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Teacher Self-Efficacy, Instructional Practices, and Student Achievement in Mathematics: A Correlational Study

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Abstract

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This mixed-methods research examined teacher self-efficacy in mathematics and the use of specific mathematical instructional practices in Grades 3-5 classrooms. The purpose was to examine the relationships among teacher self-efficacy of teaching mathematics, the use of specific mathematical instructional practices, and student achievement as measured by the North Carolina end-of-grade test. According to the National Mathematics Advisory Panel (2008), differences in students' mathematical achievement are credited to differences in teacher characteristics including their self-efficacy in teaching and use of specific instructional practices. The study sought to add to the research behind that finding.

Correlational relationships among the variables were studied. The outcome variable was student achievement as measured by the end-of-grade mathematics test. The two outcomes variables were teacher self-efficacy of teaching mathematics as measured by the Self-Efficacy for Teaching Mathematics Instrument and the use of mathematical instructional practices as measured by the Teachers' Instructional Practices Survey. Descriptive analysis, Pearson correlations, and multiple regression analysis were used to analyze the quantitative data. Qualitative data were gathered through teacher interviews. The notes from these interviews were reviewed for themes and then compared to the quantitative data.

This study yielded strong to moderate correlations between teacher self-efficacy and the six measured mathematical instructional practices. Upon further analysis, the study found strong correlations between teacher self-efficacy for pedagogy in mathematics and each of the following mathematical instructional practices: cooperative learning; communication and study skills; problem-based learning; and manipulatives, models, and multiple representations. However, correlations between the frequency of the measured mathematical instructional practices and study achievement were not established. Weak correlations were found between student achievement and teacher self-efficacy in mathematics. Additionally, the study found that teacher self-efficacy was statistically significant to the prediction of student achievement as defined by student scale scores on the end-of-grade mathematics assessment.

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Chapter 1: Introduction

The United States government, under the direction of Secretary of Education Terrell Bell, formed the National Commission on Excellence in Education (NCEE) in 1981 (NCEE, 1983). The objectives for this commission were clear. The Commission was to assess the quality of teaching, identify educational programs that saw noteworthy student success, and define the problems that America's schools face that need to be overcome in order to attain excellence (Hunt, Raisch, Carper, & Lasley, 2010). The commission submitted a report (*A Nation at Risk*) to the U.S. Education Department 2 years later.

In 1983, *A Nation at Risk* promoted the belief that in order to improve student learning, a teacher must be an integral component of the process (NCEE, 1983). Several studies on student achievement and teacher effectiveness have revealed that teachers have a direct impact on student learning (Darling-Hammond, 2007; Goldhaber, 2002; Hanushek, 2010; Rivkin, Hanushek, & Kain, 1998). Rowan, Chiang, and Miller (1997) explained that

> teachers' effects on students' achievement can be attributed to three general classes of variables: teaching ability, defined in terms of teachers' knowledge of subject matter and teaching strategies; teachers' motivation, usually defined by such constructs as teachers' efficacy, locus of control and outcome expectancies; and the school and classroom situations in which teachers work. (p. 256)

Many in the educational field believe that an effective teacher can positively impact student growth and achievement (Darling-Hammond & Youngs, 2002; Goldhaber, 2002; Williams, 2009). According to Helfeldt, Capraro, Capraro, Foster, and Carter (2009), students who are educated by ineffective teachers 3 years in a row attain fewer gains than students who have highly effective teachers for 3 years in a row. Teachers play a key role in delivering classroom instruction. Research shows that even when a school is labeled relatively ineffective, an individual teacher has a powerful influence on a student's learning (Marzano, Pickering, & Pollock, 2001).

In the 1966 landmark study *Equality of Educational Opportunity* ("the Coleman Report"), social psychologist James Coleman cited socioeconomic background as the most accurate predictor of student success (Coleman et al., 1966). He also noted that teacher quality was the most important factor in student success that was controllable by the school (Coleman et al., 1966). Teacher quality is considered multidimensional and includes two separate points: good teaching (meaning that the teacher meets the expectancy of the role, such as degree, using age-appropriate approaches, and maintaining the standards of the profession) and effective or successful teaching (meaning the results of said teacher's actions on student learning is positive; Blanton, Sindelar, & Correa, 2006).

The National Commission on Teaching and America's Future (1996) reported that teachers make the essential difference in what students learn. Darling-Hammond and Youngs (2002) researched teacher quality and found that high-quality teachers led to enhanced student success. High-quality teachers were defined as those who "knew their discipline, who engaged students in tasks that facilitated knowledge transfer and understanding, who viewed themselves as continuous learners, and who had a commitment to school-wide effectiveness and improvement" (Darling-Hammond & Youngs, 2002, p. 15).

High teacher effectiveness has a direct impact on student learning (Darling-Hammond, 2007; Goldhaber, 2002). Studies have shown correlations between teacher self-efficacy and increased student performance (Darling-Hammond & Youngs, 2002; Goldhaber, 2002; Williams, 2009). Bandura (1977) stated that self-efficacy can be a strong predictor of related performance. A sense of low self-efficacy may generate a lack of desire to continue to try an activity after a failure is experienced (Bandura, 1977). Strong teacher self-efficacy can have effects on student performance (Bandura, 1997; Cantrell, Young, & Moore, 2003; Tschannen-Moran & Hoy, 2001). Gordon, Kane, and Staiger (2006) stated that "without the right people standing in front of the classroom, school reform is a futile exercise" (p. 5).

Problem Statement

The 2001 legislation No Child Left Behind (NCLB, 2002) called for more teacher accountability and for a "highly qualified" teacher in every classroom across the nation. The federal government continued this push with the recent *Race to the Top* (RttT) grant that President Obama's administration initiated (United States Department of Education, 2009). The American Recovery and Reinvestment Act (ARRA) provided $4.35 billion for the RttT grant program which rewarded states for creating conditions for educational achievement, reformation, and innovation (United States Department of Education, 2009).

According to the U.S. Department of Education (2000), four critical reasons our students must succeed in mathematics and science are (a) the demands of our changing economy and workforce, (b) our government need for a competent citizenry, (c) the link between mathematics and science to our nation's security, and (d) the deeper value of mathematical and scientific knowledge in the preservation of our history.

During most of the 20th century, the United States possessed peerless math prowess–not just measured by the depth and number of mathematical specialists

> who practiced here but also by the scale and quality of its engineering, science, and financial leadership, and even by the extent of mathematics education in its broad population. But without substantial and sustained changes to its education system, the United States will relinquish its leadership in the 21st Century. (National Mathematics Advisory Panel, 2008, p. xi).

Hall and Ponton (2005) stated that past experiences with mathematics can and do contribute to a student's opinion about their mathematical abilities and, consequently, affect career choices involving mathematics. It is apparent from national and state assessments that students in North Carolina are being outperformed by students in other countries as well as other states (Programme for International Student Assessment [PISA], 2012; National Assessment of Educational Progress [NAEP], 2013). Students in Grades 3-5 in the researched district are being outperformed by students across the rest of the state, according to test scores dating back to the 2008-2009 school year (North Carolina Department of Public Instruction [NCDPI], 2015a). See Table 1.

Hanushek, Peterson, and Woessmann (2010) stated that "maintain[ing] our [United States] innovative edge in the world depends importantly on developing a highly qualified cadre of scientists and engineers. To realize that objective requires a system of schooling that produces students with advanced math and science skills" (p. 4). In 2009, the percentage of United States students graduating from high school who were considered highly accomplished in mathematics was well below that of most countries with which the United States compares itself (Hanushek et al., 2010). According to the American Diploma Project (2007), it is estimated that in 62% of American jobs, entry-level workers will need to be proficient in algebra, geometry, data interpretation, probability, and statistics. According to PISA (2012), students in the United States perform better with cognitively less-demanding mathematical skills and abilities, whereas weaknesses lie in higher cognitive demanding skills such as “taking real world situations, translating them into mathematical terms, and interpreting mathematical aspects in real-world problems” (p. 2).

This study sought to explore the problem of mathematics achievement in Grades 3-5. As stated previously, mathematics achievement in the United States is lagging behind other comparable countries. Moreover, students in North Carolina are performing lower on mathematical assessments than several other states. The district studied in this research has consistently performed low on mathematical EOG tests since the 2012-2013 school year. See Table 1.

Context of the Problem

The district in this study is a rural school district in the northwestern foothills of North Carolina. It serves over 10,150 students. There are 13 elementary schools, four middle schools, and four high schools as well as an early college program. The student demographics include 78.97% Caucasian, 4.16% African American, 13.19% Hispanic/Latino, 0.27% American Indian, 0.33% Asian, 3.06% Two or More, and 0.02% Pacific Islander. The free and reduced lunch rate for this district is 47.61% (District Accountability Office, personal communication, July 3, 2015).

PISA is an international measure of 15-year-old students in the areas of reading, mathematics, and science. This survey takes place every 3 years (PISA, 2012). More than 80% of the world’s economies take part in this assessment. Scores from the 2012 assessment indicate that Shanghai, China scored the highest mean score in mathematics (613 points; PISA, 2012). The students in the United States who took the assessment scored a mean score of 481 (PISA, 2012).

NAEP communicates the continual and national measures of achievement of elementary and secondary students in the United States (NAEP, 2013). Assessments are conducted periodically in reading, mathematics, science, writing, U.S. history, civics, geography, and other subjects (NAEP, 2013). NAEP collects and reports data about national, state, and local student performance (NAEP, 2013). In 2013, the national average for students in Grade 4 participating in the mathematics measure of achievement was one point higher than in 2011. The Grade 8 national average in the mathematics measure increased one point from 2011 to 2013 (NAEP, 2013). In 2015, both fourth- and eighth-grade students scored lower in mathematics than in 2013 (NAEP, 2015). The average mathematics score for a fourth-grade student was 240 (on scale of 0-500) in 2015, which is one point lower than in 2013 (NAEP, 2015). Eighth-grade students had an average mathematics score of 282 (on a scale of 0-500), which is two points lower than in 2013 (NAEP, 2015).

In North Carolina, the average 2013 Grade 4 score in mathematics was 245, which was higher than the national average of 241 (NAEP, 2013). These scores, however, were not significantly higher than North Carolina Grade 4 students in 2011 (NAEP, 2013). In North Carolina, the gap between the highest performing students (top 75%) and lowest performing students (lowest 25%) was 37 points in 2013 (NAEP, 2013). In 2011, North Carolina NAEP scores indicated that 44% of students were at or above a proficient level in mathematics, whereas 2013 scores indicated that 45% of students were at or above a proficient level (NAEP, 2013). In 2015, the average fourth-grade mathematics score dropped to 244, while the average eighth-grade mathematics score dropped five points from the 2013 assessment to a score of 281 (NAEP, 2015).

Yearly student achievement in mathematics is determined by North Carolina end-of-grade (EOG) assessments in Grades 3-8 (NCDPI, 2015b). In this district, average math scores for students in Grades 3-5 were consistently higher than the state averages until the 2012-2013 school year. This was the first year that the state changed the EOG assessments to be aligned with the new Standard Course of Study, which was the fully operational Common Core State Standards (CCSS; NCDPI, 2015b). State and district data are illustrated in Table 1.

Table 1

State and District EOG Mathematical Assessments (percentage of students at or above grade level)

Year	Grade 3		Grade 4		Grade 5	
	State	District	State	District	State	District
2008-2009	81.3	83.4	81.5	85.1	80.1	83.7
2009-2010	81.9	84.7	83.0	88.2	80.1	86.2
2010-2011	82.1	87.8	83.8	89.6	82.0	84.4
2011-2012	82.8	81.4	85.1	88.9	82.1	85.8
2012-2013	46.8	41.4	47.6	39.8	47.7	46.2
2013-2014	60.9	56.3	54.3	51.5	56.4	54.9

Note. District Accountability Office, Personal Communication (July 3, 2015); NCDPI (2015a).

CCSS was a state-led initiative led by the National Governors Association Center for Best Practices and the Council of Chief State School Officers (CCSS, 2015). According to CCSS (2015), teachers, experts in the mathematical field, and national educational organizations and agencies had a hand in the creation of the K-12 mathematical standards. The goal of this initiative was to create a set of standards that would lead students to be college and career ready by the end of high school (CCSS, 2015). “The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students” (CCSS, 2015, para. 1). According to CCSS (2015), the mathematics standards are a set of processes and procedures which cover the content and practice that students need to be mathematically proficient. The National Council of Teachers of Mathematics' (NCTM) process standards were adopted as CCSS's process standards (CCSS, 2015). These process standards are problem solving, reasoning and proof, communication, connections, and representations (NCTM, 2000). The proficiency standards were identified by the National Research Council's report *Adding It Up* (CCSS, 2015). These proficiency standards are

> adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy). (CCSS, 2015, para. 1).

According to CCSS (2015), these two sets of standards create a balanced combination of procedures and understanding, which is an intersection of what students should be able to mathematically do and know.

Purpose Statement

In this study, the researcher examined teacher self-efficacy in mathematics and the use of specific mathematical instructional practices in Grades 3-5 classrooms. The researcher also examined the relationships among teacher self-efficacy of teaching mathematics, the use of specific mathematical instructional practices, and student achievement on the North Carolina EOG test. According to the National Mathematics Advisory Panel (2008), differences in students' mathematical achievement are credited to differences in teacher characteristics including their self-efficacy in teaching and use of specific instructional practices. The study sought to add to the research behind that finding.

Research Questions

The research questions examined in this study are as follows.

1. What mathematical instructional practices do teachers in Grades 3-5 use to promote mathematical knowledge and student achievement as measured by the Teachers' Instructional Practices Survey (TIPS)?
2. What is the level of these teachers' self-efficacy of teaching mathematics as measured by the Self-Efficacy for Teaching Mathematics Instrument (SETMI)?
3. What are the relationships among teacher self-efficacy in teaching mathematics, the use of certain mathematical instructional practices, and student achievement as measured by the North Carolina EOG test?

Theoretical Framework

This study sought to add to the body of research surrounding the study of and the relationships among teacher self-efficacy, mathematical instructional practices, and student achievement. Figure 1 shows the relationship between the three variables of this study.

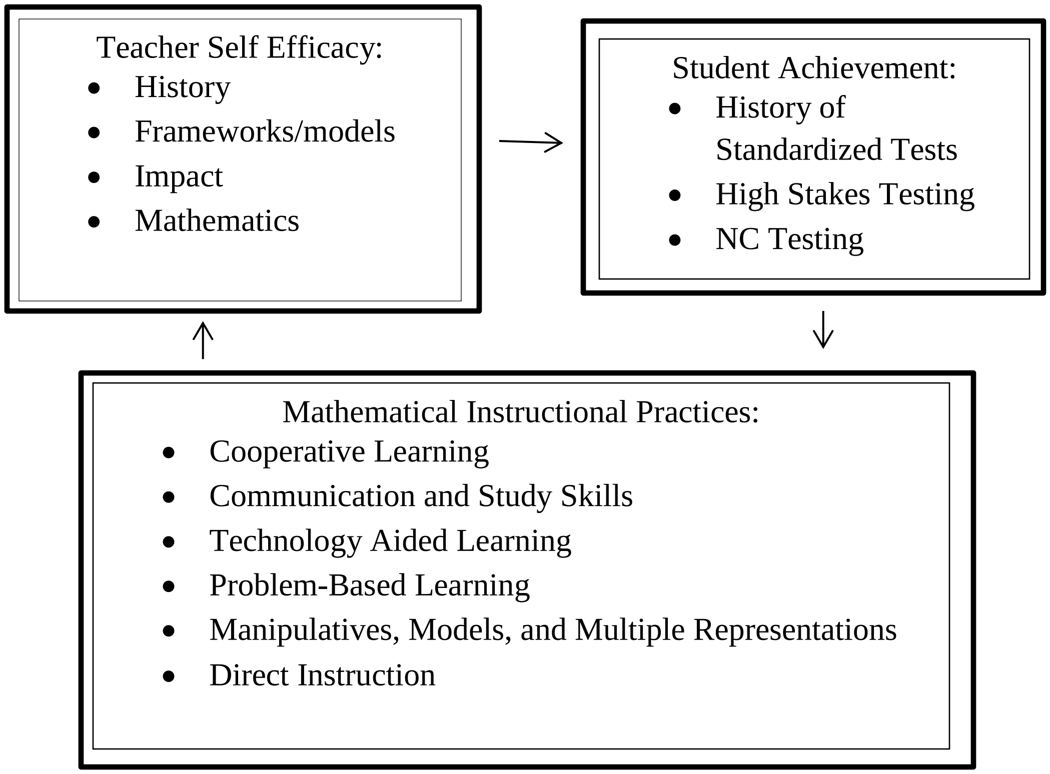

Figure 1. Theoretical Framework.

Figure 1 illustrates the supporting constructs for each variable. The concept of teacher self-efficacy is defined first through history/origins. This is then followed by the frameworks and models that exist around teacher self-efficacy. Next, teacher self-efficacy is further explored by a discussion of the impact it has on students. Finally, specific teacher self-efficacy in teaching mathematics is discussed. The second variable, student achievement, is defined by the history/origins of standardized tests, followed by a discussion surrounding high-stakes testing. Then, North Carolina specific testing is addressed. The third concept, mathematical instructional practices, is defined through the six instructional practices measured on TIPS: cooperative learning, communication/study skills, technology-aided learning, problem-based learning, manipulatives/models/multiple representations, and direct instruction.

