the semi-structured interview was adapted from *The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5* (Gojak & Harbin-Miles, 2013) and supports participants understanding of using concrete models to develop students’ conceptual understanding. Participants were asked to discuss the concrete models students could use to develop conceptual understanding of $3 \times 6$ and $15 \div 5$. I like to use double sided counters to build an array model for multiplication. Participant 4 said,

I like to use double sided counters to build an array model for multiplication. I ask my students how many counters we have altogether and then they tell me. For division I have my students start with the 15 in this case and then have them explain the number of groups and how many in each group (May, 2018).

Participant 12 said, “I would pull out color tiles and have students build arrays to represent multiplication problems and then use the tiles to have students demonstrate that 15 can be divided into five groups of three” (May, 2018). The concrete models that were discussed by Participants’ 4 and 14 were discussed during professional development session two as a possible resource to use with students.

**Fact fluency.** Question 10 from the semi-structured interview was adapted from *The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5* (Gojak & Harbin-Miles, 2013). Participants were asked to talk about strategies that students could use to become fluent with facts using understanding rather than rote memorization. Participant 9 said,

One of the things we worked on in fifth grade this year was using our tools like a multiplication chart to identify the patterns, like when they are skip counting. Also using friendly numbers can help them when trying to solve for multiplication and division. I have used lots of anchor charts for them to be able to refer to and then I remove the charts
at a later time to see if they can apply the strategies independently (Participant 9, May, 2018).

Participant 12 said, “Knowing doubles or friendly numbers and having those strategies to solve. My kids struggle to memorize so equipping them with certain strategies is helping them to recall more successfully” (May, 2018). Participant 3 selected a strategy that was discussed during instructional coaching sessions. This participant was concerned about the lack of fact fluency with students in her fifth grade group. Participant 3 said,

Applying math to real life scenarios has helped my students. I use real-life problems and have manipulatives to model the problems. The more the students use visual models to solve problems, the more fluent they become with their facts. Overall, I have not found rote memorization to be effective for a lot of my students (Participant 3, May, 2018).

Using the RTOP to Guide Instructional Coaching: Caroline and Kathleen

At the outset of the intervention, seven participants were chosen based on their pre-intervention MTEBI scores being on the lower end and agreed to take part in bi-weekly, one-on-one instructional coaching sessions with the researcher in this study. Prior to the initial meeting, the researcher completed a pre-intervention observation using the RTOP. All seven observations were completed in November of 2017. The plan was to identify two participants at opposite ends of the MTEBI rating scale to then highlight their five-month instructional coaching journey in chapter five of this dissertation. Caroline began the ESETC with a MTEBI rating of 66 which was the second lowest pre-intervention score and Kathleen began the ESETC with a MTEBI rating of 78 which was the fifth highest pre-intervention score. The reason Kathleen was selected to explore more in-depth was because she provided special education services to students at two schools so her willingness to become a better lesson planner and increase rigor
with her students was going to have an impact on several students across two buildings. From the outset, Caroline expressed her reservations with her mathematics instruction whereas Kathleen felt relatively confident about her instruction, but desired to gain new insight about getting her students to more confidently demonstrate their mathematical thinking.

After completing the pre-intervention observation, the instructional coach met with each of the seven participants for an observation post-conference. At this time, the instructional coach revealed the results of the RTOP and together the coach and the participants identified one of the Shifts in Classroom Practice (Bay-Williams & McGatha, 2014) that each participant would address during the five-month ESETC. The instructional shifts came because of what the instructional coach had noted during the observation. The idea for setting one instructional shift as a goal came from Mathematics Coaching: Resources and Tools for Coaches and Leaders (Bay-Williams & McGatha, 2014) (Figure 5.1). Based on the coach’s feedback, Caroline and the instructional coach decided to adopt Shift 1: From same instruction toward differentiated instruction and Kathleen adopted Shift 7: From mathematics-made-easy for students toward engaging students in productive struggle (Bay-Williams & McGatha, 2013, p. 3). In the following paragraphs, the two participants’ instructional shifts will be discussed in full detail including how each participants’ shift came to be selected and what was accomplished during coaching meetings to move each participant along the instructional shift continuum.

The MTE of Two Teachers

For the seven participants who received bi-weekly instructional coaching, mathematics teaching efficacy increased for each of them at varying levels. Two individuals committed to revamping their instructional approach, increase expectations for students and to provide instruction that promoted higher order thinking daily. In this section we meet these two
individuals and highlight ways in which increased teacher efficacy yielded instructional shifts that resulted in rigorous, differentiated instruction for their students. We will revisit these two individuals later in this chapter in a discussion about mathematics knowledge for teaching and the aspects of their instruction that were revamped to more effectively meet the needs of their students. Names were altered for anonymity.

**Caroline.** Caroline had a high participation rate in the five professional development sessions and met with the instructional coach on a bi-weekly basis. She increased her mathematics teaching efficacy rating on the MTEBI by 14 points. Caroline had a pre-intervention MTEBI rating of 66 (second lowest) and finished the study with an efficacy rating of 80. The 14 point increase was the second largest overall increase of the 13 participants. Caroline was honest about her weaknesses teaching mathematics and on more than one occasion said that she was not good at mathematics and was not confident in her ability to teach mathematics to her students. Taking a closer look at the MTEBI (Table 5.3) revealed that Caroline’s increase in mathematics teaching efficacy was based primarily on her renewed outlook about four statements. Based on these four statements alone, Caroline increased her MTEBI rating by eight points.

Table 5.3

*Caroline’s PMTE Subscale Statements*

<table>
<thead>
<tr>
<th>Statement</th>
<th>Pre-Intervention Response</th>
<th>Post-Intervention Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Even if I tried hard, I will not teach mathematics as well as I will most subjects.</td>
<td>Agree</td>
<td>Disagree</td>
</tr>
<tr>
<td>I am typically able to answer students’ mathematics questions.</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>I wonder if I have the necessary skills to teach mathematics.</td>
<td>Agree</td>
<td>Disagree</td>
</tr>
<tr>
<td>When a student has difficulty</td>
<td>Agree</td>
<td>Disagree</td>
</tr>
</tbody>
</table>
During the semi-structured interview Caroline emphasized her lack of confidence teaching mathematics when asked the question, “What aspect or aspects of the instructional coaching experience were most beneficial to you?” Caroline’s response was,

I have not always felt confident in math. Growing up, math was not my strong suit. I always felt like I was stronger with English. So, as a teacher I have felt like if kids had questions I was unsure if I could really help them in math. Part of the reason I wanted to do this study was to build my own math confidence. And then when I was selected to do the one-on-one coaching I thought, "Even better!” Now I can participate one-on-one to build my confidence teaching math. I went into the study expecting to become more confident, but I came out of it like ten-fold feeling so much better as a math teacher because I was able to talk through my limitations and my students’ limitations and try to figure what would be beneficial for them and for me. In the process I learned how to revamp my instruction and I got to share my student's progress with the instructional coach on a bi-weekly basis (May, 2018).

**Kathleen.** Kathleen was a high participator as well, attending four out of five professional development sessions and meeting with the instructional coach on a bi-weekly basis. Kathleen had a pre intervention MTEBI rating of 78 and a post intervention rating of 89. The 11 point increase was the third highest among the 13 participants. Kathleen entered the study as the participant with the highest teacher efficacy score of the seven chosen for instructional coaching, which was also matched by her desire to improve and learn new instructional strategies to meet the needs of her diverse group of learners. From pre intervention
to post intervention she became strong in her beliefs about her abilities to be an effective teacher which explains the 11 point increase for someone already considered as having high teacher efficacy (Table 5.4). During the semi-structured interview Kathleen expressed her desire to change when asked about the aspects of the instructional experience that proved to be most beneficial. She stated, “I appreciated being observed by the instructional coach with a critical eye to help me think about what I could change.” Coming from a nine year veteran, it said a lot about Kathleen’s desire to become a better teacher.

Table 5.4

*Kathleen’s MTOE and PMTE Subscale Statements*

<table>
<thead>
<tr>
<th>Statement</th>
<th>Pre Intervention Response</th>
<th>Post Intervention Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Students’ achievement in mathematics is directly related to their effectiveness in mathematics teaching.</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>I am typically able to answer students’ mathematics questions.</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>I wonder if I have the necessary skills to teach mathematics.</td>
<td>Disagree</td>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

**Caroline’s pre-intervention RTOP results.** Caroline’s approach to small group instruction included having her group of five, second grade students sitting around a table so that all students could see what was being presented. Caroline taught a place value lesson from a resource called *Hands on Standards: Grade 2* (2014). Caroline had the book open to the lesson and was referring to it as she and her students used base ten blocks to build two- and three-digit numbers. The instruction was the same for all students regardless of ability level and at no time
did student exploration precede formal presentation. Students did not make predictions, estimations, or reflect on their own learning. These three components were rated as a zero out of four on the RTOP.

At the post observation conference Caroline and the instructional coach discussed taking an approach where students were given more ownership for their learning and given opportunities to learn in a community of learners. The importance of planning small group instruction with students’ IEP goals, supplementary aides and services, and accommodations in mind was also discussed. Supplementary aides and services are supports provided in general education classes to students with special needs to allow for students with disabilities to be educated with nondisabled peers (IDEA, 2004). As a result, Caroline and the instructional coach started a plan of differentiating instruction for her students. Basically, Caroline was trying to get a firm grasp on what her students knew, progress monitor her students’ goals, understand how to more effectively meet their needs, and use the resources available to her more efficiently. With each instructional coaching meeting, the coach and Caroline used students’ progress monitoring data and the accommodations and supplementary aides and services in students’ IEPs to plan for specific students. The instructional coach worked with Caroline on selecting what Bay-Williams and McGatha (2014) and refer to as worthwhile tasks. Worthwhile tasks are of high cognitive demand, meaningful, and engaging (Smith & Stein, 1998). Worthwhile tasks also promote reasoning, problem-solving, communication, and representation (Bay-Williams & McGatha, 2014; Smith & Stein, 1998). Coaching conversations such as these led to Caroline taking the initiative to research and implement mathematically meaningful tasks to use with her students each day.
Kathleen’s pre-intervention RTOP results. Kathleen’s pre-intervention observation was conducted in late November 2017. At the time, Kathleen was fulfilling her role as a mentor to a special education intern. Together, they planned the pre-intervention lesson and played a part in the execution of the small group instruction. The group consisted of seven students and the task was for students to solve six fraction problems in context. Overall, the lesson involved fundamental concepts of the subject, encouraged students to collaborate with peers, and promoted a climate of respect for what others had to say. All in all, the lesson was rated as a 59 out of 100 possible points on the RTOP.

During the observation conference several days later, Kathleen discussed that she was in search of an approach to lesson planning that was efficient, yet thorough and allowed for the careful monitoring of her students’ progress. Kathleen was looking for a way to incorporate quality mathematical tasks such as those discussed in professional development sessions one and four that allowed for differentiation and a means of determining students’ strengths and weaknesses in both written and verbal form. The pre-intervention RTOP revealed that Kathleen’s greatest areas of weakness involved a lack of student exploration prior to formal presentation, limited opportunities for students to make predictions, estimations, and hypotheses, and the lack of opportunities for students to use a variety of means to represent phenomena. At that point Kathleen and the instructional coach landed on the Shift in Classroom Practice (Bay-Williams & McGatha, 2014) from mathematics made easy toward engaging students in productive struggle.

Shifts in Classroom Practice

Ultimately, Caroline decided to move away from instructing her students as one group and decided to go with a two-group model where she split her time between two groups,
providing explicit instruction to two or three students at a time while the other two or three worked independently or with a partner. During session one, the ESETC content addressed the idea of explicit instruction as a high-yield strategy according to Gersten et al. (2009). Explicit instruction as a high-yield strategy for students with special needs supports what researchers believe to be true for effectively closing gaps in achievement between students with special needs and their regular education peers (Gersten et al., 2009).

Caroline’s way of managing this transformation was the introduction of math journals. The journals provided students with a set of problems that students had yet to master (Figure 5.2). Caroline also included a story problem that she expected students to finish at some point during the week (Figure 5.3). This approach provided students with problems that were meeting their individual needs all the while, providing Caroline with the data she needed to monitor her students’ progress.

1.) Show two strategies to find the difference.

\[ 569 - 347 = \] _____________

2.) Mitchell kicked the soccer ball 11 feet, which is 6 feet farther than Jason kicked the ball. How far did Jason kick the ball?

Number Sentence: ________________________ -

3.) Circle the two comparison statements that are true.

a. 421 = 421
b. 532 < 235
c. 769 > 967
d. 346 < 643

4.) Draw an array for \(3 \times 5\).

---

**Figure 5.2. Math with a Partner**

2nd graders went on a field trip to the zoo. The students saw 70 animals. The students saw 24 monkeys, 28 bears, and some lions. How many lions did the students see at the zoo?

Number Sentence: ____________________________________________
My answer to the problem is __________________

Figure 5.3. Caroline’s Constructed Response Sample.

Over the course of several months, Caroline became more comfortable giving students more ownership over their learning and provided them with opportunities to be engaged, collaborate with peers, and exercise critical thinking skills in solving mathematical problems. All the while, Caroline was meeting with students in groups of two or three to deliver a balance of explicit instruction and classroom discussion based on the items she created for students’ math journals. At the end of each week of mathematics instruction, Caroline had the evidence to determine students’ progress with grade-level mathematics standards and IEP goals.

Kathleen’s shift in classroom practice has now provided her students with opportunities to engage with rich mathematical tasks that are differentiated, rigorous, and allow for students to share their thinking both verbally and in written form (Figure 5.4). Kathleen begins small group instruction with the success criteria, a review of resources available for learning, and an activity for students to tap into prior knowledge before moving to problem-solving. She is mindful of students’ accommodations and provides the necessary support when needed. Kathleen can monitor students’ work by asking questions to elicit oral responses or by having students justify their thinking in written form. She is also mindful of coming back to the success criteria to bring closure to the lesson and to clear up any misconceptions. Being mindful of success criteria and student misconceptions was discussed during professional development and during one-on-one instructional coaching sessions. The instructional coach emphasized to Kathleen the importance of addressing student misconceptions before sending students back to their classrooms so that misconceptions do not linger between small group sessions and from one day to the next. In the end, Kathleen is left with a variety of data points and work samples that she can use to plan for
future instruction. At the post intervention observation, Kathleen followed this format for instruction which resulted in an increase of her RTOP rating from 59 to 76.

1. Valentin and his mother made cupcakes. They put 2 cupcakes on each of 7 plates. Select the number sentence that represents all the cupcakes Valentin and his mother made.
   - Show your work
   - Select your answer
   - Can you show another way?
   - A. $2 + 7 = 9$
   - B. $7 \times 7 = 49$
   - C. $8 + 6 = 14$
   - D. $7 \times 2 = 14$

2. Write a story problem and expression that results in a product of 28
   - Write your story problem
   - Write your equation
   - Show your work in more than one way.