Operational Definitions

Self-efficacy. Bandura (1977) defined self-efficacy as a person's certainty that he or she is able to deal with complex tasks.

Teacher self-efficacy. Holzberger, Philipp, and Kunter (2013) defined teacher self-efficacy as "beliefs about their [teacher's] capability to teach their subject matter even to difficult students" (p. 1).

Student achievement. In the context of this study, student achievement is defined as proficiency on standardized tests.

TIPS. Teachers' Instructional Practices Survey developed by Haas (2002).

SETMI. Self-Efficacy for Teaching Mathematics Instrument developed by McGee in 2010 (revised in 2012).

EOG. Assessments given in North Carolina to students in Grades 3-5 in order to measure proficiency and growth over the course of a school year. At the time of the study, students in these grades were given an EOG in the subjects of reading and mathematics as well as in science in Grade 5.

Significance

This research aimed to examine and analyze the relationships among teacher efficacy in teaching mathematics, the use of certain mathematical instructional practices, and student achievement. In addition, it sought to inform the practice of teachers and administrators in investigating educational strategies to meet student learning needs in mathematics. Furthermore, this study aimed to add to the current body of knowledge in teacher efficacy, mathematical instructional practices, and student achievement in mathematics.

Each of the constructs in this study plays a role in school effectiveness and student success. There is evidence that a teacher's belief in his or her abilities to instruct students may account for individual differences in effectiveness (Bandura, 1997; Gibson & Dembo, 1984). According to NCEE's (1983) report, the issues of student achievement and high-quality education for all children in the United States have been a concern for years. Teacher self-efficacy has arisen as a noteworthy aspect of school effectiveness (Bandura, 1997; Gibson & Dembo, 1984; Tschannen-Moran & Hoy, 2001; Tschannen-Moran, Hoy, & Hoy, 1998). NCLB required schools to use the most current research-based instructional methods and strategies. This study sought to add to research surrounding effective instructional practices in elementary mathematics.

This study sought to provide district leaders with information regarding the analysis of relationships among the three constructs: teacher self-efficacy, instructional practices in mathematics, and student achievement; therefore, these leaders can use the results to improve teaching in mathematics and, consequently, student achievement.

Summary

Teaching mathematics is a tremendously multifaceted activity that involves interactions among students, teachers, and the mathematics that is being learned (Gersten, Clarke, & Jordan, 2007). Many factors play a role in a student's mathematical achievement. Three variables of mathematical teaching and learning are addressed in this study: teacher self-efficacy in teaching mathematics, the use of certain mathematical instructional practices, and student achievement on mathematical state assessments.

This study responds to the need to examine the relationships among student achievement in mathematics, teacher self-efficacy in teaching mathematics, and the use of certain mathematical instructional practices. This research adds to the body of knowledge about these three variables found in Grades 3-5. The research questions addressed in this chapter guided this study. The following literature review in Chapter 2 provides an in-depth description and examination of the aforementioned variables as well as studies conducted among these constructs.

Chapter 2: Literature Review

This chapter presents a literature review of previous studies and current research related to the variables of teacher self-efficacy, mathematical instructional strategies, and student achievement as well as relationships that have been found and researched. The National Mathematics Advisory Panel (2008) stated in its final report that research has indicated that certain forms of particular instructional practices can have a positive impact on student achievement under specified conditions. Teacher self-efficacy is consistently related to student achievement (Woolfolk, Rosoff, & Hoy, 1990). NCTM (2000) promoted the belief that effective teachers have knowledge and understanding of mathematics, students, and of strong instructional practices. The following literature review examines archival and current research that studies and connects the three variables of this study.

Teacher Self-Efficacy

History of self-efficacy. Bandura (1977) defined self-efficacy as "beliefs on one's capabilities to organize and execute the course of action required to produce given attainments" (p. 3). Vancouver and Kendall (2006) defined self-efficacy as one's belief in his or her capacity to perform. It is an individual's belief in his or her power to affect the desired result or effectiveness when performing a specific task (Bandura, 1977, 1997). According to Bandura (1993), self-efficacy beliefs help determine how people feel, think, encourage themselves, and act with particular responsibilities. According to studies by Bandura (1993, 1997), people who consider themselves to have high self-efficacy tended to attribute their failures to insufficient effort, while those who rated themselves with lower self-efficacy tended to attribute failure to inability. Self-efficacy is a reliable predictor of success (Bandura, 1977, 1997; Hansen & Wänke, 2009; Yost, 2006).

Studies have established a strong link between self-efficacy and performance (Goodstadt & Kipnis, 1970; Lyons & Murphy, 1994; Rotter, 1966). The social cognitive theory set the construct for the idea of self-efficacy and is a result of the interaction of personal, behavioral, and environmental factors (Cantrell et al., 2003). Bandura's (1977, 1993, 1997) cognitive social learning theory is comprised of two motivation expectations. According to Bandura (1977, 1993, 1997), motivation can be affected by outcome expectations, which are conclusions about the probable consequences of behaviors in a specific situation. Motivation can also be affected by efficacy expectations, which are the individual's belief that he or she is able to attain a certain level of performance in that particular situation (Bandura, 1977, 1993, 1997). According to Bandura (1977), efficacy expectations govern how much effort people will expend and how long they will continue in the face of obstacles and adverse experiences. The degree of one's perceived self-efficacy will determine the amount of effort given (Bandura, 1977). According to Holzberger et al. (2013), self-efficacy addresses the relationship between a person and a behavior. Bandura (1977) pointed out that it involves a person's capability of dealing with complex tasks. Individuals must have a strong sense of efficacy to endure and continue the effort needed to succeed, as reported by Bandura (1997). According to social cognitive theory, teachers who do not expect to be successful with particular students are likely to put forth less work in planning and instructing and are more likely to give up quickly at the first sign of struggle, even if they know of strategies that could support these students (Tschannen-Moran & Hoy, 2007).

Self-efficacy develops through four causes as proposed by Bandura (1977, 1997). Mastery experiences (or enactive mastery) include all the successful experiences and performance accomplishments of that individual (Tschannen-Moran et al., 1998). Performance-based procedures are powerful when affecting psychological change (Bandura, 1977). According to Tschannen-Moran and Hoy (2001), mastery experiences have the most effect on self-efficacy. It is the most powerful influence on a person's belief in his or her capabilities (Cantrell et al., 2003; Tschannen-Moran et al., 1998). The perception that a performance has been successful can raise efficacy beliefs as well as provide a basis for the belief that future performances in a similar situation will also be effective (Cantrell et al., 2003). Mastery experiences for teachers come from actual teaching accomplishments with students (Bandura, 1997). Teacher mastery experiences can be summed up as a sense of satisfaction with one's past teaching experiences (Tschannen-Moran & Hoy, 2007).

Vicarious learning is another source of self-efficacy, according to Bandura (1977). Any model used in the learning process including visual, written, and kinesthetic is considered vicarious learning (Bandura, 1977). Learning and self-efficacy are most affected when the individual is using or seeing models that best fit his or her learning style (Tschannen-Moran & Barr, 2004). For teachers, vicarious experiences can come in the form of observing a target activity being modeled by someone else (Tschannen-Moran & Hoy, 2007). The effect of this observation on the observer's self-efficacy depends on the degree with which he or she identifies with the person modeling (Tschannen-Moran & Hoy, 2007). If the person models the activity well and the observer closely identifies with him or her, the self-efficacy of the observer is enhanced (Tschannen-Moran & Hoy, 2007). If the person modeling the activity performs the activity well but the observer sees that they differ in significant ways (such as experience, training, gender), the person witnessing the activity may not experience increased self-efficacy (Tschannen-Moran & Hoy, 2007).

Verbal (or social) persuasion encompasses both encouraging and criticizing feedback from a creditable source (Bandura, 1977). This can result in an increase (encouragement) or decrease (criticism) in a person's self-efficacy (Cantrell et al., 2003). Cantrell et al. (2003) indicated that verbal persuasion is a strong source of self-efficacy, particularly for teachers. Social persuasion can provide information about the nature of the teacher, give encouragement and strategies for overcoming difficulties, and provide advice on a teacher's performance (Cantrell et al., 2003). Verbal persuasion for teachers comes in the form of verbal exchanges that a teacher receives about his or her performance and predictions for success from significant others in the teaching environment such as administrators, parents, and colleagues (Tschannen-Moran & Hoy, 2007).

Studies by Bandura (1977) also showed that physiological and emotional arousal is linked to feelings of self-efficacy. These can include the environment, emotions, and/or health factors (Bandura, 1977). A stressful environment can have a negative effect on one's perception of abilities (Cantrell et al., 2003). Teachers can experience feelings of joy and/or pleasure when teaching a successful lesson, which increases his or her level of self-efficacy (Tschannen-Moran & Hoy, 2007). If the lesson was successful but the teacher feels high levels of stress or anxiety associated with a fear of losing control, said teacher may actually experience a decrease in self-efficacy (Tschannen-Moran & Hoy, 2007). People will approach, explore, and attempt to deal with situations within their self-perceived competences, but they will try to evade situations that include stressful conditions that they see as exceeding their ability (Bandura, 1977). People will not persist if they do not believe they can perform necessary activities that will yield certain outcomes (Bandura, 1977).

Tschannen-Moran and Hoy (2001) characterized teacher-efficacy as the self-belief that the teacher can make judgments and form action plans to make a difference in their own classrooms. Teacher self-efficacy was first introduced in two Rand Corporation initiatives. These two evaluations studied innovative educational programs that were funded by the United States government (Armor et al., 1976). The first study researched school preferred reading programs in Los Angeles and found that a teacher's sense of efficacy and increased student standardized reading test scores held a significant relationship (Ashton, Buhr, & Crocker, 1984). The second study was an evaluation of teacher uses of innovative ideas and projects (Ashton et al., 1984). The researchers found that a teacher's self-efficacy was positively related to improved student performance as well as the continuation of methods and materials (Ashton et al., 1984). Both studies contained two questions that participants were to answer using a 5-point Likert scale. The two questions were, "When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his or her home environment" and "If I try really hard, I can get through to even the most difficult or unmotivated student" (Armor et al., 1976). The Rand Corporation based these two questions on Rotter's social learning theory (Armor et al., 1976). Rotter's social learning theory is based on the amount an individual believes he or she can control an outcome (Ashton et al., 1984). Ashton and Webb (1986) asserted that the first Rand question correlates to beliefs about outcome expectations, whereas the second question reflects efficacy expectations. Gibson and Dembo (1984) adopted this same view and developed an expanded 30-item evaluation. Woolfolk et al. (1990) found that the Rand questions are better characterized as general teaching efficacy and personal teaching efficacy.

General teaching efficacy is the power of teaching to offset any negative effects from a student's background (Woolfolk et al., 1990). Personal teaching efficacy is the impact of a specific teacher (Woolfolk et al., 1990).

General teaching efficacy extends beyond an individual's view of his or her own capabilities to a view of teaching in general (Cantrell et al., 2003). Teachers who exhibit low general teaching efficacy typically believe that a teacher cannot really have a strong influence on a student's motivation and performance because of the impact of the home environment (Cantrell et al., 2003). Teachers with high levels of personal teaching efficacy have confidence that they have appropriate training or experience to develop strategies for overcoming difficulties to student learning (Bandura, 1997). These teachers will expend great determination to reach goals, will persist longer when faced with difficulties, and will recover from temporary setbacks stronger and more quickly than teachers with low personal teaching efficacy (Cantrell et al., 2003).

Self-efficacy is a motivational concept based on self-perception of ability rather than actual level of competence (Tschannen-Moran & Hoy, 2007). A teacher's perceived level of competence may be higher or lower than an external assessment of the actual teaching skill (Tschannen-Moran & Hoy, 2007). Bandura (1997) suggested that it is most productive when teachers slightly overrate their actual teaching skills, as their motivation to try and persist through obstacles will help them to make the most of the skills and abilities they do possess.

Framework/models. In 1984, Ashton et al. added interviews and classroom observations to the Rand evaluation to expand the study (Woolfolk et al., 1990). The researchers turned to Bandura's cognitive social theory to conceptualize teacher-efficacy (Woolfolk et al., 1990). In this framework, Ashton et al. developed classroom scenarios for teachers to rate their effectiveness in handling each scenario (Ashton et al., 1984). The scale also asked teachers to rate how well they could handle the scenarios in relation to other teachers (Ashton et al., 1984).

Gibson and Dembo (1984) developed a scale to measure teacher efficacy. Their Teacher Efficacy Scale (Gibson & Dembo, 1984) included 30 items that are answered using a 6-point Likert scale, ranging from strongly agree to strongly disagree. A factor analysis yielded two factors which the authors identified as general teaching efficacy and personal teaching efficacy (Gibson & Dembo, 1984). This research study identified distinct differences between teachers with high teacher self-efficacy to those teachers with low teaching self-efficacy. The researchers observed how these two groups of teachers (high self-efficacy and low self-efficacy) taught and found that teacher self-efficacy is a complex idea (Gibson & Dembo, 1984).

Enochs, Smith, and Huinker (2000) developed an instrument that measures a teacher’s belief in his or her own ability to teach mathematics. This instrument is called the Math Teaching Efficacy Belief Instrument (MTEBI) (Enochs et al., 2000). The researchers adapted the Science Teaching Efficacy Beliefs Instruction (STEBI; Riggs & Enochs, 1990) to create the MTEBI. According to Enochs et al. (2000), the MTEBI was developed to measure preservice elementary teachers’ efficacy in teaching mathematics. This instrument contained two subscales–one to measure personal math teaching efficacy and one to measure math teaching outcome expectancy (Enochs et al., 2000). The factor analysis of construct validity for the scale yielded an index fit value of 0.919 (Enochs et al., 2000). The reliability analysis yielded a Cronbach alpha coefficient of internal consistency score of 0.88 for the personal math teaching efficiency subscale (13 items on the instrument) and a score of 0.77 for the math teaching outcome expectancy subscale (eight items on the instrument; Enochs et al., 2000).

Developed by Tschannen-Moran and Hoy (2001), the Teachers' Sense of Efficacy Scale (TSES) is a 24-item tool that uses a Likert scoring system (Tschannen-Moran & Hoy, 2007). Teachers rate themselves based on a continuum of 1-9, ranging from 1–nothing to 9–a great deal. There are three subscales embedded in the tool: efficacy for instructional strategies, efficacy for classroom management, and efficacy for student engagement (Tschannen-Moran & Hoy, 2001). Each of these subscales contain eight items. The reliabilities for the full scale range from .92 to .95. The reliabilities for the subscales range from .86 to .90 (Tschannen-Moran & Hoy, 2007). Tschannen-Moran and Hoy (2001) also created a short form for TSES, which contains 12 items.

Impact. Ashton and Webb (1986) characterized teacher self-efficacy as a belief in the ability to have a positive effect on student learning. Teacher self-efficacy is consistently related to student achievement (Woolfolk et al., 1990). Teacher self-efficacy can have implications in the classroom (Holzberger et al., 2013). How a teacher views his or her effectiveness in the classroom is an important part of a class dynamic. These views can have implications across several educational aspects such as classroom management, student achievement, job satisfaction, learning goals, and student motivation (Holzberger et al., 2013). According to Lohman (2006), teachers with high self-efficacy tend to work harder, be more involved in the learning activities, are more persistent, and have less signs of stress. A teacher's judgment of his or her ability to impact student outcomes has been consistently related to teacher behaviors, student attitudes, and student achievement (Tschannen-Moran & Hoy, 2007).

Tschannen-Moran et al. (1998) asserted that teacher efficacy appears to influence students in their achievement and attitude. According to Winheller, Hattie, and Brown

(2013), a teacher's attitudes and beliefs make a difference in the way they teach. This includes their levels of self-efficacy. Teachers with positive self-efficacy in teaching have a vast impact on instructional practices as well as the level of student engagement in the classroom (Winheller et al., 2013). These two factors shape how students understand the curriculum (Roettinger, 2013). Tschannen-Moran and Hoy (2007) stated that teacher self-efficacy beliefs are associated with the effort teachers devote to teaching, the goals they set, their persistence when things do not go smoothly, and their resilience in the face of obstacles. The standards that a teacher believes constitute effective teaching will influence his or her sense of self-efficacy (Bandura, 1977; Tschannen-Moran & Hoy, 2007).

Mathematical. Mathematical teaching efficacy can be defined as "a teacher's belief in his or her own capabilities of designing and using meaningful math instruction" (Philippou & Christou, 2002, p. 212). "The practice of teaching mathematics depends on a number of key elements, including the teacher's mental contents or schemas, particularly the system of beliefs concerning math and its teaching and learning" (Ernest, 1989, p. 249). Stipek, Givvin, Salmon, and MacGyvers (2001) conducted a study of the self-confidence and enjoyment of mathematics and mathematics teaching of 21 fourth- through sixth-grade teachers. Along with confidence and enjoyment, these researchers also studied the teachers' beliefs about the nature of mathematics, mathematics learning, who should control students' math activity, the nature of mathematical ability, and the value of extrinsic rewards as student engagement (Stipek et al., 2001). The study yielded that teacher confidence as mathematical teachers, also known as self-efficacy, was significantly associated with their students' self-confidence as mathematics learners (Stipek et al., 2001).