Figure 5.4. Sample problems for 3.OA.3.

Caroline’s post-intervention RTOP results. During the post-intervention observation, Caroline met with her group of second graders for 45 minutes. In the 45 minutes, Caroline and her students were able to accomplish small group instruction, spiral review mathematics problems in mathematics journals, and discuss effective ways to tackle a “change unknown” additive story problem. Caroline was observed asking questions to students to clarify their thinking, engaging students in thought-provoking activities, encouraging and valuing the active participation of students, and acting more as a facilitator of learning rather than teaching from a teacher’s manual. As a reminder, the scoring for the RTOP includes a Likert-type rating scale from zero to four, with zero being “never occurred” to four being “very descriptive.” Caroline made the greatest gains from pre- to post-intervention in three domains (a) lesson design and
implementation, (b) procedural knowledge, and (c) student/teacher relationships. In these three areas combined, Caroline improved by 28 points.

**Kathleen’s post-intervention RTOP results.** In contrast to the pre-intervention observation where Kathleen provided students with a series of problems in context and had them solve those problems using manipulatives and show their work on the worksheet provided, the post observation was strategic, efficient, and differentiated for the diverse learning needs of the group. Differentiation during the post observation included story problems with numbers and digits adjusted for students’ ability levels, use of graphic organizers, extended time, teacher monitoring of student responses, and support from a classmate as needed. Kathleen planned her lesson with students’ areas of need in mind and adapted the materials, problems, and representations based on the accommodations and supplementary aides and services listed on students’ IEPs. Kathleen made the greatest gains from pre- to post-intervention in three components (a) grasp of the subject matter (from a score of 2 to 4 from pre to post), (b) students used a variety of means to represent phenomena (from a score of 2 to 4 from pre to post), and (c) student exploration preceded formal presentation (from a score of 0 to 4 from pre to post). The difference from pre- to post-intervention for these three components was a combined eight points.

In each of the seven instructional coaching scenarios, the participants were committed to the coaching process and dedicated to becoming better mathematics educators and special education teachers. Each adopted a Shift in Classroom Practice (Bay-Williams & McGatha, 2014) and made changes to their instructional program to accommodate the instructional shift. The instructional shift came because of the feedback from the pre-intervention RTOP. The coach and teacher reviewed the observation results and decided on one instructional shift. When
the results from the RTOP revealed that the teacher provided the same instruction for all students, then differentiation became the instructional shift of choice. In cases where the RTOP revealed that the teacher provided students with too much guidance and scaffolding such that students reached solutions quickly and easily, then engaging students in productive struggle became the instructional shift. When the RTOP results showed that the teacher dominated much of the small group conversation, then the instructional shift became the teacher communicating expectations for learning rather than the teacher demonstrating “how to.”

During the instructional coaching sessions, the coach and teacher used *The Common Core Mathematics Companion: The Standards Decoded* (Gojak & Harbin-Miles, 2016) as the guide for understanding and unpacking standards then discussed how the standards would be translated into aligned instruction for students with special needs. For example, for those individuals that decided to differentiate more effectively, they had to dedicate more hours to planning and preparation and be cognizant of their pace of instruction to ensure that they had the opportunity to address students’ specific learning needs. Those individuals that needed to address rigor, they worked with instructional coach over the five-month intervention on evaluating and planning rich mathematical tasks then held students accountable for showing their work and justifying their mathematical thinking. Caroline and Kathleen were highlighted as case studies to bring life to the instructional coaching process, but in the end all participants made significant instructional gains and were open to candid feedback.

**The Effectiveness of Professional Development**

The Professional Development Feedback Form (Ross & Morrison, 2017) was used to determine participants’ confidence in their skills for using the instructional strategies discussed and modeled during the monthly professional development sessions. This form was used
primarily to answer research question three and to capture process evaluation data for sessions two, four, and five. It was completed at the end of each session but did not include participants’ names or any identifiable information to encourage candid, honest feedback to the researcher.

**Cronbach’s alpha.** The eight-item feedback form used in this study was adapted from a 32-item professional development feedback form developed by Ross and Morrison (2017) at Towson, MD: Center for Research and Reform in Education, Johns Hopkins University. Cronbach’s alpha was used to assess the reliability of the form. The Cronbach’s alpha for the 32-item survey demonstrated a high internal consistency with an overall alpha of 0.96. Content validity and face validity were established by two experts in evaluation research. The process of creating the survey involved first establishing the constructs to be measured, measuring changes in participants' knowledge and assessing changes in participants' confidence. A total of 16 items were constructed to assess participants' changes in knowledge for various strategies taught through the program, and 16 were constructed to assess changes in confidence related to those strategies. Once a draft survey was developed, an expert in the content areas was asked to review the survey and provided suggested refinements.

Once adapted with the author’s permission, (see Appendix C) the Cronbach’s alpha for the 8-item survey demonstrated acceptable internal consistency. The December survey yielded an alpha of 0.75, the February survey yielded an alpha of 0.73, and the March survey yielded an alpha of 0.70. This means that the survey produced similar results under consistent conditions. More importantly were the increases in participants’ confidence in using identified instructional strategies. For example, in December there were 10 out of 13 participants who felt “somewhat doubtful” or “neither confident nor doubtful” when asked to rate their confidence to promote students’ higher order thinking. In March when asked to rate their confidence with the same
instructional strategy, only one out of 13 participants felt “neither confident not doubtful” while the remaining 12 participants felt either “confident” or “very confident.” Results of the repeated measures ANOVA revealed a significant difference pre- to post-intervention in teachers’ confidence in promoting students’ higher order thinking $F(2, 24) = 11.05, p < .001$. When asked to rate their ability to stimulate productive class discussion through questioning, 10 participants in December were “very doubtful,” “somewhat doubtful,” or “neither confident nor doubtful.” In March, all 13 participants were either “confident” or “very confident” in their ability to stimulate productive class discussion through questioning. Results of the repeated measures ANOVA revealed a significant difference pre- to post-intervention in teachers’ confidence in promoting students’ higher order thinking $F(2, 24) = 5.72, p = .009$.

Promoting higher order thinking and stimulating productive class discussions were two instructional strategies that the special educators in this study emphasized as being difficult when working with students who struggle with mathematics. However, pre- and post-intervention data support participation in professional development that includes opportunities for teachers to learn effective instructional strategies to increase the potential for teachers to feel confident about using them with students. For two participants, it became their goal to address these two instructional strategies so that students were engaged in rigorous small group instruction and held accountable for sharing and demonstrating their mathematical thinking with their peers in the small group setting.

**Participation**

In conjunction with changes to teachers’ mathematics teaching efficacy, participation rates at each of the five face-to-face professional development sessions were calculated and analyzed as one potential reason for overall increases in teacher efficacy. In chapter four,
fidelity of implementation was described as high participation rates at the professional
development sessions, executing each session as planned, offering follow-up opportunities for
non-attenders to access the professional development materials and topics, completing all
instructional coaching sessions, conducting all pre- and post-intervention classroom observations
using the RTOP, and conducting post-observations conferences to provide feedback.

Overall, the ESETC attendance rate at the five, face-to-face professional development
sessions was 89%. Five of the participants attended all five professional development sessions.
Six participants attended four out of five professional development sessions and two participants
attended three out of five professional development sessions. The two participants who missed
two professional development sessions were from the same school where mandatory staff
meetings prevented them from attending the sessions. For 11 of the 13 participants, the
participation rate was considered high, whereas the two individuals who missed two sessions; the
participation rate was low within the context of this study (Table 5.5). However, one of the
participants who attended only three out of five sessions showed the greatest increase in
mathematics teaching efficacy ($\Delta = 18$), whereas the participant who showed the largest decrease
in mathematics teaching efficacy ($\Delta = 9$) attended all five sessions.

Table 5.5

<table>
<thead>
<tr>
<th>Participant</th>
<th>Participation in PD</th>
<th>Change in MTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>High</td>
<td>11</td>
</tr>
<tr>
<td>P2</td>
<td>High</td>
<td>14</td>
</tr>
<tr>
<td>P3</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>P4</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>P5</td>
<td>High</td>
<td>2</td>
</tr>
<tr>
<td>P6</td>
<td>High</td>
<td>7</td>
</tr>
<tr>
<td>P7</td>
<td>High</td>
<td>-1</td>
</tr>
<tr>
<td>P8</td>
<td>High</td>
<td>3</td>
</tr>
<tr>
<td>P9</td>
<td>Low</td>
<td>18</td>
</tr>
<tr>
<td>P10</td>
<td>High</td>
<td>3</td>
</tr>
<tr>
<td>P11</td>
<td>High</td>
<td>8</td>
</tr>
</tbody>
</table>
A closer look at these data revealed one situation where a teacher with a low attendance rate at professional development sessions increased mathematics teaching efficacy by 18 points whereas a teacher with a high attendance rate decreased mathematics teaching efficacy by nine points. The participant with a low attendance rate was coached one-on-one on a bi-weekly basis and the participant with a high attendance rate was provided professional development only. The one advantage that the participant with low attendance at the face-to-face professional development sessions had, was access to the instructional coach on a regular basis to provide a make-up session for the sessions missed. Instructional coaching participants were then given support to implement new instructional strategies and were provided with feedback on how the instructional strategies were executed with students. The coach also modeled the use of instructional resources while the teacher observed. For example, on one accession the instructional coach modeled the use of Cuisenaire rods when teaching equivalent fractions to students. The teacher observed the instructional coach, tried out the Cuisenaire rods with a different group of students with the coach present, and received feedback about her effectiveness with the rods as a representation of the mathematical ideas.

Leading into the intervention, it was determined by the researcher that for those participants who were unable to attend a professional development session, the option to view the video recording of the session would be available. Although videos may have been a convenient option, participants asked if this researcher could offer “make-up” sessions with individuals or small groups so that participants could have the opportunity to attend in real-time and ask questions specific to their caseloads and students’ IEP goals. Because the researcher was
approved for sabbatical and not working as an administrator during the five month intervention, 
the researcher was always available to the ESETC participants. Make-up sessions proved to be 
an effective approach and one that demonstrated to participants that their professional growth 
was the priority. Make-up sessions also eliminated the need to video record professional 
development sessions. When asked during the post intervention semi-structured interview about 
the most important attributes an instructional coach should possess one participant said, 
“Flexibility! The instructional coach listened to my concerns and gave me support where I 
needed it most. Through the process we worked together to find out what worked best for my 
students” (Participant 12, May, 2018).

In addition, the participant who missed the two professional development sessions 
regarding fractions but was able to meet with the instructional coach during the one-on-one 
coaching sessions had the greatest increase in mathematics teaching efficacy said, 

The most important attributes an instructional coach should possess to help teachers 
become more confident, knowledgeable mathematics instructors are, being open to 
questions and giving feedback. The instructional coach was very good with that. If I was 
struggling with some aspect of my instruction I would ask him during our one-on-one 
sessions and he would always have good suggestions and good resources. I wish I would 
have had the opportunity to attend the two fraction sessions with the other participants 
because that is the area in my instruction that I struggle most with, but I feel strongly that 
going into my instruction next year now having the opportunity to meet with the 
instructional coach one-on-one I now have lots of resources and tools that will help me 
tremendously, especially when moving from one grade level to the next (Participant 9, 
May, 2018).
Responses such as these demonstrated that what participants needed as equally as receiving professional development opportunities, were those moments to go beyond the presented material and ask specific questions related to their practice to more effectively apply new learning to their specific small group instruction with special education students. Additionally, the concern or anxiety about having to miss a session was alleviated because participants knew that the researcher was committed to making sure that no one missed an opportunity to participate or learn new material.

**Implications for Practice**

Despite having 13 participants, this study revealed results that can be replicated by school districts with the responsibility of providing professional development for special education teachers in mathematics. The ESETC yielded positive results from pre- to post-intervention as evident in a statistical significance in the participants’ MTE and sustained MKT for all participants. As a group, instructional coaching participants increased MTE and sustained MKT from pre- to post-intervention, while professional development only participants increased both MTE and MKT from pre- to post-intervention. Teachers who incorporate those teaching practices that address misconceptions, prior knowledge, and effectively represent mathematics content have the potential to yield positive student outcomes. Therefore, students with special needs who struggle to meet grade-level expectations in mathematics require mathematics instruction from special education teachers who effectively translate curriculum standards into aligned instruction (Greer & Meyen, 2009). Further, effective special education teachers incorporate explicit instruction, opportunities for cumulative review, help students decipher the most effective problem-solving strategies based on the context of the problem, and encourage the use of visual representations when solving problems (Gersten et al., 2009). However, with the
expectation to now deliver standards-based instruction to all students, some special education
teachers struggle to meet the needs of diverse learners who in some cases are performing more
than two years below grade level in mathematics (Watkins, 2016). Despite the challenge to
translate curriculum standards into aligned instruction for students with special needs in
mathematics, researchers have determined that individuals with a strong sense of teacher efficacy
believe they can have a positive impact on student achievement (Greer & Meyen, 2009; Zambo
& Zambo, 2008). Knowledge about how changes in MTE and MKT resulting from professional
development and instructional coaching, opportunities to engage with colleagues, and feedback
could provide stakeholders with important information to transform professional development
practices for those teachers who provide direct instructional services to students with special
needs in mathematics. This section will address the implications for those who provide in-
service professional learning opportunities for special education teachers.

**Instructional Coaching Matters**

Maintaining teachers in critical instructional positions such as special education requires
on-going, authentic support and high-quality feedback (Rock, Gregg, Gable, & Zigmond, 2009). Instructional coaching provides teachers with opportunities for “on the job” professional learning related to everyday teaching and learning experiences (Johnson, 2016). An instructional coach serves as a continuous resource for teachers as they plan and prepare instruction, reflect on student learning, and seek new or more effective instructional strategies to meet the needs of students. Vygotsky (1978) explained the importance of social interaction for psychological development through the concept of the Zone of Proximal Development (ZPD). According to Vygotsky (1978) ZPD is “the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through
problem-solving under adult guidance or in collaboration with more capable peers” (p. 86). Individuals who work in collaboration with one another to share ideas, negotiate positions, and collaborate with peers at varying levels can construct knowledge and maximize their full potential (Bednar, Cunningham, Duffy, & Perry, 1992; Cobb, 1994; Vygotsky, 1978). Further, researchers contend that professional development followed by instructional coaching and feedback increases the understanding and implementation of newly learned skills by 90% (Knight, 2006; Showers & Joyce, 2002).

Participant 11 supports the findings of Knight (2006) and Joyce and Showers (2002) that professional development combined with instructional coaching have positive effects on teachers’ performance. During the post-intervention interview Participant 11 said,

I found the instructional coaching and observations to be very beneficial to me. The instructional coach gave me good insight into my students' learning styles and how to modify instruction to meet my students' needs. Even though my students are all about two years below grade level, they still have unique individual needs. I don't feel math is my strength, so I think it was extremely helpful to have the informal, non-evaluative feedback. I knew I could make mistakes and learn from them. I did not feel stressed when the coach came to meet with me because I knew he was there to provide support (May, 2018).