Kahle (2008) studied the relationship among elementary teachers' mathematics self-efficacy, mathematics teaching self-efficacy, and conceptually and procedurally oriented teaching practices. The researcher conducted the study with 75 third- through sixth-grade mathematics teachers (Kahle, 2008). The researcher found a relationship between positive self-efficacy and conceptually oriented teaching (Kahle, 2008). A teacher who had a high mathematics self-efficacy on a particular topic of study was inclined to be conceptually focused on that specific topic, whereas a teacher who had low self-efficacy on that topic was more likely to use procedural practices when teaching (Kahle, 2008). The study's results indicate that mathematical self-efficacy may be a precursor to mathematical teaching self-efficacy (Kahle, 2008).

Mathematical Instructional Practices

NCTM (2000) published *Principles and Standards for School Mathematics*. This document calls for and presents a common foundation of mathematics to be learned by all students (NCTM, 2000). This document also set forth a comprehensive and coherent set of learning goals which are broken down into principles and standards (NCTM, 2000). According to NCTM (2000), the six principles (equity, curriculum, teaching, learning, assessments, and technology) are statements reflecting basic guidelines that are essential to high quality mathematical education. The standards are descriptions of what mathematics instruction should enable students to know and do (NCTM, 2000). These are broken down into five content standards (numbers and operations, algebra, geometry, measurement, and data analysis and probability) and five process standards (problem solving, reasoning and proof, communication, connections, and representations). NCTM (2000) stated that together, the principles and standards establish a foundation to guide educators in mathematics instruction.

The National Mathematics Advisory Panel (2008) stated, “Substantial differences in the mathematical achievement of students are attributable to differences in teachers” (p. 35). NCLB (2002) called for schools and teachers to enact the most current research-based instructional methods and programs. Marzano et al. (2001) conducted a meta-analysis of instructional practices and identified nine broad research-based instructional strategies that have the possibility of improving student achievement for all students in all subject areas and in all grades. These are identifying similarities and differences, summarizing and note taking, reinforcing effort and providing recognition, homework and practice, nonlinguistic representations, cooperative learning, setting objectives and providing feedback, generating and testing hypotheses, cues, questions, and advance organizers (Marzano et al., 2001). Marzano et al. (2001) recommended that the effectiveness of instructional strategies on various student populations and particular content areas needs to be studied. The National Mathematics Advisory Panel found that explicit instruction improved the performance of low-achieving students. A study conducted by Gagnon and Maccini (2007) yielded findings that pointed to a variety of factors that affect a teacher’s selection and usage of certain instructional strategies. The factors included teacher knowledge of and familiarity with the mathematical content, teacher preparation, and teacher beliefs about the meaning of the mathematics (Gagnon & Maccini, 2007).

Lee and Olszewski-Kubilius (2006) explored gifted teachers’ selection of instructional strategies. The researchers found that time and teacher perception of student capabilities affected the usage of certain instructional practices (Lee & Olszewski-Kubilius, 2006). Their study compared 3-week instructional courses with 9-week instructional courses (Lee & Olszewski-Kubilius, 2006). Courses ranged from Latin to science and mathematics (Lee & Olszewski-Kubilius, 2006). Lee and Olszewski-Kubilius found that even though the material did not change, instructional strategies were adjusted based on time and teacher perceptions of student capabilities. NCTM (2000) suggested that the instructional strategies teachers choose to use in the mathematics classroom influence student understanding of math, their confidence to solve problems, their ability to apply their knowledge to unfamiliar situations, and their attitudes towards learning mathematics.

Cooperative learning. "Cooperative learning is method of instruction characterized by students working together to reach a common goal" (Haas, 2002, p. 46). This instructional practice is endorsed by NCTM (2000). It is also widely researched. Marzano et al. (2001) conducted a synthesis of research on instructional strategies across grade levels and subject areas. The researchers reported an effect size of 0.73 on the instructional practice cooperative learning (Marzano et al., 2001). Johnson and Johnson (1994) described cooperative learning in terms of five elements. These elements are positive interdependence, face-to-face promotive interaction, individual and group accountability, interpersonal and small group skills, and group processing (Johnson & Johnson, 1994).

House (2005) studied the 1999 Trends in International Mathematics and Science Study (TIMSS) assessment results. The researcher examined the relationship among several instructional strategies, student interest in mathematics, and TIMSS scores (House, 2005). The research yielded that students in Japan and the United States showed a positive correlation between three instructional strategies (practical application for learning, cooperative learning, and teacher demonstration) and attitudes towards mathematics (House, 2005). House stated that students taught with these three strategies constantly scored high on TIMSS as well as exhibited high levels of enjoyment when learning mathematics. This indicates the importance of using certain instructional strategies in the mathematics classroom.

Communication and study skills. "Communication and study skills is a method of instruction characterized by teaching students to read and study mathematical information effectively and by providing opportunities for students to communicate mathematical ideas verbally or in writing" (Haas, 2002, p. 65). NCTM (2000) considered this instructional practice a stand-alone process standard. NCTM (2000) stated that mathematical communication is a way to share ideas and explain understanding. Through this instructional practice, ideas become reflective, refined, deliberated, and modified (NCTM, 2000). When done in writing and orally, students learn to express their thinking in a clear and conclusive way (NCTM, 2000). According to NCTM (2000), students become precise in their mathematical language use. Conversations and arguments/rationales should explore ideas from various perspectives so students can improve their thinking (NCTM, 2000).

Communication and study skills provide students with opportunities to read, write, and talk about their mathematical learning in a nonthreatening environment (Haas, 2002). NCTM (2000) posited that teachers must help students to focus and clarify their thinking. This will lead to students refining and adjusting their ideas (NCTM, 2000). Hodo (1989) defined mathematical study skills as distinct abilities used when studying mathematics, such as reading graphs, charts, and examples to better understand the material being taught. This instructional practice became more widely accepted as part of mathematical teaching and learning after NCTM's (1989) report, Curriculum and Evaluation.

Technology aided. "Technology aided learning is a method of instruction characterized by using computer software applications and/or hand-held calculators to enhance instruction" (Haas, 2002, p. 67). Technology is one of the six mathematical principles described in NCTM's (2000) Principles and Standards for School Mathematics. NCTM (2000) suggested that technology enhances student learning and influences the mathematical content that is taught. This instructional practice is essential to teaching and learning as long as its appropriate use is helping students develop deeper mathematical knowledge (NCTM, 2000). The right technology can allow students to concentrate on decision making, reflection, reasoning, and problem solving (NCTM, 2000). According to NCTM (2000), the abundance and accessibility of today's technology causes teachers to consider what mathematics students learn as well as how they can best learn it. Haas (2002) found that technology-aided instruction was an effective mathematical instructional practice with a small to medium effect size on student achievement in algebra.

"Electronic technologies–calculators and computers–are essential tools for teaching, learning, and doing mathematics. They furnish visual images of mathematical ideas, they facilitate organizing and analyzing data, and they compute efficiently and accurately" (NCTM, 2000, p. 24). Prior to the 1980s, computers were not widely used to enhance instruction, and hand-held calculators were primarily used to assist with computation and for answer checking (Haas, 2002). Now, electronic technologies allow students the opportunities to practice skills and visual concepts. The National Mathematics Advisory Panel's (2008) Final Report provided a review of available literature on the effect of instructional strategies in mathematics achievement and reported that calculator use had a limited to no effect size on calculation skills, problem solving, and conceptual development. This study finding was deemed inconclusive because none of the studies reviewed examined the long-term use of calculators (National Mathematics Advisory Panel, 2008). This report did find that computers had positive effects on mathematical achievement but noted that more research was needed (National Mathematics Advisory Panel, 2008).

Problem-based learning. "Problem-based learning is a method of instruction characterized by teaching through problem solving where students apply a general rule (deduction) or draw new conclusions or rules (induction) based on information presented in the problem" (Haas, 2002, p. 70). This instructional practice is very similar to Marzano et al.'s (2001) practice of generating and testing hypotheses, where students apply knowledge to new situations. Problem-based learning is a teaching method that could include several other teaching methods and be considered a framework for instruction (Haas, 2002). Haas (2002) found that problem-based instruction was an effective mathematical instructional practice with medium effect size on student achievement in algebra.

NCTM (2000) named problem solving as one of their five process standards. Problem solving is both a goal and a means to that goal in the mathematical classroom and should not be practiced in isolation (NCTM, 2000). In the mathematics class, students should have repeated opportunities to communicate, grapple with, and solve complex problems that contain significant effort (NCTM, 2000). According to NCTM (2000), students should also reflect throughout the problem-solving process so they can apply and adapt their thinking to other problems and contexts. Problem-based instruction provides students practice with thinking, developing problem-solving habits, and confidence, all of which could benefit them in unfamiliar situations outside the mathematics class (NCTM, 2000).

Manipulatives, models, and multiple representations. “Manipulatives, models, and multiple representations is a method of instruction characterized by teaching students techniques for generating or manipulating representations of algebraic content or processes whether concrete, symbolic, or abstract” (Haas, 2002, p. 73). This process involves students manipulating materials, models, and visual aids to illustrate a problem (Haas, 2002). This instructional practice is similar to Marzano et al.’s (2001) nonlinguistic representation which includes a variety of activities such as creating graphic representations, making physical models, creating mental pictures, drawing pictures and/or pictographs, and engaging in kinesthetic movements. By using manipulatives, models, and multiple representations, teachers provide the students with opportunities to see and feel the math as well as communicate their thinking in various formats (Haas, 2002).

NCTM (2000) included representations as one of the five mathematical process standards for students in Grades K-12. Mathematical ideas can be represented in a number of ways including graphs, tables, hands-on materials, symbols, and pictures (NCTM, 2000). “The ways in which mathematical ideas are represented is fundamental to how people understand and use those ideas” (NCTM, 2000, p. 360).

Direct instruction.

> Direct instruction is a method of instruction characterized by teaching through establishing a direction and rationale for learning by relating new concepts to previous learning, leading students through specified sequence of instructions based on predetermined steps that introduce and reinforce a concept, and providing students with practice and feedback relative to how well they are doing.

(Haas, 2002, p. 75).

This instructional practice is similar to Marzano et al.'s (2001) strategy of setting objectives and providing feedback to students. This teaching method could be considered a framework that encompasses other instructional practices across disciplines (Haas, 2002). Haas (2002) found that direct instruction was an effective mathematical instructional practice with a medium effect size on student achievement in algebra. The National Mathematics Advisory Panel's (2008) Final Report provided a review of available literature on the effect of instructional strategies in mathematics achievement and reported that high-quality research does not support the exclusive use of teacher direct instruction.

Student Achievement

Student achievement has been correlated with the effectiveness of the teacher (Winheller et al., 2013). "Substantial differences in mathematics achievement of students are attributable to differences in teachers" (National Mathematics Advisory Panel, 2008, p. 35). Noddings (2004) emphasized that the purpose of testing is to allow teachers to think about what is being taught, which leads to improving instructional strategies to meet educational goals. The Center for Public Education (2007) described two student achievement measurement models used on standardized tests: the growth model and the value-added model. The growth model calculates the amount of academic progress a student makes between two points in time, such as from one EOG test to the next (Center for Public Education, 2007). The value-added model is a type of growth model that evaluates the effectiveness of a school and/or teacher by applying student growth scores (Center for Public Education, 2007). According to the Center for Public Education, this model assesses the degree to which schools and teachers advance student performance.

History of standardized testing. Standardized tests were originally developed to measure specific forms of learning, but political and public accountability pushes have changed them into high-stakes tests (Noddings, 2004). Anderson, Medrich, and Fowler (2007) indicated that standardized tests can provide data on large numbers of students quickly. The standards-based, or norm-referenced assessments that provide these data points allow for stakeholders to compare scores and achievement among individual students and even groups of students who are the same age and in the same grade (Anderson et al., 2007; Ediger, 2003). Norm-referenced assessments measure student achievement through an atmosphere of uniform test taking conditions such as time table, directions, and material tested (Ediger, 2003). Noddings (2004) posited that standardized tests measure specific kinds of learning but are not ideal to report individual diagnosis. Popham (1999) referenced making valid inferences about the knowledge or skills that a student possesses in a certain area as the purpose of standardized tests. Increasing accountability pushes, at state and federal levels, has built an historical context for standardized assessments (International Literacy Association [ILA], formerly the International Reading Association, 2014).

The Elementary and Secondary Education Act (ESEA) was signed into law in 1965 by President Lyndon Baines Johnson, who believed that "full educational opportunity" should be "our first national goal" (United States Department of Education, 2015, para. 1). This act created NAEP and began the road of increasing accountability under Title 1 (Sabin, 2012). NCEE (1983) released its report, *A Nation at Risk*, which threw the educational system into a whirlwind by its claim that United States schools were not at the top of world rankings in terms of educational performance. Interestingly, for a decade after the *Nation at Risk* report was released, the United States enjoyed exceptional prosperity (Noddings, 2004). In 2002, with bipartisan support, Congress reauthorized ESEA giving it a new name: NCLB (United States Department of Education, 2015).

NCLB (2002) mandated that schools, districts, and states use standardized student achievement assessments to compare student learning. NCLB created a federal mandate for accountability, assessments, and sanctions–all tied to annual performance scores on standardized student achievement tests. State education policies and procedures have been greatly affected by the federal expectations of how student performance is measured and evaluated (Zvoch & Stevens, 2008). NCLB required schools to show annual increases in the performance of student achievement. Each subsequent group of students is expected to be more proficient than the last (NCLB, 2002). Because of NCLB, student achievement and productivity, in the form of test scores, have become a central issue for public schools (Zvoch & Stevens, 2008). Pre-NCLB legislation state accountability systems varied with respect to the types and frequency of assessments, testing students from special populations, standards used to assess school performance, and rewards and sanctions if a school did not meet expected guidelines (Zvoch & Stevens, 2008).

Adequate Yearly Progress (AYP) measured student proficiency incrementally in order for states to meet the uniform guideline of 100% of students being proficient in reading and mathematics by the 2013-2014 school year, but states were left to determine the measurement tools as well as the level considered proficient (NCLB, 2002; Zvoch & Stevens, 2008). Many states received waivers from the United States Department of Education before the 2013-2014 school year including North Carolina, which means the state did not designate each school as having met or not met AYP (NCDPI, 2014b, 2015b). According to the United States Department of Education (2015),

> In 2012, the Obama administration began offering flexibility to states regarding specific requirements of NCLB in exchange for rigorous and comprehensive state-developed plans designed to close achievement gaps, increase equity, improve the quality of instruction, and increase outcomes for all students. Thus far 42 states, DC and Puerto Rico have received flexibility from NCLB. (para. 7)

This flexibility on specific requirements is requested by states so their educational systems can focus on improving student learning and increase the quality of instruction (United States Department of Education, 2015). It was intended to build on and support the significant state and local reform efforts already underway in North Carolina in the areas of transitioning to the new standards and assessments, developing a system of differentiated recognition, accountability, and evaluating teacher and principal effectiveness (NCDPI, 2015b). The framework of NCLB is not in coherence with recognized standards of professional assessment practices according to Zvoch and Stevens (2008).

The common format for standardized testing is multiple choice. The multiple choice design allows the tests to be scored by technology and with a higher level of objectivity than performance assessments (Ediger, 2003). Current standardized tests in North Carolina include constructed response on English language arts assessments and gridded items on mathematics assessments (NCDPI, 2015b). Marzano (2003) stated that standardized tests are an indirect measure of learning. He cited state tests based on state standards as being

> better than off the shelf standardized tests but they do not provide a comprehensive and timely picture of student achievement. Neither a single test nor even a set of tests can ever address all the content that is taught within a given

subject area at a given grade level. (Marzano, 2003, p. 57).

It is important for educators and other stakeholders to understand the limitations that accompany all tests, standardized or not (Zvoch & Stevens, 2008).

ILA (2014) provided a few benefits to using standardized tests. The organization stated that benefits include efficiency in measurement and grading and providing a broad overall achievement picture (ILA, 2014). Standardized tests can provide effective program evaluation information (ILA, 2014). These tests are also constructed from required, uniform standards that all students in the state's public schools are taught (ILA, 2014). Noddings (2004) stated that a positive aspect of standardized tests is the fact that they have been tested for validity and reliability. According to Zvoch and Stevens (2008), standardized testing has relative objectivity, reliability, and validity. The steady access to quantitative data on student achievement is created by standardized tests (Zvoch & Stevens, 2008). Ediger (2003) asserted that the measurement of student achievement for research purposes is largely restricted to standardized achievement assessments. Marzano (2003) indicated that schools should use data that are directly associated with student achievement as a means to guide decisions. Standardized tests and state tests based on standards have their place in education but not as the primary indicator of student learning (Marzano, 2003).

High-stakes testing. According to Decker and Bolt (2008), one of the most contentious aspects of large-scale assessment and accountability systems is related to the types of consequences associated with test scores, commonly referred to as high stakes. "As part of the accountability movement, stakes are also deemed high because the results of tests, as well as the ranking and categorization of schools, teachers, and children that extend from those results, are reported to the public" (Au, 2007, p. 258). High stakes can be defined as consequences that could directly affect individuals and have a significant impact on their lives (Au, 2007; Decker & Bolt, 2008). For students, this could mean retention, promotion, and/or allowance to graduate high school (Decker & Bolt, 2008; Nichols & Berliner, 2005). For teachers, this could mean performance pay, personnel evaluations, and/or continued or terminated employment (Decker & Bolt, 2008; Nichols & Berliner, 2005). High-stakes tests are based on the premise that rewards and/or threats guarantee change (Decker & Bolt, 2008). Nichols, Glass, and Berliner (2012) defined high-stakes testing as "standardized tests developed specifically for the purpose of evaluating teachers and students" (p. 3). The researchers continue their definition of high-stakes testing by adding that these tests "may result in important consequences to schools, administrators, teachers and students" (Nichols et al., 2012, p. 3). The consequences can be positive (bonuses, positive reviews) or negative (retention, termination, school closure) (Nichols et al., 2012). Decker and Bolt indicated that the four intended consequences of high-stakes testing are

1. To improve curriculum and instruction,
2. To produce gains in student learning and achievement,
3. To increase teacher and student motivation, and
4. To promote equity among historically at-risk groups of students. (p. 44)

According to Nichols et al. (2012), in theory "by tying negative consequences (e.g., public exposure, external takeover) to standardized test performance, teachers and students in low performing schools will work harder and more effectively, thereby increasing what students learn" (p. 2).