Participant 9 was another example of how professional development and continuous instructional coaching supported changes in MTE and MKT. During the post-intervention interview Participant 9 said,

He (the instructional coach) referred me a lot to the Common Core Companion resource when we met to discuss the planning process. He shared a planning template that helped
me walk through the important components of a lesson. Although using the planning template is time consuming, it has helped me develop more effective lessons. Also, one of the things that I took away from his first observation was the importance of giving students more time to talk and to give them more ownership of the discussion. I feel strongly that going into my instruction next year now having lots of resources and tools will help me tremendously, especially when moving from one grade level to the next (May, 2018).

The experiences discussed by Participants 9 and 11 support researchers’ contentions that individuals who work in collaboration with one another can construct knowledge and maximize their full potential (Bednar, Cunningham, Duffy, & Perry, 1992; Cobb, 1994; Vygotsky, 1978). These two participants were also an example of how teachers can become empowered to incorporate research-based instructional strategies into small group instruction as demonstrated by post-intervention RTOP results. For example, Participant 9 showed evidence of having students make predictions, estimations, hypotheses, and connections with real-world phenomena during the post-intervention observation, whereas the pre-intervention observation included none of these components. According to the MTEBI, Participant 11 wondered if she had the necessary skills to teach mathematics and was uncertain whether she taught mathematics effectively. Post-intervention MTEBI results revealed that Participant 11 was confident in her skills and ability to teach mathematics effectively. Responses like those shared by Participants’ 9 and 11 also demonstrate the need for increased professional development opportunities for in-service special education teachers and more opportunities for mathematics methodology coursework for pre-service teachers. The hope would be that through greater capacity and confidence in delivering mathematics instruction to students with special needs, teachers would
be more willing to embrace changes in instructional practice to potentially impact gains in student achievement.

**Hiring Effective Instructional Coaches**

Equipped with the data from this study and extant research to support the impact that instructional coaches have on teachers’ sense of efficacy, knowledge of mathematics content, and classroom instruction, hiring effective coaches may present a challenge for districts, schools, and administrators. One challenge is finding coaches who are knowledgeable and credible in the minds of all stakeholders (Johnson, 2016; Neufeld & Roper, 2003). To successfully impact teaching and learning, instructional coaches should possess certain professional qualities, leadership skills, and be excellent teachers (Johnson, 2016; Knight, 2006). Effective coaches assist teachers with lesson preparation, model lessons, provide teachers with feedback, and should possess deep pedagogical content knowledge (Kinkead, 2007; Neufeld & Roper, 2003). The instructional coach in this study was a veteran elementary teacher, former elementary mathematics specialist, and current elementary school principal with 10 years of instructional leadership experience. Participant 3 reiterated Kinkead (2007) and Neufeld and Roper’s (2003) findings when she stated,

The most important attributes an instructional coach should possess to help teachers become more confident, knowledgeable mathematics instructors are approachability, understanding his or her audience, evaluating without judgement, and providing feedback that is helpful. Instructional coaches should not make teachers feel horrible and should reassure teachers that it is okay to make mistakes. Also, effective instructional coaches should have strong knowledge of mathematics content standards and guide teachers in the right direction (May, 2018).
Participant 3 emphasized the point that coaches should be respectful of teachers and avoid making judgements such that a non-threatening, non-judgmental relationship can be built between coach and teacher. The instructional coach in this study was cognizant of the importance of trust, maintained confidentiality throughout the intervention, and did not talk to other teachers or administrators about the coach-teacher relationship. Bean and DeFord (2012) reiterated the importance of trust building and warned against coaches being viewed as one who reports back to administration. Instructional coaches who lack trusting relationships with teachers are not seen as partners in teaching and learning (Bean & DeFord, 2012). Participant 12 mentioned the importance of trust and partnerships when she said, “The instructional coach listened to my concerns and gave me support where I needed it most. Through the process we worked together to find out what worked best for my students” (May, 2018). The opinions expressed by Participant 3 and Participant 12 demonstrate the importance of identifying and selecting instructional coaches who foster positive relationships with teachers and respect teachers’ ability to make decisions that are in the best interest of students. Further, instructional coaches have the potential to impact the way teachers prepare for and deliver instruction but more importantly, are positioned for fostering a coach-teacher relationship built upon shared responsibility and autonomy (Greenleaf, 1977). Despite not being an immediate fix, districts can employ instructional coaches to improve instruction one teacher, one classroom, and one school at a time, however this approach would require patience on the part of districts to develop effective instructional coaches.

**Limitations**

This study revealed several limitations including sample size, intervention length, having only volunteer participants, and a lack of student achievement data. Other limitations include
RTOP observations conducted by the individual who delivered the professional development sessions and scored the observation protocol created a lack of interrater reliability. Also, this is a study of self-reported data, creating the potential for bias. Having only 13 participants was manageable for the researcher who was also the instructional coach in this study; however, the small sample size may have impacted the generalizability of the research findings. A larger sample size could have revealed more information about the impact of mathematics instructional coaching and mathematics professional development on special education teachers’ mathematics teaching efficacy.

The length of the intervention may have impacted changes in mathematics teaching efficacy and mathematics knowledge for teaching. In chapter two it was shared that professional development delivered over the course of at least six months and includes no less than 14 hours of direct teacher learning is positively correlated to increased student achievement in mathematics, however correlational evidence recommends 20 hours or more (Yoon, Duncan, Lee, Scarloss, and Shapley (2007). With 15 hours of face-to-face professional development for the six participants who did not receive instructional coaching, it remains to be seen whether the time allotted for professional development was enough to make a significant impact on MTE.

As stated earlier in chapter five, the data from the MTEBI revealed that the participants receiving only professional development did not demonstrate a significant difference between pre-intervention MTE and post-intervention MTE ($p = 0.91$). The limitation of receiving professional development only was the lack of opportunities to receive feedback from the instructional coach about the implementation of those strategies learned during professional development. Further, it remains to be seen whether the time allotted for professional development and instructional coaching were enough to make a significant impact on
participants MKT because the seven participants that received both professional development and instructional coaching did not demonstrate a significant difference between pre-intervention and post-intervention on the DTAMS WNC scores ($p = 0.11$).

The research study included only volunteer participants who may be more likely to participate in professional learning opportunities regarding mathematics instruction or teacher efficacy. Also, some of the participants knew each other prior to participation in the ESETC which may have increased their interest in taking part in the research study. Further, the researcher was also a principal in the district and knew some of the participants prior to the intervention which may have impacted whether individuals decided to participate.

Finally, as the researcher, instructional coach, and observer in this study, interrater reliability on the RTOP must be considered. Being the only rater on the RTOP and having a vested interest in the success of each participant, the researcher may have been biased to give higher scores. However, quantitative data from the Professional Development Feedback Form, the MTEBI, and qualitative data from the semi-structured interviews supported increased mathematics teaching efficacy and teachers’ desire to make instructional shifts.

**Conclusion**

This research study examined 13 in-service special education teachers’ experiences as members of the ESETC. Six participants received face-to-face mathematics professional development only, while seven participants received face-to-face mathematics professional development and one-on-one instructional coaching. Participants experienced a statistical difference between pre- and post-intervention mathematics teaching efficacy and mathematics knowledge for teaching. Qualitative data from semi-structured interviews suggest that participation in the ESETC supported mathematics teaching efficacy and mathematics
knowledge for teaching as well. Further, participants who experienced both professional
development and instructional coaching experienced the greatest gains in mathematics teaching
efficacy but did not experience the greatest gains in mathematics knowledge for teaching. Using
instructional coaching in conjunction with professional development encouraged participants to
try new instructional strategies, introduce rich mathematical tasks to students, and raise the level
of expectations for students with special needs.

Traditionally, the professional learning of in-service special education teachers is
provided by schools during general education team meetings on a weekly or bi-weekly basis with
little acknowledgement of the complexities involved in translating curriculum into aligned
instruction for students with special needs. As the literature and this research study indicate,
special education teachers desire more opportunities for exposure to mathematics methodology
and to the support of an instructional coach who not only understands mathematics, but also
understands those instructional strategies that are effective for students with special needs. The
ESETC provided participants with the opportunity to develop a greater understanding of
mathematics standards, investigate the appropriate resources to address the standards, and to
collaborate about planning and teaching with colleagues.

Further research is needed to determine the most effective approach for providing
professional development to in-service special education teachers in mathematics. Currently,
special education teachers balance compliance, paperwork, IEP meetings, parent communication,
collaboration with general education teachers, instruction, and assessment; leaving little time for
professional growth. Developing strategic, meaningful, and efficient professional development
opportunities that include on-going feedback will help special education teachers develop the
confidence and knowledge to more effectively close the gap in achievement for students with special needs.
References

http://reportcard.msde.maryland.gov/


it special? Journal of Teacher Education, 59(5), 389-407. doi:
10.1177/0022487108324554

Retrieved from http://books.google.co.uk/books?id=Cj97DKKRE7AC


tp.udel.edu/bitstream/handle/19716/2446/opp%20to%20learn.pdf?sequence=1

from: http://www.aaidjournals.org/loi/ajmr


Desimone, L. M., & Pak, K. (2017). Instructional coaching as high-quality professional

professional development on teachers’ instruction: Results from a three-year longitudinal
study. *Educational evaluation and policy analysis, 24*(2), 81-112. doi:
10.3102%2F01623737024002081

to professional development participation and changes in instruction: A longitudinal
study of elementary students and teachers in title I schools. *Teachers College
Record, 115*(5), 1-46. Retrieved from

Researchers Examine How a Team of Middle School Teachers Use Common Planning
Time to Cultivate Professional Learning Opportunities. *Middle School Journal, 45*(1),
12-17. doi: 10.1080/00940771.2013.11461877

work. *Bloomington, IN: Solution Tree.*

Innovations in cognitively guided instruction.* Portsmouth, NH. Heinemann.


doi: 10.1002/9781118660584.ese1218

Learning Disabilities or Difficulty Learning Mathematics: A Guide for Teachers. Center


Joyce, B. R., & Showers, B. (2002). Students achievement through staff development. White
Plains, NY: Longman.

Alliance for Excellent Education. Retrieved from
http://www.all4ed.org/publication_material/reports/adolescents_and_literacy.

Mathematics, 21(1), 18-25.

Strengthening the Teaching Profession.

Teachers’ content knowledge and pedagogical content knowledge: The role of structural
differences in teacher education. Journal of Teacher Education, 64(1), 90-106. doi:
10.1177/0022487112460398


Education Quarterly, 35(1), 159-168. Retrieved from
http://www.jstor.org/stable/23479036

### Appendix A

#### Logic Model

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Activities and Participants</th>
<th>Outputs</th>
<th>Short-term Outcomes</th>
<th>Medium-term Outcomes</th>
<th>Long-term Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Partnership between researcher and district leaders</td>
<td>• 13 elementary special education teachers</td>
<td>• 13 elementary special education teachers with the capacity to write standards-based IEP goals</td>
<td>• Increase in perceived mathematics teaching efficacy in PD participants</td>
<td>• Increased student achievement in mathematics for students with special needs</td>
<td>• Narrowing or closing of the achievement gap for students with special needs in mathematics</td>
</tr>
<tr>
<td>• Meeting space with access to technology</td>
<td>• Five three-hour PD sessions over the course of three months</td>
<td>• 13 elementary special education teachers with the capacity to create lesson plans that translate curriculum into aligned instruction</td>
<td>• Increase in knowledge of developing standards-based IEP goals in mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Chromebooks</td>
<td>• Prioritize and “unpack” priority standards</td>
<td>• Bi-weekly one-on-one instructional coaching</td>
<td>• Increase in participants’ mathematics knowledge for teaching</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Increase in perceived mathematics teaching efficacy in PD participants
- Increase in knowledge of developing standards-based IEP goals in mathematics
- Narrowing or closing of the achievement gap for students with special needs in mathematics

• Increased student achievement in mathematics for students with special needs
• Increased student achievement in mathematics for students with special needs
• Narrowing or closing of the achievement gap for students with special needs in mathematics

- Increase in participants’ mathematics knowledge for teaching
- Increase in participants’ mathematics knowledge for teaching
- Increase in participants’ mathematics knowledge for teaching
Appendix B

Mathematics Teaching Efficacy Beliefs Instrument

Directions: Select the response that best describes your level of agreement with each statement.

<table>
<thead>
<tr>
<th>MTOE subscale</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>4. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>8. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>9. The inadequacy of a student’s mathematics background can be overcome by good teaching.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>10. The low mathematics achievement of some students cannot generally be blamed on their teachers.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>12. I understand mathematics concepts well enough to be effective in teaching mathematics.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>13. Increased effort in mathematics teaching produces little change in some students’ mathematics achievement.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>14. The teacher is generally responsible for the achievement of students in mathematics.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PMTE subscale</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. I will continually find better</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>3. Even if I try very hard, I will not teach mathematics as well as I will most subjects.*</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
</tbody>
</table>
4. I know the steps necessary to teach mathematics concepts effectively.  
   A B C D E

5. I am not very effective in monitoring mathematics activities.*  
   A B C D E

6. I generally teach mathematics ineffectively.*  
   A B C D E

11. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.  
   A B C D E

15. Students’ achievement in mathematics is directly related to their teacher’s effectiveness in mathematics teaching.  
   A B C D E

16. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child’s teacher.  
   A B C D E

17. I find it more difficult to use manipulatives to explain to students why mathematics works.*  
   A B C D E

18. I am typically able to answer students’ mathematics questions.  
   A B C D E

19. I wonder if I have the necessary skills to teach mathematics.*  
   A B C D E

20. Given a choice, I would not invite the principal to evaluate my mathematics teaching.*  
   A B C D E

21. When a student has difficulty understanding a mathematics concept, I am usually at a loss to how to help the student understand it better.*  
   A B C D E

*Negatively worded item that required reverse coding.

Note. Developed by Enochs, Smith, & Huinker (2000).
**Appendix C**

**Professional Development Feedback Form**

Based upon our work in today’s professional development session, indicate your confidence in your skills for using each of the following instructional strategies.