High-stakes tests are used as a comparison tool for students, teachers, schools, districts, and states (Sabin, 2012). Nichols and Berliner (2005) indicated that in order for tests to be high stakes, the student achievement tests must have decisions about student promotion, teacher ratings, teacher pay, school sanctions and funding, and district rankings tied to the results. Newmann, Bryk, and Nagaoka (2001) asserted that large-scale assessments should not define a school's success, because they only measure narrow types of student achievement. Standardized tests are unable to test much of what teachers and schools are trying to teach (Newmann et al., 2001).

Noddings (2004) declared that "no test should, by itself, carry high stakes for children forced to take it" (p. 264). ILA (2014) stated that a student's educational career can be severely altered if high-stakes decisions are made because of poor performance on a standardized test. Standardized tests are being used as mechanisms to reward, evaluate, and punish students and teachers (ILA, 2014). Several issues in the educational system are arising because of the continued use of standardized test results as the only indicator in high-stakes decisions (Sabin, 2012). ILA (2014) highlighted the narrowing of curriculum, focusing only on students close to the proficiency score, and the moving of decisions making power away from the local level as issues that are increasing because of the emphasis on standardized test scores. Decker and Bolt (2008) cited decreasing student and teacher morale as an issue that is gaining prominence in schools. Au (2007) specified a "teaching to the test" mentality as an issue that teachers are increasingly turning to in order to raise standardized test scores.

NCLB is considered to involve high-stakes testing because if a school failed to demonstrate adequate student achievement, penal consequences were enacted (Zvoch & Stevens, 2008). This legislation is credited to be the reason why high-stakes testing has grown in prominence (Nichols et al., 2012). Zvoch and Stevens (2008) stated that "studies of the No Child Left Behind framework suggest that the analytic approaches required by the legislation may not reliably and validly capture the impact that schools have on students or effectively measure school improvement" (p. 571).

Many researchers urge caution when using high-stakes testing results in accountability decisions (Decker & Bolt, 2008; Ediger, 2003; Noddings, 2004; Zvoch & Stevens, 2008). Ediger (2003) indicated that

> there is a certain logic involved in equating teaching well with pupil achievement. However, the teacher is not the only being who influences pupils. The home, community, religious institutions, among others, do affect the pupil's values and standards. Then, too a single test is not adequate to show pupil achievement. (pp. 235-236)

In a study conducted by Nichols and Berliner (2005), it was reported that

> the over-reliance on high-stakes testing has serious negative repercussions that are present at every level of the public school system. Standardized-test scores and other variables used for judging the performance of school districts have become corruptible indicators because of the high stakes attached to them. (p. i)

Because high-stakes testing affects future employability, bonus pay, student promotions/ retentions, and state and/or federal funding, problems arise (Nichols & Berliner, 2005). The study indicated that high-stakes testing can and does stimulate administrative, teacher, and student cheating, exclusion of low-performing students from testing, misrepresentation of student dropouts, teaching to the test, narrowing the curriculum, contradictory accountability ratings, questions about the meaning and level of proficiency, decreasing teacher morale, and score reporting errors (Nichols & Berliner, 2005). In 2004, NCDPI reported that according to state proficiency guidelines, 75% of eighth graders were proficient in mathematics, but the NAEP scores showed that 30% of these same eighth graders were proficient in mathematics (Noddings, 2004). This illustrates the issue of differing levels of proficiency. Another issue that arises from high-stakes testing is the concentration of time, teaching, and resources on students whose achievement is just below the proficiency cut score (Noddings, 2004). This practice ignores low-performing students who could benefit from these resources, but advocates of NCLB say that schools “cannot get away with this forever” (Noddings, 2004, p. 267) because of the guidelines and consequences built into the framework.

Along with standardized, high-stakes testing comes student fear of the test, which is often heightened by constant teacher warnings of consequences associated with doing poorly (Noddings, 2004). Teachers are also being affected, becoming demoralized by the fear and warnings of consequences associated with their students performing below expectations on the standardized assessments (Noddings, 2004). Student performance on high-stakes assessments is increasingly being used to evaluate a teacher’s effectiveness; thus, class time is increasingly being centered on teaching to the test and classroom assessments are often mirroring the high-stakes test format (ILA, 2014). Testing is important but, according to Hess (2009), is only one indicator of student progress. Furthermore, Hess posited that schools should not be evaluated exclusively on student test scores. Noddings (2004) declared that stakeholders must look at more than just trends in standardized test scores when making important decisions.

High-stakes assessments are currently aligned to CCSS for many states in the United States, including North Carolina (ILA, 2014). Au (2007) conducted a metasynthesis study that analyzed 49 qualitative studies to find out how high-stakes testing affects the curriculum that teachers are teaching and students are learning in classrooms on a daily basis. Au found that the primary effect high-stakes tests were having on classroom curriculum is a narrowing of curriculum to just tested subjects as well as subject-area knowledge being fragmented into test-related pieces. Along with this, teachers were increasing the use of teacher-centered instructional strategies (Au, 2007). Au noted that a significant minority of cases were found to show that certain high-stakes testings have led to curriculum content expansion, the integration of subject area knowledge, and more student-centered instructional strategies. Au asserted that the findings "suggest that the nature of high-stakes-test-induced curricular control is highly dependent on the structures of the tests themselves" (p. 258).

North Carolina testing. North Carolina established the North Carolina Standard Course of Study (NCSCoS) in 1898 as an attempt to determine competencies for each grade level and each high school course with a demanding set of educational standards that would be constant across the state (NCDPI, 2011). Every child in North Carolina's public schools should have access to these content standards which indicate what students should know and be able to do (NCDPI, 2011).

In the 1996-1997 school year, North Carolina implemented the ABCs of Public Education which formalized the accountability of standardized assessments in the state (NCDPI, 2011). This was in response to a federal emphasis on stronger accountability (Sabin, 2012). NCDPI (2011) asserted that the ABCs of Public Education, the state's first school-level accountability system, allowed educators and other stakeholders to concentrate on school improvement efforts. At the elementary level, EOG tests were given in Grades 3-8 for the first time (NCDPI, 2011). The tests, as a part of the accountability system, are given one time at the end of a grade or course (Center for Public Education, 2007). The ABCs of Public Education implemented monetary incentives to school-based educators per the Excellent Schools Act during the 1997-1998 school year (NCDPI, 2012). A one-time payment of $1,500 to certified staff and a one-time bonus of up to $500 for teacher assistants were given to staff at schools that showed exemplary growth/gain on EOG and/or EOC standardized assessments (NCDPI, 2012). Staff at schools that were designated as meeting expected growth/gain were given a one-time payment of either $750 (certified staff) or $375 (teacher assistants; NCDPI, 2012). This stopped after the 2007-2008 school year (NCDPI, 2012). In 2006, new growth formulas were implemented to measure changes in student performance from 1 year to the next (NCDPI, 2011).

In 2008, the North Carolina State Board of Education adopted, "Framework for Change: The Next Generation of Assessments and Accountability" (NCDPI, 2011). This brought a change to the standards, assessments, and accountability model in North Carolina public schools (NCDPI, 2011). In 2010, North Carolina was one of 12 states to receive a competitive federal grant titled RttT, which brought nearly $400 million dollars to the state educational system (NCDPI, 2015b). To receive this grant, North Carolina completed an application process in which state education leaders laid out a plan for remodeling and revamping certain aspects of the state's public school system (NCDPI, 2015b). The READY initiative was North Carolina's broad plan to ambitiously increase student achievement, close achievement gaps, increase the number of graduates who were college and career ready, and ensure that every student is taught by excellent teachers (NCDPI, 2015b).

The READY model included the adoption of CCSS, a new accountability model, revised teacher and principal evaluations, and the digital suite of classroom management tools and instructional resources known as HomeBase (NCDPI, 2015b). As part of the initiative, NCDPI (2015b) revised the educator effectiveness standards and evaluations to include standardized test scores. According to NCDPI (2014b), a value-added growth model was implemented to measure student growth as a part of the educator effectiveness process. Standard VI for the educator effectiveness standards states that teachers will contribute to the academic success of all students (NCDPI, 2015d). Teachers are evaluated in part by the standardized test scores that their students receive (NCDPI, 2015d). Teacher effectiveness ratings are annually assigned based on student growth data in the following grades/courses/subjects: Grades 3-8 English language arts and mathematics, Grades 5 and 8 science, biology, Math I, and English II (NCDPI, 2015d). Also, analysis of student work, career and technical assessments, and North Carolina final exams in non-EOC high school content classes function as measures of student achievement (NCDPI, 2015d).

NCDPI (2011) reported multiple scores after standardized tests are taken. Achievement levels, development scales, and percentile ranks are reported (NCDPI, 2011). The achievement levels began as four levels (1, 2, 3, or 4), with levels 3 and 4 considered proficient (NCDPI, 2011). These levels of proficiency were criterion-referenced (NCDPI, 2011). The North Carolina State Board of Education adopted College and Career Readiness (CCR) academic achievement standards and descriptors in October 2013 (NCDPI, 2014b). In March 2014, the North Carolina State Board of Education adopted a new achievement level 3 and added a level 5 (NCDPI, 2014b). The level 3 of proficiency identified students who are prepared for the next grade level but do not meet CCR Standards (NCDPI, 2014b). See Table 2.

Table 2

North Carolina Achievement Levels

Achievement Level	Meets On-Grade-Level Proficiency Standard	Meets College-and-Career Readiness Standard
Level 5 denotes Superior Command of knowledge and skills	Yes	Yes
Level 4 denotes Solid Command of knowledge and skills	Yes	Yes
Level 3 denotes Sufficient Command of knowledge and skills	Yes	No
Level 2 denotes Partial Command of knowledge and skills	No	No
Level 1 denotes Limited Command of knowledge and skills	No	No

(NCDPI, 2014b)

NCDPI (2014b) released level descriptors to accompany Table 2. "Students performing at this level [Level 1] have limited command of the knowledge and skills contained in CCSS for Mathematics and are likely to need intensive academic support to engage successfully in further studies in this content area" (NCDPI, 2014b, p. 2).

Students performing at Level 2 are described as having partial command of CCSS and will likely need additional academic support (NCDPI, 2014b). Students scoring a Level 3 are stated to have sufficient command of CCSS, may need academic support, and are prepared for the next grade level but are not yet on track for CCR without extra academic support (NCDPI, 2014b). Students are described as having a solid command of CCSS and are academically prepared for further mathematical studies when they score a Level 4 (NCDPI, 2014b). Students who score a Level 5 on the EOG are stated to have superior knowledge of CCSS and are well-prepared for further mathematical studies (NCDPI, 2014b). North Carolina reports the percentage of students who meet CCR (Level 4 and 5) and also the percentage of students who meet grade-level proficiency as determined by the State Board of Education descriptors (Level 3, 4, and 5; NCDPI, 2014b). CCR standards (Level 4 and 5) are used to report Annual Measurable Objectives (AMOs) to the federal government (NCDPI, 2014b). The READY accountability reports and the North Carolina Report Card contain both the grade-level proficient (Level 3 and up) and CCR standard (Levels 4 and up; NCDPI, 2014a). State school performance grades are assigned based on grade-level proficient (Level 3 and up) student scores (NCDPI, 2014a).

NCSCoS is reviewed and accepted or modified by the State Board of Education every 5 years. This 5-year cycle includes input from stakeholders, current research, and revisions, if necessary, before the standards are brought forth to the State Board of Education (NCDPI, 2011). In July 2010, the State Board of Education voted on and accepted new English language arts and mathematics standards, which are CCSS (NCDPI, 2015c). The current mathematics and reading standards were fully implemented state-wide during the 2012-2013 school year (NCDPI, 2014a). For the 2013-2014 school year, the North Carolina State Board of Education, per legislation, began to designate all North Carolina public schools' overall scores for student achievement, student growth, and performance (NCDPI, 2014b). These school performance grades are either A, B, C, D, or F with designations of met, exceeded, or did not meet expected annual student growth (NCDPI, 2014b). These labels are reported on the publicly announced school report cards (NCDPI, 2014b).

The current North Carolina mathematics EOG test is in its fourth edition (NCDPI, 2015c). Grades 3-8 and Math I are the grades and course used to measure a student's proficiency on the mathematics NCSCoS through an EOG or end-of-course (EOC) test, which are North Carolina's standardized assessments (NCDPI, 2015c). Those scores are what is reported to the federal government, used in part (with other EOG/EOC test results, if applicable) to determine teacher effectiveness, and used to rank schools and districts (NCDPI, 2015c). In Grades 3 and 4, the math EOG tests contain four-response multiple choice items (NCDPI, 2015c). On the math EOG tests for Grades 5 through 8 and the Math I EOC, students answer four-response multiple choice questions as well as gridded responses which require numerical responses (NCDPI, 2015c). These gridded response items account for approximately 20% of the assessment (NCDPI, 2015c). The math EOG tests for Grades 3-8 and Math I EOC tests are broken down into two separate parts: calculator active and calculator inactive (NCDPI, 2015c). The calculator inactive portion accounts for one third to one half of the elementary and middle school EOG tests, while it accounts for approximately one third of the high school EOC tests (NCDPI, 2015c).

Purpose Statement

In this study, the researcher examined teacher self-efficacy in mathematics and the use of specific mathematical instructional practices in Grades 3-5 classrooms. The researcher also examined the relationships among teacher self-efficacy of teaching mathematics, the use of specific mathematical instructional practices, and student achievement on the North Carolina EOG test. According to the National Mathematics Advisory Panel (2008), differences in students' mathematical achievement are credited to differences in teacher characteristics, including their self-efficacy in teaching and use of specific instructional practices. The study sought to add to the research behind that finding.

Summary

This chapter examined the research surrounding the three variables addressed in this study: teacher self-efficacy, mathematical instructional practices, and student achievement. Teacher self-efficacy research yields information on the origins and history of this construct as well as frameworks that have been created. Moreover, research yielded detailed findings on the impact that teacher self-efficacy has on the classroom. Mathematical teacher self-efficacy has also been studied as a variable in student achievement. The second variable, mathematical instructional practices, was broken down into specific instructional strategies that mathematics teachers employ in daily lessons. Research around the six specified instructional practices continues to produce studies focusing on the importance they play in the classroom. The last variable, student achievement, was viewed through the lenses of the history of standardized testing, high-stakes testing, and North Carolina student achievement in the form of EOG tests. This study intended to research the relationship among teacher self-efficacy in teaching mathematics, instructional practices in mathematics, and student achievement as measured by the North Carolina EOG test of mathematics. The next chapter examines the methodology used in this study.

Chapter 3: Methodology

The purpose of this research was to examine and analyze the relationships among teacher self-efficacy in mathematics, instructional practices in mathematics, and student achievement. This chapter describes the methodology of this study by describing participants and instruments as well as the data collection procedures and analysis.

Participants

There are 13 elementary schools in this rural district in North Carolina. All 105 third- through fifth-grade mathematics teachers in this district were invited to participate in the study. Fifty-four teachers chose to participate (n=54). The researcher delimited the study to third- through fifth-grade math teachers to ensure that the study had a consistent validation measure which was the North Carolina mathematics EOG tests in these grades. The student demographics include 78.97% Caucasian, 4.16% African American, 13.19% Hispanic/Latino, 0.27% American Indian, 0.33% Asian, 3.06% Two or More, and 0.02% Pacific Islander. The free and reduced lunch rate for this district is 47.61% (District Accountability Office, personal communication, July 3, 2015). During the 2014-2015 school year, this district served 2,104 third- through fifth-grade students (District Accountability Office, personal communication, July 3, 2015). Teacher phone interviews were conducted to gather qualitative data regarding mathematical instructional practices as well as teacher self-efficacy in mathematics. Participants for the phone interviews were chosen randomly from the pool of third- through fifth-grade mathematics teachers participating in the study (n=54). The researcher spoke with these teachers either during a teacher workday or during a grade level planning time, depending on the schedule of the teachers and principal or curriculum facilitator recommendations.

Research Design

This study was a mixed-method design. Creswell (2012) stated that "the basic assumption is that the uses of both quantitative and qualitative methods, in combination, provide a better understanding of the research problem and question than either method by itself" (p. 535). Teacher self-survey results (SETMI and TIPS), scores from the curriculum facilitators' TIPS survey, and EOG scores quantified the study. Teacher interviews fulfilled the qualitative side of this mixed-methods study. The teacher self-efficacy and the use of mathematic instructional practices research data came from one point in time in the form of a survey. Curriculum facilitators completed a TIPS survey for each teacher participating in the study during the spring of the 2015-2016 school year. Student achievement research data were collected from one point in time in the form of EOG test scores. To further investigate mathematical instructional practices, teacher interviews were conducted to collect qualitative data. The researcher sought to determine relationships among teacher self-efficacy, the use of certain mathematical practices, and student achievement.