<table>
<thead>
<tr>
<th>Ability</th>
<th>Very doubtful</th>
<th>Somewhat doubtful</th>
<th>Neither confident nor doubtful</th>
<th>Confident</th>
<th>Very confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to plan and design effective instruction.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to make learning engaging.</td>
<td>Very doubtful</td>
<td>Somewhat doubtful</td>
<td>Neither confident nor doubtful</td>
<td>Confident</td>
<td>Very confident</td>
</tr>
<tr>
<td>Ability to create a positive learning environment.</td>
<td>Very doubtful</td>
<td>Somewhat doubtful</td>
<td>Neither confident nor doubtful</td>
<td>Confident</td>
<td>Very confident</td>
</tr>
<tr>
<td>Promote students’ higher order thinking.</td>
<td>Very doubtful</td>
<td>Somewhat doubtful</td>
<td>Neither confident nor doubtful</td>
<td>Confident</td>
<td>Very confident</td>
</tr>
<tr>
<td>Helping students to become more self-directed learners.</td>
<td>Very doubtful</td>
<td>Somewhat doubtful</td>
<td>Neither confident nor doubtful</td>
<td>Confident</td>
<td>Very confident</td>
</tr>
<tr>
<td>Offering feedback to help students improve.</td>
<td>Very doubtful</td>
<td>Somewhat doubtful</td>
<td>Neither confident nor doubtful</td>
<td>Confident</td>
<td>Very confident</td>
</tr>
<tr>
<td>Ability present material in an engaging way</td>
<td>Very doubtful</td>
<td>Somewhat doubtful</td>
<td>Neither confident nor doubtful</td>
<td>Confident</td>
<td>Very confident</td>
</tr>
<tr>
<td>Ability to stimulate productive class discussion through questioning</td>
<td>Very doubtful</td>
<td>Somewhat doubtful</td>
<td>Neither confident nor doubtful</td>
<td>Confident</td>
<td>Very confident</td>
</tr>
</tbody>
</table>

*Note.* Developed by Ross & Morrison (2017).
Appendix D

Semi-Structured Mathematics Interview

Script

1. Say, “I appreciate your time today and thank you for agreeing to participate in this interview. I also understand how busy you are as a special education teacher and value the time and effort you are sharing with me today. I hope that you feel comfortable being candid with me today because my goal is to understand your experiences teaching mathematics as a member of the ESETC.”

2. Share the consent form with the participant and ask they read it carefully before signing. Ask the participant if he/she has any questions about the consent form. Begin the interview after the participant has signed the consent form.

3. Say, “I encourage you to be candid in your responses and share as much or as little as you would like. At any point during the interview you may ask questions, share concerns, or stop the interview if you so desire. With your permission, I will be recording the interview using the voice recorder on my computer while making visual record of our conversation. My computer is password protected and the data will only be shared with my advisor, and dissertation committee. I will not be using your name or any other personal identifying information in this study. The data will be reported in chapter five of my dissertation.

4. Say, “Do you have any questions?”

5. Say, I will begin by gathering some background information about you and your special education caseload.”
Background Information

1. What grade levels are represented on your current caseload?

2. Based on your current students’ IEPs, how many goals are specific to mathematics problem-solving? Mathematics calculation?

3. What domain of the CCSS-M is most represented in your students’ IEP goals?

Interview Questions

The following questions are adapted from the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) (Enochs, Smith, & Huinker, 2000).

4. One statement on the MTEBI says, when a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher. What does this statement look like for you when carried out in your mathematics instruction?

5. One statement on the MTEBI says, if students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching. Describe what ineffective teaching means to you.

6. One statement on the MTEBI says, the inadequacy of a student’s mathematics background can be overcome by good teaching. Define “good teaching.”

The following questions are adapted from The Common Core Mathematics Companion: The Standards Decoded, Grades 3-5 (Gojak & Harbin-Miles, 2013).

7. Can you please provide one common misconception that students demonstrate with fractions and then discuss your approach to addressing this conception?

8. How does understanding the meaning of multiplication and division of whole numbers relate to understanding the meaning of multiplication and division of fractions? How can this relationship help build conceptual understanding when multiplying and dividing fractions and mixed numbers?

9. How does the use of problem situations help students to develop a conceptual understanding of multiplication and division?
10. Talk about strategies that students can use to become fluent with facts using understanding rather than rote memorization.

11. Discuss the concrete models students can use to develop conceptual understanding of $3 \times 6$ and $15 \div 5$.

The following questions were adapted from the Reformed Teaching Observation Protocol (RTOP) (Piburn & Sawada, 2000).

12. Discuss a lesson where students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena. Or in other words, in what ways were students encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence?

13. Discuss a lesson that promoted strongly coherent conceptual understanding. What is the evidence to support your answer?

14. What aspect(s) of the instructional coaching experience were most beneficial to you?

15. What are the most important attributes an instructional coach should possess to help teachers increase mathematics teaching efficacy and mathematical knowledge for teaching?

Closing

Say, “Thank you again for answering my interview questions today. I enjoyed our time together and appreciate your thoughtful responses. Have a wonderful rest of your day and school year.”
Appendix E

Reformed Teaching Observation Protocol (RTOP)

Background Information

Teacher pseudonym_______________ Years of teaching________
Grade level________ Date____________
Start time________ End time__________

Contextual Information

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

Lesson Design and Implementation

Likert-type rating scale from zero to four, with zero being “never occurred” to four being “very descriptive.”

1. The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein. Score_____

2. The lesson was designed to engage students as members of a learning community. Score_____

3. In this lesson, student exploration preceded formal presentation. Score_____
4. This lesson encouraged students to seek and value alternative modes of investigation or of problem solving. Score_____

5. The focus and direction of the lesson was often determined by ideas originating with students. Score_____

Content

Propositional knowledge

6. The lesson involved fundamental concepts of the subject. Score_____

7. The lesson promoted strongly coherent conceptual understanding. Score_____

8. The teacher had a solid grasp of the subject matter content inherent in the lesson. Score_____

9. Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so. Score_____

10. Connections with other content disciplines and/or real world phenomena were explored and valued. Score_____

Procedural knowledge

11. Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena. Score_____

12. Students made predictions, estimations and/or hypotheses and devised means for testing them. Score_____

195
13. Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures. Score_____

14. Students were reflective about their learning. Score_____

15. Intellectual rigor, constructive criticism, and the challenging of ideas were valued. Score_____

Classroom Culture

Communicative interactions

16. Students were involved in the communication of their ideas to others using a variety of means and media. Score_____

17. The teacher's questions triggered divergent modes of thinking. Score_____

18. There was a high proportion of student talk and a significant amount of it occurred between and among students. Score_____

19. Student questions and comments often determined the focus and direction of classroom discourse. Score_____

20. There was a climate of respect for what others had to say. Score_____

Student/teacher relationships

21. Active participation of students was encouraged and valued. Score_____

196
22. Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence. Score_____

23. In general, the teacher was patient with students. Score_____

24. The teacher acted as a resource person, working to support and enhance student investigations. Score_____

25. The metaphor "teacher as listener" was very characteristic of this classroom. Score_____

Adapted from the Reformed Teaching Observation Protocol (RTOP) (Piburn & Sawada, 2000).
Appendix F
Diagnostic Teaching Assessment in Mathematics and Science

Whole Number & Computation Assessment—Version 4.3
Do Not Use or Duplicate without Permission

Date __________ Start Time __________ Finish Time __________

Diagnostic Teacher Assessments in Mathematics and Science
Elementary Mathematics

<table>
<thead>
<tr>
<th>Please provide the following information about yourself:</th>
<th>Gender: M ☐ F ☐</th>
<th>Last 4 digits of Soc. Sec. # __________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of teaching experience: _________________________</td>
<td>Grade level(s) currently teaching: (Check all that apply)</td>
<td></td>
</tr>
<tr>
<td>(0 if preservice teacher)</td>
<td>K ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐</td>
<td></td>
</tr>
<tr>
<td>Number of college math courses: ☐ 0-3 ☐ 4-6 ☐ 7-9 ☐ 10-12 ☐ &gt;12 ☐</td>
<td>Teaching certificate grade level(s): (Check all that apply)</td>
<td></td>
</tr>
<tr>
<td>☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>The YEAR you received your most recent teaching degree or Rank: __________</td>
<td>Teaching certificate content area(s): (Check all that apply)</td>
<td></td>
</tr>
<tr>
<td>☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>Elem. ☐</td>
<td>M.S. ☐</td>
<td>H.S. ☐</td>
</tr>
</tbody>
</table>

Directions for completing items:

Please record data and starting and finishing times in the spaces in the upper right-hand corner of this page. It is very important to fill out the demographic information above, especially the last 4 digits of your SSN, as test results will be reported using that as your ID.