Instruments

Demographic questions were added to the beginning of the teacher self-efficacy survey. These questions were self-reported by the participants completing the online survey. Teacher self-efficacy is defined as a belief of his or her abilities to bring out preferred student engagement and learning in all students as well as their beliefs surrounding the ability to teach their subject matter even to difficult students (Bandura, 1977; Holzberger et al., 2013; Tschannen-Moran & Hoy, 2001, 2007). The instrument used to measure teacher self-efficacy was SETMI, developed in 2010 by McGee and further revised by McGee in 2012. The 22-item survey uses a 5-point Likert-scale response: 1–none at all, 2–very little, 3–strong degree, 4–quite a bit, and 5–a great deal. Reliability of SETMI was determined by calculating Cronbach's Alpha. The item questions fall into two subscale constructs of teacher self-efficacy: efficacy for pedagogy in mathematics and efficacy for teaching mathematics content. Table 3 shows the reliabilities and descriptive statistics for each construct of teacher self-efficacy measured on SETMI.

Table 3

Reliability and Descriptive Statistics of the Constructs

	α	M	SD
Efficacy for Pedagogy in Mathematics	.86	3.68	.57
Efficacy for Teaching Mathematics Content	.93	3.39	.64

(McGee & Wang, 2014)

To determine the subscales for the two aspects of teacher self-efficacy measured by SETMI (pedagogy in mathematics and teaching mathematics content), the authors computed unweighted means of the items that load on each factor. For pedagogy in mathematics, questions 1-7 were grouped. For efficacy for teaching mathematics, questions 8-22 were grouped (McGee & Wang, 2014).

SETMI was developed using two instruments as a framework for the creation of items. TSES developed by Tschannen-Moran and Hoy (2001) was used to guide work on the SETMI. The short form of TSES contains 12 questions that address three constructs: efficacy in student engagement, efficacy in instructional strategies, and efficacy in classroom management. The instrument Teaching Mathematics in Inclusive Settings was also used as a guide for SETMI. This instrument uses the TSES short form, modified to be specific to teaching mathematics. It also contains mathematics content items (McGee, 2012). SETMI is broken up into two moderately correlated factors: Efficacy for Pedagogy in Mathematics (questions 1-7) and Efficacy for Teaching Mathematics Content (questions 8-22; McGee, 2012). SETMI was revised in 2012 to "both simplify the factor structure and to align mathematics content items more closely with the state standard course of study" (McGee, 2012, p. 106).

Construct validity of SETMI was tested using confirmatory factor analysis (CFA). Findings indicated that SETMI is a valid and reliable measure of two aspects of teacher self-efficacy in mathematics: pedagogy in mathematics and teaching mathematics content (McGee & Wang, 2014). Correlating the two aspects provided evidence of validity. The purpose of this analysis was to provide confirmation that items in Part 2 were true measures of self-efficacy. Part 1 of SETMI was compared against Part 2. A scale score for pedagogy in mathematics and efficacy in teaching mathematics content was computed for each participant after missing values were imputed with the means of their respective constructs. Correlations between these two aspects were examined (McGee & Wang, 2014).

> Evidence of validity for test content and response processes were provided through consultation with the state Standard Course of Study and Common Core Standards for Kindergarten through fifth grade, elementary mathematics experts, elementary education experts, and a focus group of elementary teachers. (McGee & Wang, 2014, pp. 397-398)

To gather data on the instructional practices that the elementary mathematics teachers use in their teaching, participants completed TIPS developed by Haas in 2002. Haas (2002) designed TIPS as part of his study to determine the effect of teaching methods on student achievement. The purpose of this instrument is to identify the instructional strategies used by mathematics teachers and use it to compare these strategies to student achievement. Haas grouped teaching methods in six categories resulting from a meta-analysis he conducted. As addressed in Chapter 2, these categories are (1) cooperative learning; (2) communication and study skills; (3) technology-aided instruction; (4) problem-based learning; (5) manipulatives, models, and multiple representations; and (6) direct instruction. Since the study was conducted with Grades 7-12, the researcher obtained permission to use the instrument with elementary Grades 3-5. The data analysis for internal consistency was the split-half technique. The reliability coefficient of r=.89 was obtained by using the Spearman-Brown prophecy formula (Haas, 2002).

Another defined variable in this study is student achievement. This was measured by student scale scores on the EOG assessments. Student achievement data were taken from the North Carolina mathematics EOG tests, which were given within the last 10 days of school. NCDPI uses the state tests to monitor student growth and student performance (NCDPI, 2015c). According to NCDPI (2015c),

> when properly administered and interpreted, [EOG’s] provide reliable and valid information that enables:
>
> students to know the extent to which they have mastered expected knowledge and skills and how they compare to others;
>
> parents to know if their children are acquiring the knowledge and skills needed to succeed in highly competitive job market;
>
> teachers to know if their students have mastered grade-level knowledge and skills in the curriculum and, if not, what weaknesses need to be addressed;

community leaders and lawmakers to know if students in NC schools are improving their performance over time;

citizens to assess the performance of the public schools. (pp .6-7)

Reliability is defined as the consistency of a measure (Huck, 2012). For the purpose of EOG testing, reliability is needed when the testing procedure is repeated on a population (NCDPI, 2015c). An internal consistency coefficient is used to quantify the reliability of mathematics EOG tests (NCDPI, 2015c). According to NCDPI (2014a), “test scores must be reliable if any valid inferences are to be made on examinees’ performances. The North Carolina Statewide Testing Program meets or exceeds industry norms for reliability” (p. 1). The procedure uses coefficient alpha. The North Carolina Statewide Testing Program maintains a reliability coefficient of at least 0.85 on multiple choice tests (NCDPI, 2015c). See Table 4.

Table 4

EOG Mathematics Reliabilities (Cronbach Coefficient Alpha)

Grade	Form A	Form B	Form C
3	0.91	0.92	0.91
4	0.92	0.92	0.92
5	0.91	0.92	0.91
6	0.93	0.93	0.93
7	0.93	0.93	0.93
8	0.92	0.92	0.92

Table 4 shows the reliability coefficients for the math EOG tests in Grades 3-8 on all forms of the assessment. Validity is the degree to which evidence and theory support the interpretation of the test scores and how well the test fulfills its functions founded on scientific basis (NCDPI, 2015c). NCDPI addresses the validity of the tests from the first stage of development through the analysis and even reporting of scores (NCDPI, 2015c). Reading and mathematics EOG test validity differ in the process.

The mathematics EOG test items are written to measure the math constructs in the state curriculum (NCDPI, 2015c). NCDPI contracts a major testing company to handle the logistics. North Carolina teachers write at least half of the test items and are trained to do so (NCDPI, 2015c). The items are reviewed by at least two other North Carolina math content teachers and are finally reviewed by an Exceptional Children's and English as a Second Language specialist to ensure content validity (NCDPI, 2015c). The instructional validity is measured through teacher surveys sent to teachers who teach and test the subjects and grades in which EOGs are administered.

To determine criterion-related validity, a Pearson coefficient is used to provide a measure of association between the scale score and external variables (NCDPI, 2015c). The external variables defined for the math EOG tests are teacher judgments of student achievement, expected grade, and achievement level (NCDPI, 2015c). The math state tests' correlation coefficients range from 0.47 to 0.81, which indicates a moderate to strong correlation between the scale score and above-mentioned external variables (NCDPI, 2015c).

Procedures

After IRB approval, the researcher obtained permission from the district superintendent before proceeding with the research. Written permission is found in Appendix A. Also, permission to use SETMI for research purposes was granted on November 25, 2014 by developer Dr. Jennifer McGee. This printed letter is found in Appendix B. Permission to use TIPS for research purposes was granted on July 7, 2014 by developer Dr. Steven Haas. This printed letter is found in Appendix C. Dr. Haas also gave permission for TIPS to be modified for the use of a curriculum facilitator to complete on each third-, fourth-, and fifth-grade math teacher in their respective school. This printed letter is found in Appendix D.

After permission was granted by district and IRB approval was secured, the researcher contacted the Associate Superintendent of Curriculum and Instruction, as well as the Director of Elementary Education. The researcher also contacted the principals at the intended schools to gain permission to use their student data and to conduct the study in his or her school. This was done in email form. The principal permission letter is found in Appendix E.

After permission letters were sent to the principals, the researcher contacted the third- through fifth-grade math teachers at the school via email, explaining the purposed study. See Appendix F.

The survey was distributed to teachers in early 2016. This was done through email. The survey (TIPS and SETMI) was combined and electronically sent using a Google Form. See Appendix G. Each teacher received a unique identifying number to enter when filling out the survey.

Teacher interviews were conducted in spring 2016. These interviews took place over the telephone during a work day and/or during a grade level planning period. Teachers from each grade level were randomly chosen to participate in the interviews. Questions for the teacher interviews were created by the researcher according to the results from the teacher survey. These questions focused on teacher self-efficacy of teaching mathematics and mathematical instructional practices.

Curriculum facilitators were contacted and trained by the researcher. They agreed to complete a TIPS survey on each third- through fifth-grade math teacher with whom they worked. See Appendix H. The researcher trained the curriculum facilitators via virtual meeting in early 2016.

Data Collection

SETMI and TIPS were put into electronic form. These surveys were sent via Google Forms to teachers participating in the study. Demographic questions were added to the beginning of the survey to gather information on gender, grade level, years teaching, advanced degree status, National Board certification status, years in current position, and previous grades taught. These demographic questions did not jeopardize the integrity of the surveys. TIPS for curriculum facilitators were also sent in electronic form. Each elementary school in the district has a full-time curriculum facilitator. In order to validate and strengthen the instructional practices construct, each facilitator was sent TIPS to be completed on each participating third- through fifth-grade mathematics teacher. The developer (Haas, 2002) gave the researcher permission to reword the survey to be applicable to curriculum facilitators as they completed this survey according to their observations of teachers participating in the study.

To keep the data from the survey organized, each teacher and facilitator in a particular school participating in the study received a unique link to the survey. The surveys were the same, but the data from these teachers and facilitators were organized in a separate spreadsheet for each school. The participants were given a unique identifier (ex. T1, T2, T3) to keep the information anonymous to anyone viewing the data. The numbers were kept in a codebook spreadsheet by the researcher to be used when student achievement data were collected.

The researcher distributed the surveys to participating teachers and facilitators in early 2016. In the email that explained the study, participants were given the option of receiving the survey in paper form, if requested. Participants were given ample time and reminders to complete the surveys.

The researcher sent several email reminders. In these reminders, the researcher reiterated that the data collected were anonymous and would not be able to be traced back to individual teachers and/or schools. The researcher offered to send paper copies, but this was not requested by any teacher.

The researcher also conducted teacher interviews to further investigate teacher self-efficacy in teaching mathematics and mathematical instructional practices. These group interviews featured questions developed after the teachers completed SETMI and TIPS. The researcher randomly selected mathematics teachers from each grade level in the study. The researcher recorded the discussions taking place. The use of audio recording was fully disclosed to the participating teachers. The researcher gathered this qualitative data to strengthen the validity of the study.

Student achievement data were collected from the North Carolina EOG scores in mathematics for Grades 3-5. EOG test data were collected from the district accountability department. The scores for students in participating teachers' classes were used in the study. Scale scores for the EOG were collected. This determined the student's achievement for that school year. A mean score for each teacher was reported. The scores were kept in the spreadsheet codebook by the researcher so outside viewers could not connect the data to the student and/or teacher.

Data Analysis

The researcher used Statistical Package for the Social Sciences (SPSS) for all quantitative analysis. A password-protected codebook was utilized to code the responses for all participants from each instrument. The researcher also cleaned the data to inspect for scores outside the accepted ranges. The qualitative data were transcribed in the form of teacher interview notes. The originals of all data sources were destroyed.

To address the first research question (What mathematical instructional practices do teachers in Grades 3-5 use to promote mathematical knowledge and student achievement as measured by TIPS?), mathematical instructional practices were analyzed. Each participant received a score for each of the six subscales on TIPS. They are cooperative learning; communication and study skills; technology-aided instruction; problem-based learning; manipulatives, models, and multiple representations; and direct instruction. The same process was run for the data collected from TIPS completed by curriculum facilitators. Descriptive analysis was run on this variable. The researcher also cross-tabulated the teacher-reported scores with the scores reported by the curriculum facilitators.

To address the second research question (What is the level of these teachers' self-efficacy of teaching mathematics as measured by SETMI?), the researcher analyzed teacher self-efficacy in teaching mathematics. Each participant received a teacher self-efficacy score for each of the two subscale factors as well as a total self-efficacy score. These subscales on SETMI are efficacy for pedagogy in mathematics and efficacy for teaching mathematics content. Unweighted means of the items were loaded for each subscale as determined by McGee and Wang (2014). The sums of the subscales were calculated in order to determine one overall teacher self-efficacy in teaching mathematics score. Descriptive analysis was run on this variable.

To address the third research question (What are the relationships among teacher self-efficacy in teaching mathematics, the use of certain mathematical instructional practices, and student achievement as measured by the North Carolina EOG test?), correlational statistics was used to analyze the interaction or relationships among the variables. This study contains one outcome variable of student achievement as measured by EOG test scale scores on the mathematics assessments for students in Grades 3-5. Each student's scale score on the EOG was collected. A mean score was determined for each teacher. This score was used for correlational analysis with teacher self-efficacy of teaching mathematics and the use of mathematical instructional practices. There are two predictor variables in this study: teacher self-efficacy as measured by SETMI and mathematical instructional practices as measured by TIPS. SETMI and TIPS provided continuous, interval data. The EOG is one single score at one point in time. Each participant had a score for each variable. Multiple regression analysis was run by the researcher to determine the relationship among the three variables. A multiple regression analysis examines the impact that multiple variables have on an outcome as well as examines the combined relationship of multiple independent variables with a single dependent variable (Creswell, 2012).

Teacher interviews were conducted after data from SETMI and TIPS were collected and analyzed. Questions were determined based on the data analysis of aforementioned instruments. All interviews were recorded, and the researcher was also taking notes. All notes from the teacher interviews were analyzed for themes. This information was compared to the quantitative data collected.

Limitations and Delimitations

There are several limitations and delimitations associated with this study. First, the researcher delimited this study to Grades 3-5; therefore, the results could not be generalized to other grade levels. Second, the researcher delimited the study to one district which limits the ability to generalize the findings to other districts and across the state as a whole. Third, data regarding teacher self-efficacy in teaching mathematics and the use of mathematical instructional practices were collected through surveys. It can be assumed that not all of the data were accurately depicted. Additionally, student achievement test scores were collected at one point in time, in the form of a single snapshot. Finally, the relationship between the teacher and curriculum facilitator could limit the accuracy of the mathematical instructional practices data the curriculum facilitator reports.

Summary

The purpose of this study was to examine and analyze the relationships among teacher self-efficacy in teaching mathematics, the use of certain instructional mathematical practices, and student achievement. The study focused on third- through fifth-grade elementary school teachers. This chapter described the methodology that was used in this mixed-method correlational research. The results are described in the next chapter of this study.

Chapter 4: Results

The purpose of this research was to examine and analyze the relationships among teacher self-efficacy in mathematics, instructional practices in mathematics, and student achievement. Teacher self-efficacy in mathematics was measured using SETMI. Mathematical instructional practices were measured by TIPS. Student achievement was determined by the EOG assessment in mathematics. This chapter describes the data collected during the study as well the analysis of the findings. The findings are organized by research questions.

Findings

Research Question 1. What mathematical instructional practices do teachers in Grades 3-5 use to promote mathematical knowledge and student achievement as measured by TIPS? To gather data on the instructional practices that elementary mathematics teachers use in their teaching, the participants completed TIPS developed by Haas (2002). Haas grouped teaching methods into six categories resulting from a meta-analysis he conducted. As addressed in Chapter 2, these categories are (1) cooperative learning; (2) communication and study skills; (3) technology-aided instruction; (4) problem-based learning; (5) manipulatives, models, and multiple representations; and (6) direct instruction. The survey contains 48 questions, eight per instructional practice category. Participants were asked to indicate the number of times they use the instructional practice, given five typical mathematics class periods, from 0-5. The researcher determined an overall teacher score for each of the six instructional practice categories listed above. The curriculum facilitators completed the same survey for each participating teacher at their respective school. The researcher determined an overall curriculum facilitator score for each of the six instructional practice categories listed above.

Table 5 shows the descriptive statistics for teacher self-reported incidences of cooperative learning; communication and study skills; technology-aided instruction; problem-based learning; manipulatives, models, and multiple representations; and direct instruction in a given week.

Table 5

Descriptive Statistics for Teacher Scores (Mathematical Instructional Practices)

Constant	Mean	Standard Deviation	Median
Cooperative Learning	3.6852	.63911	4.00
Communication and Study Skills	4.2037	.65530	4.00
Technology-aided Instruction	1.9444	.83365	2.00
Problem-based Learning	3.5926	.94207	4.00
Manipulatives, Models, and Multiple Representations	3.0000	.80094	3.00
Direct Instruction	3.5556	.88310	4.00

The average cooperative learning score for Grades 3-5 mathematics teachers who participated in the study (n=54) was 3.69 (SD=.63911), which indicated that teachers, on average, used this instructional practice between three and four times per week. The minimum cooperative learning score was 2.00, which was qualified as twice per week. The maximum cooperative learning score was 5.00, which was qualified as every mathematics class period.

The average communication and study skills score for the teachers who participated in the study (n=54) was 4.20 (SD=.65530), which indicated that teachers, on average, used this instructional practice between four and five times per week. The minimum communication and study skills score was 2.00, which was qualified as twice per week. The maximum communication and study skills score was 5.00, which was qualified as every mathematics class period.

The average technology-aided instruction score for the teachers who participated in the study (n=54) was 1.94 (SD=.83365), which indicated that teachers, on average, used this instructional practice between one and two times per week. The minimum technology-aided instruction score was 1.00, which was qualified as once per week. The maximum technology-aided instruction score was 5.00, which was qualified as every mathematics class period.

The average problem-based learning score for the teachers who participated in the study (n=54) was 3.60 (SD=.94207), which indicated that teachers, on average, used this instructional practice between three and four times per week. The minimum problem-based learning score was 1.00, which was qualified as once per week. The maximum problem-based learning score was 5.00, which was qualified as every mathematics class period.

The average manipulatives, models, and multiple representations score for the teachers who participated in the study (n=54) was 3.00 (SD=.80094), which indicated that teachers, on average, used this instructional practice three times per week. The minimum manipulatives, models, and multiple representations score was 1.00, which was qualified as once per week. The maximum manipulatives, models, and multiple representations score was 5.00, which was qualified as every mathematics class period.

The average direct instruction score for the teachers who participated in the study (n=54) was 3.56 (SD=.88310), which indicated that teachers, on average, used this instructional practice between three and four times per week. The minimum direct instruction score was 2.00, which was qualified as twice per week. The maximum direct instruction score was 5.00, which was qualified as every mathematics class period.

Phone interviews were conducted with a random sampling of participating classroom teachers. These interviews took place during late May and early June 2016, after the teachers completed the surveys. The researcher interviewed 22 of the 54 (40.7%) participating teachers from multiple schools.

During the interviews, teachers strongly noted that a variety of instructional practices should be implemented during math lessons in order for students to succeed. They felt that they choose the instructional strategy or strategies based on their students and the content being taught. Many teachers explained that the EOG assessments do not allow for students to communicate and collaborate, so there is pressure to teach students in the way that they will be assessed and ultimately evaluated. It was noted during the interviews that teachers feel students enjoy cooperative learning strategies because they are able to work with peers and are learning without sometimes realizing it. Teachers implement these types of activities but not as often as they would like because of the EOG format. The EOG format was a common concern among the teachers. Many noted that the multiple choice format limits their creativity in their lessons because they feel they should prepare students for the assessment by exposing them to that type of test as much as possible. Interviews also revealed that teachers do not use technology-aided instruction often, which correlates with the mean score in Table 5. Teachers perceived technology-aided instruction as games students play on the computer, oftentimes purchased by the school. It was noted that this is usually reserved for low-performing students who need extra practice with a particular math skill.

Table 6 displays the cross-tabulation of cooperative learning incidences of the teachers by the curriculum facilitators, including the number as well as the percentages.

Teachers and curriculum facilitators chose a score based on how many times the mathematical instructional practice was used, given five typical class periods. The lowest score possible was 0 (never used) and the highest score was 5 (used every class period).

Table 6

Cross-Tabulation of Cooperative Learning Incidences of Teachers (CLT) by Curriculum Facilitator (CLCF)

		CLCF										
		1.00		2.00		3.00		4.00		5.00		Total
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count
CLT	2.00	0	0.0%	0	0.0%	0	0.0%	2	100.0%	0	0.0%	2
	3.00	0	0.0%	2	12.5%	5	31.3%	7	43.8%	2	12.5%	16
	4.00	1	3.0%	3	9.1%	13	39.4%	15	45.5%	1	3.0%	33
	5.00	0	0.0%	0	0.0%	0	0.0%	2	66.7%	1	33.3%	3
	Total	1	1.9%	5	9.3%	18	33.3%	26	48.1%	4	7.4%	54

The data in Table 6 provide the cooperative learning incidence score for the teachers by the cooperative learning incidence score for the curriculum facilitators. The chart shows that the curriculum facilitators stated that 48 of 54 (88.8%) teachers use cooperative learning practices three or more times a week. The table shows that 52 of 54 (96.3%) teachers self-reported using cooperative learning practices three or more times a week. The teachers rated themselves higher than the curriculum facilitators. There are 21 incidences of the teacher and curriculum facilitator agreeing on the frequency of teaching with cooperative learning practices. The majority of the responses from both teachers and curriculum facilitators fell between three and four times per week.

Table 7 displays the cross-tabulation of communication and study skills incidences of the teachers by the curriculum facilitators, including the number as well as the percentages.

Table 7

Cross-Tabulation of Communication and Study Skills Incidences of Teachers (CommT) by Curriculum Facilitators (CommCF)

		CommCF										
		1.00		2.00		3.00		4.00		5.00		Total
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count
CommT	2.00	0	0.0%	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1
	3.00	0	0.0%	2	50.0%	1	25.0%	1	25.0%	0	0.0%	4
	4.00	2	6.3%	4	12.5%	11	34.4%	13	40.6%	2	6.3%	32
	5.00	0	0.0%	4	23.5%	10	58.8%	3	17.6%	0	0.0%	17
	Total	2	3.7%	10	18.5%	22	40.7%	18	33.3%	2	3.7%	54

The data in Table 7 provide the communication and study skills incidence score for the teachers by the communication and study skills incidence score for the curriculum facilitators. The chart shows that the curriculum facilitators stated that 42 of 54 (77.8%) teachers use communication and study skills practices three or more times a week. The chart shows that 53 of 54 (98.2%) teachers self-reported using communication and study skills practices three or more times a week. The teachers rated themselves higher than the curriculum facilitators. There are 14 incidences of the teacher and curriculum facilitator agreeing on the frequency of teaching with communication and study skills practices. The majority of the responses from both teachers and curriculum facilitators fell between three and four times per week.

Table 8 displays the cross-tabulation of technology-aided instruction incidences of the teachers by the curriculum facilitators, including the number as well as the percentages.

Table 8

Cross-Tabulation of Technology-aided Instruction Incidences of Teachers (TAIT) by Curriculum Facilitators (TAICF)

		TAICF								
		1.00		2.00		3.00		4.00		Total
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count
TAIT	1.00	8	47.1%	6	35.3%	3	17.6%	0	0.0%	17
	2.00	8	32.0%	13	52.0%	3	12.0%	1	4.0%	25
	3.00	5	45.5%	4	36.4%	2	18.2%	0	0.0%	11
	5.00	0	0.0%	1	100.0%	0	0.0%	0	0.0%	1
	Total	21	38.9%	24	44.4%	8	14.8%	1	1.9%	54

The data in Table 8 provide the technology-aided instruction incidence score for the teachers by the technology-aided instruction incidence score for the curriculum facilitators. The chart shows that the curriculum facilitators stated that nine of 54 (16.7%) teachers use technology-aided instruction three or more times a week. The chart shows that 12 of 54 (22.2%) teachers self-reported technology-aided instruction three or more times a week. The teachers rated themselves higher than the curriculum facilitators. There are 23 incidences of the teacher and curriculum facilitator agreeing on the frequency of teaching with technology-aided instruction. The majority of the responses from both teachers and curriculum facilitators fell between one and three times per week.

Table 9 displays the cross-tabulation of problem-based learning incidences of the teachers by the curriculum facilitators, including the number as well as the percentages.

Table 9

Cross-Tabulation of Problem-based Learning Incidences of Teachers (PBLT) by Curriculum Facilitators (PBLCF)

		PBLCF										
		1.00		2.00		3.00		4.00		5.00		Total
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count
PBLT	1.00	0	0.0%	0	0.0%	1	50.0%	0	0.0%	1	50.0%	2
	2.00	0	0.0%	3	75.0%	1	25.0%	0	0.0%	0	0.0%	4
	3.00	1	6.7%	5	33.3%	5	33.3%	4	26.7%	0	0.0%	15
	4.00	1	3.8%	10	38.5%	8	30.8%	5	19.2%	2	7.7%	26
	5.00	1	14.3%	3	42.9%	3	42.9%	0	0.0%	0	0.0%	7
	Total	3	5.6%	21	38.9%	18	33.3%	9	16.7%	3	5.6%	54

The data in Table 9 provides the problem-based learning incidence score for the teachers by the problem-based learning incidence score for the curriculum facilitators. The chart shows that the curriculum facilitators stated that 30 of 54 (55.6%) teachers use problem-based instruction three or more times a week. The chart shows that 48 of 54 (88.9%) teachers self-reported problem-based instruction three or more times a week. The teachers rated themselves higher than the curriculum facilitators. There are 13 incidences of the teacher and curriculum facilitator agreeing on the frequency of teaching with problem-based instruction. The majority of the responses from both teachers and curriculum facilitators fell between two and four times per week.

Table 10 displays the cross-tabulation of manipulatives, models, and multiple representations incidences of the teachers by the curriculum facilitators, including the number as well as the percentages.

Table 10

Cross-Tabulation of Manipulatives, Models, and Multiple Representations Incidences of Teachers (MMMT) by Curriculum Facilitators (MMMCF)

		MMMCF										
		1.00		2.00		3.00		4.00		5.00		Total
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count
MMMT	1.00	0	0.0%	1	50.0%	0	0.0%	1	50.0%	0	0.0%	2
	2.00	0	0.0%	4	40.0%	4	40.0%	2	20.0%	0	0.0%	10
	3.00	3	10.3%	13	44.8%	7	24.1%	5	17.2%	1	3.4%	29
	4.00	0	0.0%	4	33.3%	8	66.7%	0	0.0%	0	0.0%	12
	5.00	0	0.0%	0	0.0%	1	100.0%	0	0.0%	0	0.0%	1
	Total	3	5.6%	22	40.7%	20	37.0%	8	14.8%	1	1.9%	54

The data in Table 10 provides the manipulatives, models, and multiple representation incidence score for the teachers by the manipulatives, models, and multiple representations incidence score for the curriculum facilitators. The chart shows that the curriculum facilitators stated that 29 of 54 (53.7%) teachers use manipulatives, models, and multiple representations instruction three or more times a week. The chart shows that 42 of 54 (77.8%) teachers self-reported manipulatives, models, and multiple representations instruction three or more times a week. The teachers rated themselves higher than the curriculum facilitators. There are 11 incidences of the teacher and curriculum facilitator agreeing on the frequency of teaching with manipulatives, models, and multiple representations instruction. The majority of the responses from both teachers and curriculum facilitators fell between two and three times per week.

Table 11 displays the cross-tabulation of direct instruction incidences of the teachers by the curriculum facilitators, including the number as well as the percentages.

Table 11

Cross-Tabulation of Direct Instruction Incidences of Teachers (DIT) by Curriculum Facilitators (DICF)

		DICF										
		1.00		2.00		3.00		4.00		5.00		Total
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count
DIT	2.00	0	0.0%	0	0.0%	1	14.3%	4	57.1%	2	28.6%	7
	3.00	2	11.8%	4	23.5%	7	41.2%	4	23.5%	0	0.0%	17
	4.00	0	0.0%	1	4.3%	11	47.8%	10	43.5%	1	4.3%	23
	5.00	0	0.0%	2	28.6%	3	42.9%	2	28.6%	0	0.0%	7
	Total	2	3.7%	7	13.0%	22	40.7%	20	37.0%	3	5.6%	54

The data in Table 11 provides the direct instruction incidence score for the teachers by the direct instruction incidence score for the curriculum facilitators. The chart shows that the curriculum facilitators stated that 45 of 54 (83.3%) teachers use direct instruction three or more times a week. The chart shows that 47 of 54 (87.0%) teachers self-reported direct instruction three or more times a week. The teachers rated themselves higher than the curriculum facilitators by a small margin. There are 17 incidences of the teacher and curriculum facilitator agreeing on the frequency of teaching with direct instruction. The majority of the responses from both teachers and curriculum facilitators fell between two and four times per week.

Research Question 2. What is the level of these teachers' self-efficacy of teaching mathematics as measured by the SETMI? Teacher self-efficacy is defined as a belief of his or her abilities to bring out preferred student engagement and learning in all students as well as their beliefs surrounding the ability to teach their subject matter even to difficult students (Bandura, 1977; Holzberger et al., 2013; Tschannen-Moran & Hoy, 2001, 2007). The instrument used to measure teacher self-efficacy was SETMI, developed in 2010 by McGee and further revised by McGee in 2012. The 22-item survey uses a 5-point Likert-scale response: 1–none at all, 2–very little, 3–strong degree, 4–quite a bit, and 5–a great deal. The item questions fall into two subscale constructs of teacher self-efficacy: efficacy for pedagogy in mathematics and efficacy for teaching mathematics content. Teachers completed the survey in early 2016. To address this research question, the following data were collected and analyzed.

Table 12 shows the descriptive analysis for teacher self-efficacy of teaching mathematics. The researcher calculated a total score from both subscales of SETMI.

Table 12

Descriptive Analysis for Teacher Total Mathematics Self-Efficacy

			Statistic	Std. Error
Total Efficacy	Mean		3.7062	.08743
	95% Confidence Interval for Mean	Lower Bound	3.5309	
		Upper Bound	3.8816	
	5% Trimmed Mean		3.7097	
	Median		3.6591	
	Variance		.413	
	Std. Deviation		.64250	
	Minimum		2.05	
	Maximum		4.95	
	Range		2.91	
	Interquartile Range		1.05	
	Skewness		-.029	.325
	Kurtosis		-.532	.639

The average total self-efficacy score for Grades 3-5 mathematics teachers who participated in the study (n=54) was 3.71 (SD=.64250), which was between "strong degree" (score of 3) and "quite a bit" (score of 4). The minimum total self-efficacy score was 2.05, which was qualified as "very little." The maximum total self-efficacy score was 4.95, which was qualified as "quite a bit" but very close to "a great deal" (score of 5). The scores had a range of 2.91. The ratio of skewness to the standard error was

-.029, which indicates a slightly negative skewness of the sample distribution.

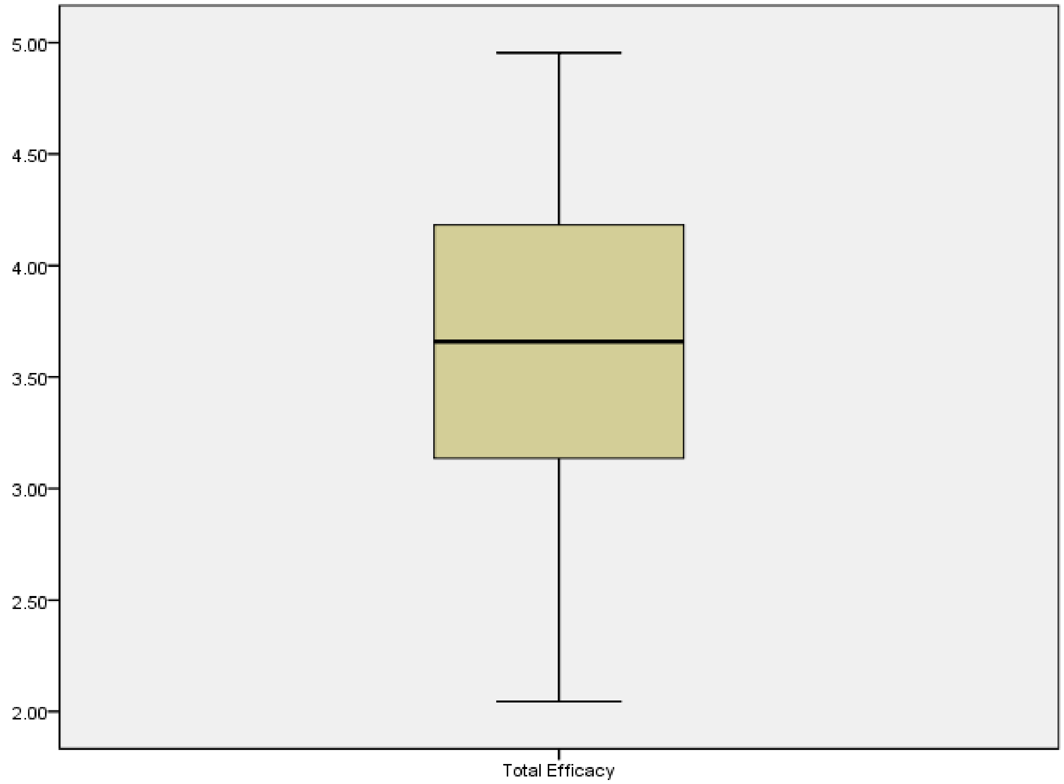

Figure 2. Box and Whisker Plot for Teacher Total Mathematics Self-Efficacy.

Figure 2 shows the box and whisker plot for the score of total self-efficacy of teaching mathematics. This plot summarizes the degree of variability within the data set. The box of teachers' total self-efficacy scores (n=54) shows that the scores do not vary greatly. The whiskers are of similar length, which indicates a fairly symmetrical distribution of scores.

Table 13 shows the descriptive analysis for teacher self-efficacy for pedagogy in mathematics. This is one of two subscales of SETMI.