Please answer all questions as completely as possible. Show all work in responding to items and briefly explain your thinking on all items.

Let the test facilitator know when you are finished. Thank you very much for your time.

<table>
<thead>
<tr>
<th>#</th>
<th>Item</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Which of the following is expanded notation for the number 207,035?</td>
<td>207,000 + 35</td>
</tr>
<tr>
<td></td>
<td>a. 207,000 + 35</td>
<td>b. 207 x 1,000 + 35 x 1</td>
</tr>
<tr>
<td></td>
<td>c. 20 x 10,000 + 70 x 100 + 35 x 1</td>
<td>d. 2 x 100,000 + 3 x 10,000 + 7 x 1,000 + 5 x 10 + 5 x 1</td>
</tr>
<tr>
<td>2</td>
<td>Which of the following numbers, when rounded to the nearest thousand, becomes 21,000?</td>
<td>21,523</td>
</tr>
<tr>
<td></td>
<td>a. 21,523</td>
<td>b. 21,379</td>
</tr>
<tr>
<td>3</td>
<td>The distributive property holds for</td>
<td>a. addition over multiplication</td>
</tr>
<tr>
<td></td>
<td>b. multiplication over addition</td>
<td>c. addition over subtraction</td>
</tr>
<tr>
<td></td>
<td>d. multiplication over subtraction</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Solve: 36 ÷ (9 + 3) =</td>
<td>[ ]</td>
</tr>
<tr>
<td></td>
<td>a. 3</td>
<td>b. -3</td>
</tr>
<tr>
<td>5</td>
<td>Which one of the following statements is true about all factors of 12?</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>a. They are odd numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. They are divisible by 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. They are divisors of 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. They are composite numbers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6</th>
<th>Which means the same as 4 ten thousands, 40 hundreds, 400 tens, and 4,000 ones?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 44,400</td>
<td></td>
</tr>
<tr>
<td>b. 48,000</td>
<td></td>
</tr>
<tr>
<td>c. 44,444</td>
<td></td>
</tr>
<tr>
<td>d. 52,000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7</th>
<th>What numbers do A, B, and C probably represent on the number line below?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. A = 105, B = 175, C = 625</td>
<td></td>
</tr>
<tr>
<td>b. A = 40, B = 300, C = 640</td>
<td></td>
</tr>
<tr>
<td>c. A = 220, B = 310, C = 600</td>
<td></td>
</tr>
<tr>
<td>d. A = 220, B = 300, C = 359</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8</th>
<th>Which of the following shows the meaning of $2 \times 3$?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. $\underline{00} \times \underline{000}$</td>
<td></td>
</tr>
<tr>
<td>b. $\overset{\circ\circ}{\circ\circ}$</td>
<td></td>
</tr>
<tr>
<td>c. $2 \times 3 =$</td>
<td></td>
</tr>
<tr>
<td>d. $\overset{\circ\circ\circ}{\circ\circ\circ}$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9</th>
<th>If a number N has an odd number of factors, then N can only be</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. a prime number</td>
<td></td>
</tr>
<tr>
<td>b. an odd number</td>
<td></td>
</tr>
<tr>
<td>c. an even number</td>
<td></td>
</tr>
<tr>
<td>d. a square number</td>
<td></td>
</tr>
</tbody>
</table>
10 What is the sum of the prime factors of 315?
   a. 18   b. 15   c. 21   d. 20

11 Francis James, a math teacher, teaches in a special school. The school board pays Francis $1 dollar for each minute of teaching. Francis teaches (with no breaks) from 8 am until 4 pm each day, Monday through Friday. Francis teaches 180 days each year.
   a. When will Francis earn the one-million dollar? Give your answer to the nearest week, such as 4 years and 12 weeks. (Consider a week to be 5 days of teaching.)
   b. Explain your reasoning

12 Each of the letters in the following addition problem stands for a unique number 0-9. Find the value of each letter and justify your answers.
   \[
   \begin{array}{c}
   S O \\
   + S O \\
   \hline
   T O O
   \end{array}
   \]

13 I started thinking about the number of sandwiches I could make with individual ingredients. A loaf of bread contains twenty slices. Each 16-ounce jar of peanut butter will make 13 sandwiches, and each 43-ounce jar of jelly will make 60 sandwiches.
   If I were to start with full loaves of bread and new jars of peanut butter and jelly, how many PB&J sandwiches would I have to make before emptying a bread bag, a jar of jelly, and a jar of peanut butter at the same time?
<table>
<thead>
<tr>
<th></th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>When three numbers are multiplied their product is -108. When they are added their sum is 23. What are the three numbers?</td>
</tr>
<tr>
<td>15</td>
<td>Justify that the difference of an even number and an even number is an even number.</td>
</tr>
</tbody>
</table>
| 16 | A student uses the counting strategy 'counting down' to solve 16 - ___ = 10. She explains, 'I start at 16 and count down to 10. That's 16, 15, 14, 13, 12, 11, 10.' (Each time she says a number she raises another finger.) 'That's 7 fingers, so the answer is 7.'
   | a. How would you help the student understand her misconception?          |
   | b. How would you help the student understand the correct procedure? Use a drawing or diagram in your explanation. |
### 17. One student estimates \( \times \) by first rounding \( \times \) and \( \times \) to \( \times \).

Explain how you would help the student understand two other methods of estimation.

### 18. A student during your mathematics lesson used the following steps to solve the multiplication problem \( \times \). Mathematically speaking, why did her method work? Explain.

```
  4 5
+ 9 0
---
 3 6 0
+ 7 2 0
---
 720 + 180 + 45 = 945
```
<table>
<thead>
<tr>
<th>19</th>
<th>Consider the expression $3 \times -4$. Explain how you would help students understand this expression by using two real world applications of negative integers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>A student is looking for all of the factors of 70. She says to you, “My mom said that after I try 1, 2, 3, 4, 5, 6, 7 and 8, I don’t need to test any numbers larger than 8.” Is her mom correct? Explain why or why not.</td>
</tr>
</tbody>
</table>
Biographical Information

Allie S. Watkins IV is an elementary school principal in Frederick County, MD. With a passion and commitment for urban school leadership, Allie has built a career on serving Title I communities in a variety of capacities. From his time as a classroom teacher, mathematics specialist, or administrator, Allie has found a home working with students from diverse backgrounds. Providing leadership to several schools over the years has resulted in high attendance percentages, quality instruction, increased opportunities for family involvement, and recognition as a Maryland Blue Ribbon School. Despite success leading some great schools, the one thing that motivates Allie to get out of bed each morning are the enthusiastic learners and outstanding teachers that fill the classrooms, hallways, and cafeteria every day.

When not at work serving Title I communities, Allie spends time at home with his wife, Kathleen and his two children, Caroline and Stiles. Together, he and his family enjoy traveling, spending time with friends, and walking their dog Garth. Allie plans to continue his work supporting special education teachers in the area of mathematics to develop pedagogical content knowledge and confidence to deliver mathematics instruction to students with special needs.