Table 13

Descriptive Analysis for Teacher Efficacy for Pedagogy in Mathematics

			Statistic	Std. Error
Self-Efficacy Pedagogy	Mean		3.9788	.08414
	95% Confidence Interval for Mean	Lower Bound	3.8101	
		Upper Bound	4.1476	
	5% Trimmed Mean		3.9882	
	Median		3.9286	
	Variance		.382	
	Std. Deviation		.61830	
	Minimum		2.57	
	Maximum		5.00	
	Range		2.43	
	Interquartile Range		.86	
	Skewness		.024	.325
	Kurtosis		-.563	.639

The average teacher efficacy for pedagogy in mathematics score (n=54) was 3.98 (SD=.61830), which was between “strong degree” (score of 3) and “quite a bit” (score of 4) but very close to the latter. The minimum teacher efficacy for pedagogy in mathematics score was 2.57, which was qualified as “very little.” The maximum total self-efficacy score was 5.00, which was qualified as “a great deal.” The scores had a range of 2.43. The ratio of skewness to the standard error was .024, which indicates a slightly positive skewness of the sample distribution.

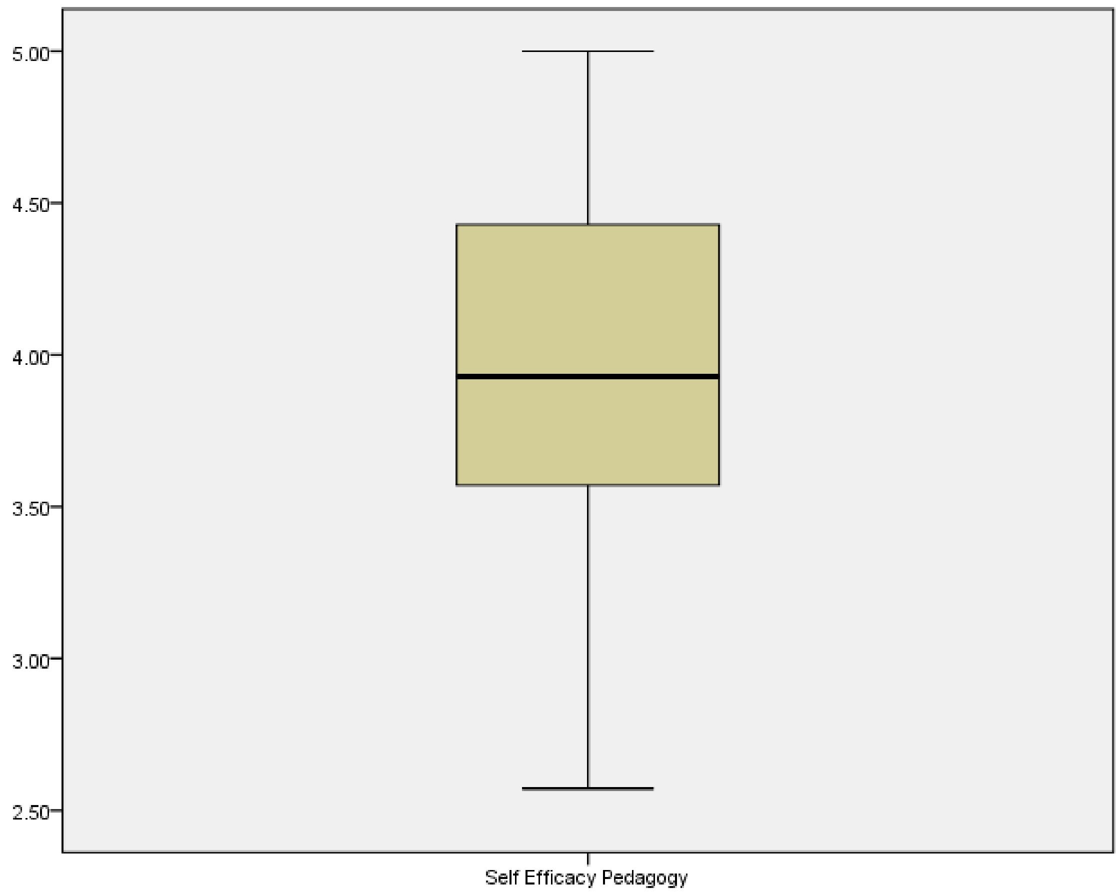

Figure 3. Box and Whisker Plot for Efficacy for Pedagogy in Mathematics.

Figure 3 shows the box and whisker plot for the score for efficacy for pedagogy in mathematics. This plot summarizes the degree of variability within the data set. The box of teacher efficacy for pedagogy in mathematics (n=54) shows that the scores do not vary greatly. The whiskers are of similar length, which indicates a fairly symmetrical distribution of scores.

Table 14 shows the descriptive analysis for teacher self-efficacy for teaching mathematics content. This is one of two subscales of SETMI.

Table 14

Descriptive Analysis for Efficacy for Teaching Mathematics Content

			Statistic	Std. Error
Efficacy for Teaching Math Content	Mean		3.5790	.09833
	95% Confidence Interval for Mean	Lower Bound	3.3818	
		Upper Bound	3.7762	
	5% Trimmed Mean		3.5863	
	Median		3.5667	
	Variance		.522	
	Std. Deviation		.72254	
	Minimum		1.80	
	Maximum		4.93	
	Range		3.13	
	Interquartile Range		1.08	
	Skewness		-.118	.325
	Kurtosis		-.683	.639

The average efficacy for teaching mathematics content score (n=54) was 3.58 (SD=.72254), which was between "strong degree" (score of 3) and "quite a bit" (score of 4). The minimum teacher efficacy for teaching mathematics content score was 1.80, which was qualified between "none at all" (score of 1) and "very little" (score of 2). The maximum total self-efficacy score was 4.93, which was qualified between "quite a bit" (score of 4) and "a great deal" (score of 5) but was very close to the latter. The scores had a range of 3.13. The ratio of skewness to the standard error was -.118, which indicates a slightly negative skewness of the sample distribution.

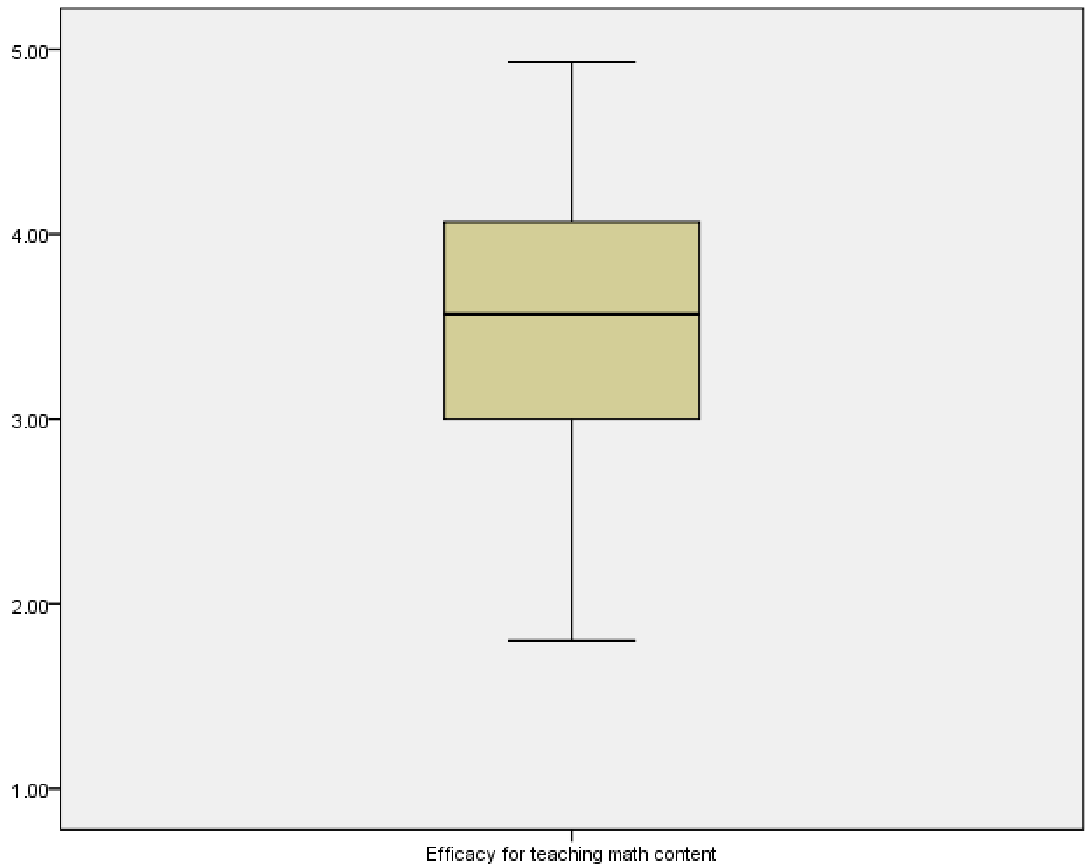

Figure 4. Box and Whisker Plot for Efficacy for Teaching Mathematics Content.

Figure 4 shows the box and whisker plot for the score for efficacy for teaching mathematics content. This plot summarizes the degree of variability within the data set. The box of teacher efficacy for teaching mathematics content scores (n=54) shows that the scores do not vary greatly. The whiskers are of similar length, which indicates a fairly symmetrical distribution of scores.

During interviews, teachers expressed a strong sense of efficacy for pedagogy in mathematics, which corresponds to the survey results. They felt that they are able to motivate the majority of students to perform well in mathematics during classroom instruction. A common concern was that the EOG assessments are oftentimes unaligned to what and how they teach mathematics. They expressed a desire to implement fun, engaging activities but claimed to limit them especially at the end of the year. The interviews revealed that teachers feel they can reach students who show low interest in mathematics by planning projects, collaboration time, and real-life examples. Teachers stated that they create their own formative and classroom level summative assessments. They noted that these assessments include a variety of strategies but a common concern is the pressure to familiarize students with multiple choice formats and test-taking strategies when answering a multiple choice question. As for providing alternative explanations or examples when students are confused, interviews revealed that teachers feel this is very important during mathematics instruction. They noted that the “new” standards emphasize the importance of students being able to solve problems in a variety of ways. Teachers find helping students understand and implement multiple ways to solve a problem difficult. They noted pushback from parents because it is different from the way they learned mathematics. Teachers expressed a need for more training on how to provide alternative explanations and examples.

Another common theme during the interviews was the pacing and time needed to instruct the mathematics standards. Teachers noted that it is difficult to build in times for review and remediation. An overall concern was the uncertainty of how long the current mathematics standards would be in place. Teachers feared that the current standards may change in the next year or 2. Teachers commented that the area of mathematics that is most difficult to teach is the area that they themselves struggle with currently or struggled with in school. The same was true for what area they find the easiest to teach. Teachers revealed that they enjoy teaching the area of mathematics that is or was the easiest for them to understand. Overall, the teachers expressed a need for more resources and training on how to teach one or more areas of the mathematics standards.

Research Question 3. What are the relationships among teacher self-efficacy in teaching mathematics, the use of certain mathematical instructional practices, and student achievement as measured by the North Carolina EOG test? To address this research question, the following data were collected and analyzed.

Table 15 shows the results of the Pearson correlation analysis between student achievement (EOG math test scores), total self-efficacy, efficacy for pedagogy in mathematics, and efficacy for teaching mathematics content. Creswell (2012) described correlational research as a study where researchers use a correlation statistic method to measure and define the degree of association or relationship between two or more variables. According to Cohen (as cited by Laerd Statistics, 2015), $0.1<| r |<.3$ yields small or weak correlations, $0.3<| r |<.5$ yields medium or moderate correlations, and $| r | > .5$ yields large or strong correlations.

Table 15

Correlations of Student Achievement and Teacher Self-Efficacy

		Total Efficacy	Self-Efficacy Pedagogy	Efficacy for Teaching Math Content
2015-2016 Math EOG Scores 3-5	Pearson Correlation	.229	.224	.209
	Sig. (2-tailed)	.096	.103	.130
	N	54	54	54

As shown in Table 15, the Pearson correlation coefficient shows a weak positive correlation between student achievement (average mathematics EOG scores) and teacher self-efficacy in mathematics (total teacher efficacy in mathematics scores). The correlation is illustrated in Figure 5.

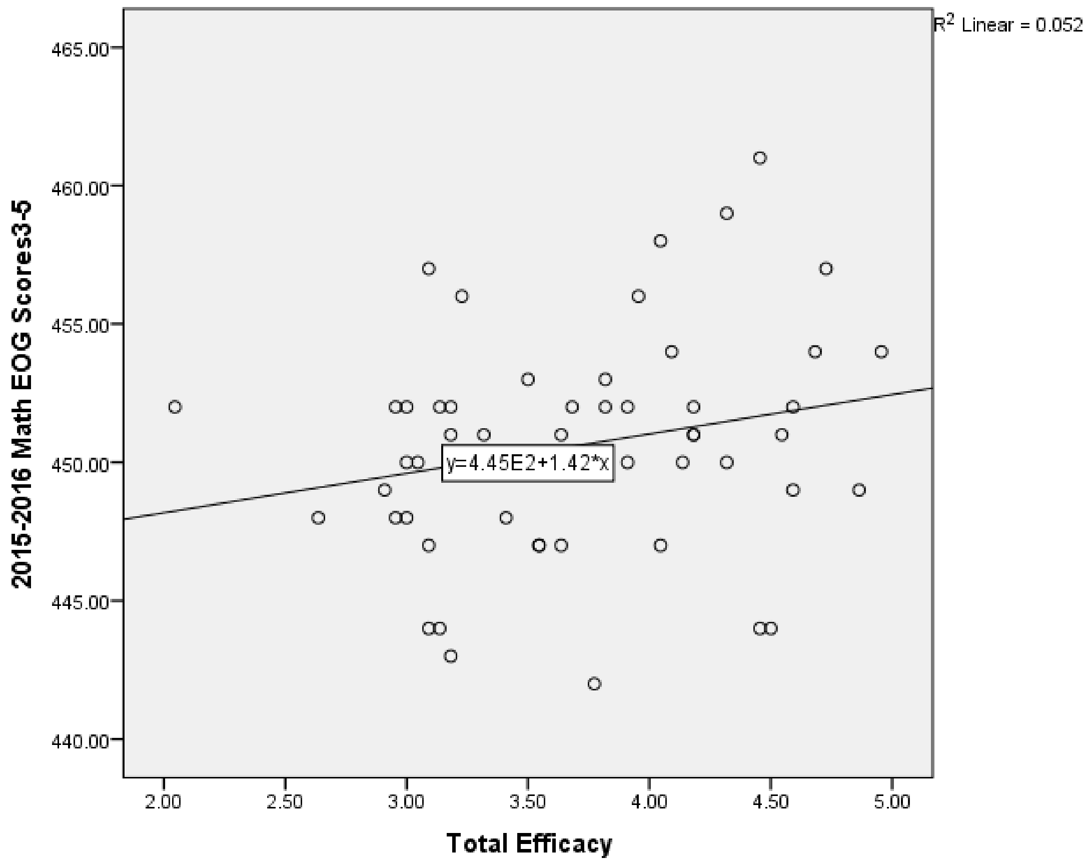

Figure 5. Student Achievement as Related to Teacher Self-Efficacy.

The correlation as indicated in Figure 5 reveals that there is a positive linear relationship between student achievement and teacher self-efficacy in mathematics, $r(52)=.229$, $p<.096$. The scatterplot shows that 5.2% of the variation of EOG scores can be explained by the total efficacy score ($r^2=.052$).

As shown in Table 15, the Pearson correlation coefficient shows there is a weak positive correlation between student achievement (average mathematics EOG scores) and teacher self-efficacy for pedagogy in mathematics, which is a teacher self-efficacy subscale on SETMI. The correlation is illustrated in Figure 6.

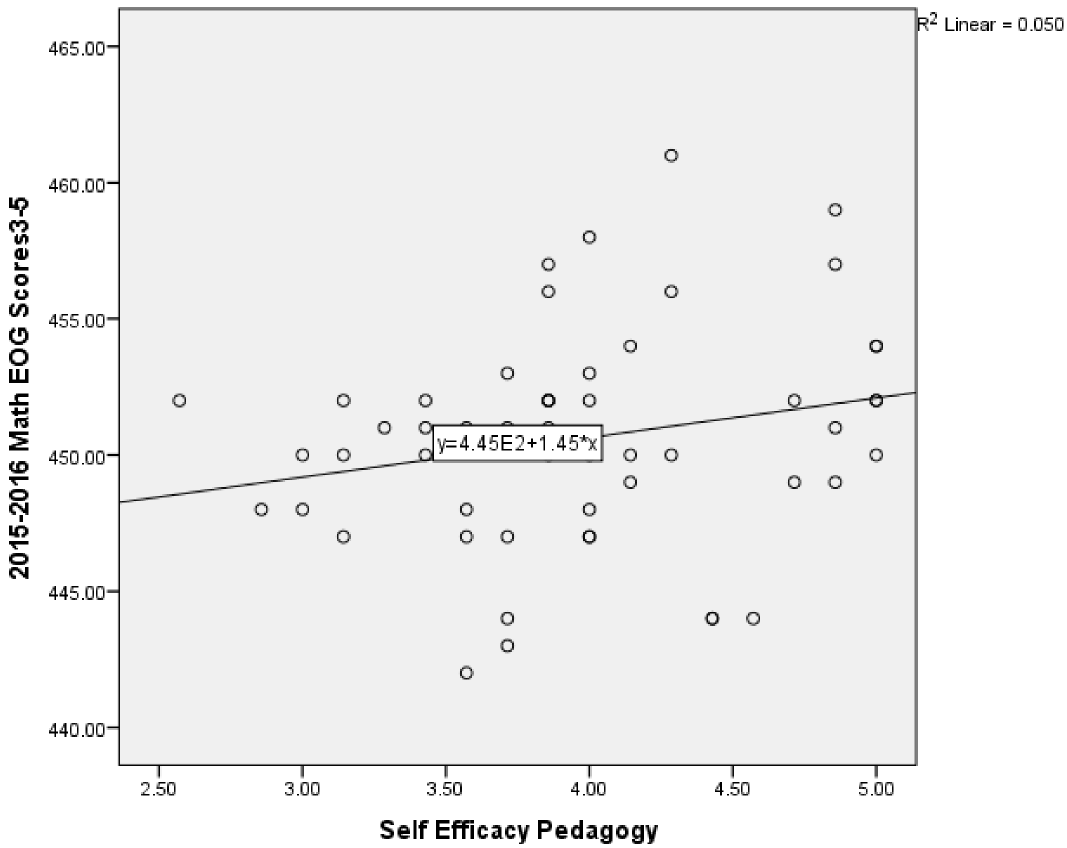

Figure 6. EOG Mathematics Scores as Related to Efficacy for Pedagogy in Mathematics.

The correlation as indicated in Figure 6 reveals that there is a positive linear relationship between student achievement and teacher self-efficacy in mathematics, $r(52)=.224$, $p<.103$. The scatterplot shows that 5.0% of the variation of EOG scores can be explained by the self-efficacy pedagogy score ($r^2=.050$).

As shown in Table 15, the Pearson correlation coefficient illustrates there is a weak positive correlation between student achievement (average mathematics EOG scores) and efficacy for teaching mathematical content, which is a teacher self-efficacy subscale on the SETMI. The correlation is illustrated in Figure 7.

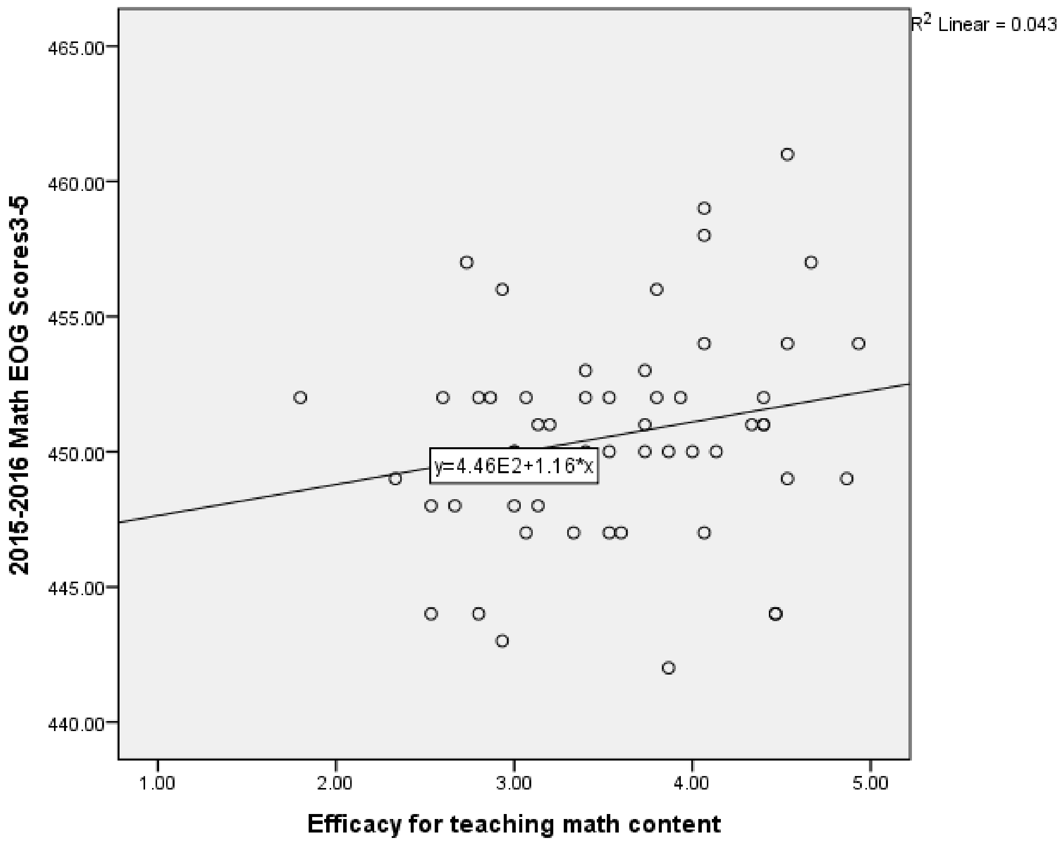

Figure 7. EOG Mathematics Scores as Related to Efficacy for Teaching Mathematical Content.

The correlation as indicated in Figure 7 reveals that there is a positive linear relationship between student achievement and teacher self-efficacy in mathematics, $r(52)=.209$, $p<.130$. The scatterplot shows that 4.3% of the variation of EOG scores can be explained by the efficacy for teaching math content score ($r^2=.043$).

Teachers claimed that they prepare students well for the EOG assessment during phone interviews. They expressed concern that the assessment is not in alignment with what the standards require students to know. They also expressed concern that the EOG does not assess Grades 3-5 students in a developmentally appropriate way. The interviews revealed that the teachers feel confident in their ability to motivate students to learn. Teachers noted that the real-life examples and collaborative projects enhance student engagement and motivation. They also expressed that they use mathematical examples containing student interests such as sports teams and television characters which increases student motivation.

Table 16 shows the results of the Pearson correlation analysis between student achievement (EOG math test scores) and the six mathematical instructional practices that were measured on TIPS. These instructional practices are cooperative learning; communication and study skills; technology-aided instruction; problem-based learning; manipulatives, models, and multiple representations; and direct instruction. These scores were self-reported by the participating teachers.

Table 16

Correlations of EOG Math Scores and Mathematical Instructional Practices

		Cooperative Learning Score	Communication and Study Skills	Technology-aided Instruction	Problem-based Learning	Manipulatives, Models, Multiple Representations	Direct Instruction
EOG Scores	Pearson Correlation	.032	.120	-.001	.015	.109	-.127
	Sig. (2-tailed)	.816	.387	.996	.913	.431	.360
	N	54	54	54	54	54	54

As shown in Table 16, the Pearson correlation coefficient shows no correlation between student achievement (average mathematics EOG scores) and cooperative learning. The correlation is illustrated in Figure 8.

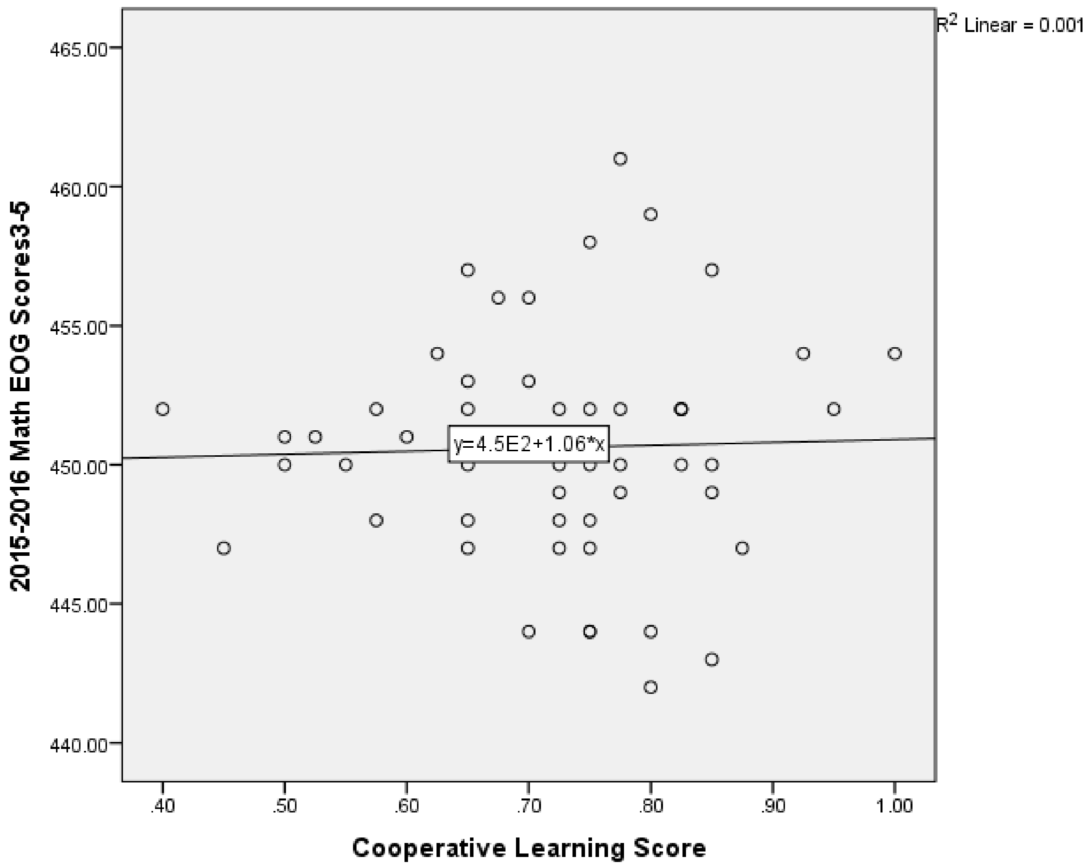

Figure 8. EOG Mathematics Scores as Related to Teacher Self-reported Cooperative Learning Frequency.

The correlation as indicated in Figure 8 reveals that there is no linear relationship between student achievement and teacher self-reported cooperative learning scores, $r(52)=.032$, $p<.816$. The scatterplot shows that 0.1% of the variation of EOG scores can be explained by the teacher self-reported cooperative learning score ($r^2=.001$).

As shown in Table 16, the Pearson correlation coefficient illustrates there is no correlation between student achievement (average mathematics EOG scores) and communication and study skills. The correlation is illustrated in Figure 9.

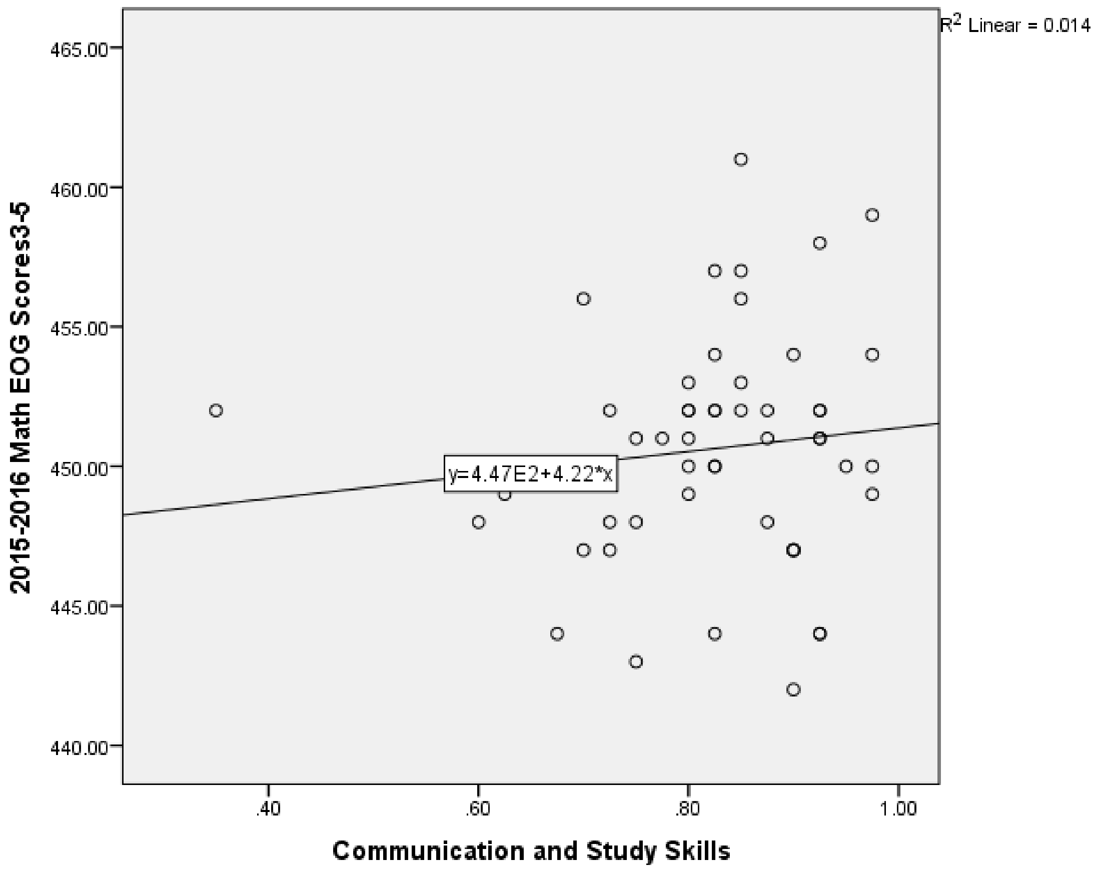

Figure 9. EOG Mathematics Scores as Related to Teacher Self-reported Communication and Study Skills Frequency.

The correlation as indicated in Figure 9 reveals that there is no linear relationship between student achievement and teacher self-reported communication and study skills scores, $r(52)=.120$, $p<.387$. The scatterplot shows that 1.4% of the variation of EOG scores can be explained by the teacher self-reported communication and study skills score ($r^2=.014$).

As shown in Table 16, the Pearson correlation coefficient illustrates there is no correlation between student achievement (average mathematics EOG scores) and technology-aided instruction. The correlation is illustrated in Figure 10.

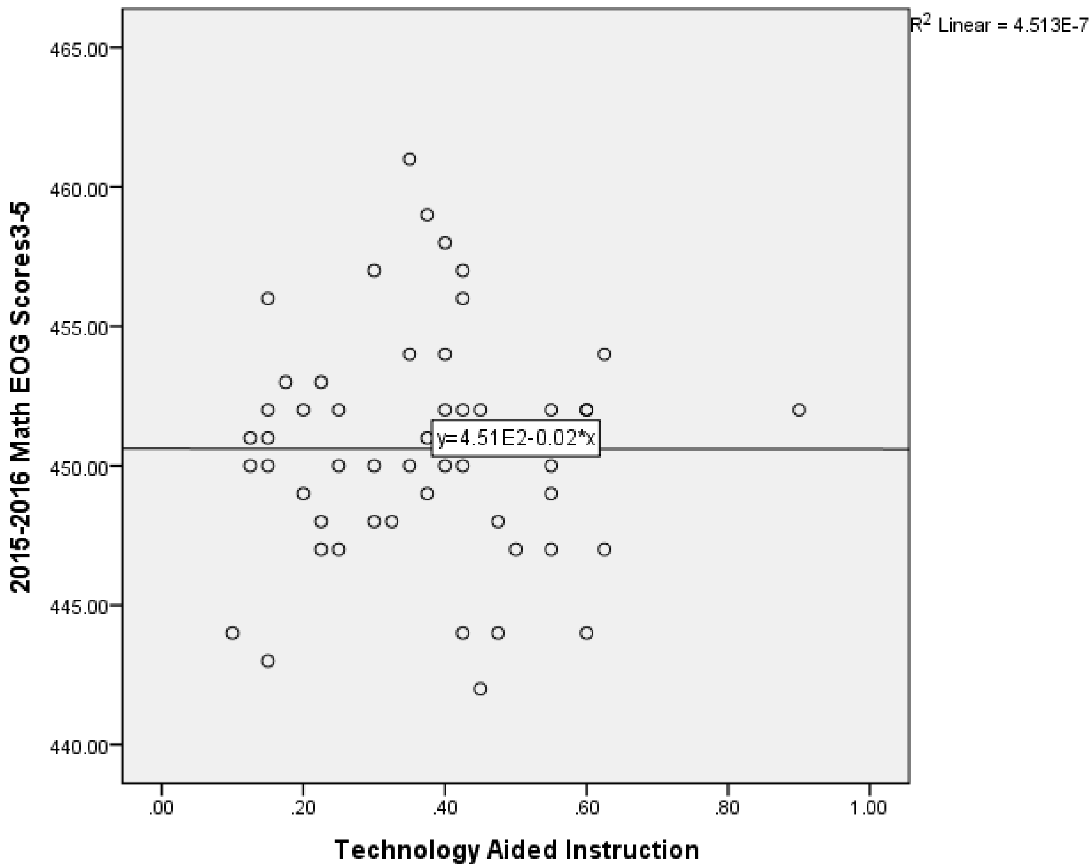

Figure 10. EOG Mathematics Scores as Related to Teacher Self-reported Technology-aided Instruction Frequency.

The correlation as indicated in Figure 10 reveals that there is a negative linear relationship between student achievement and teacher self-reported technology-aided instruction scores, $r(52)=-.001$, $p<.996$. The scatterplot shows that >0.01% of the variation of EOG scores can be explained by the teacher self-reported communication and study skills score ($r^2=4.51 \times 10^{-7}$).

As shown in Table 16, the Pearson correlation coefficient illustrates there is no correlation between student achievement (average mathematics EOG scores) and problem-based learning. The correlation is illustrated in Figure 11.

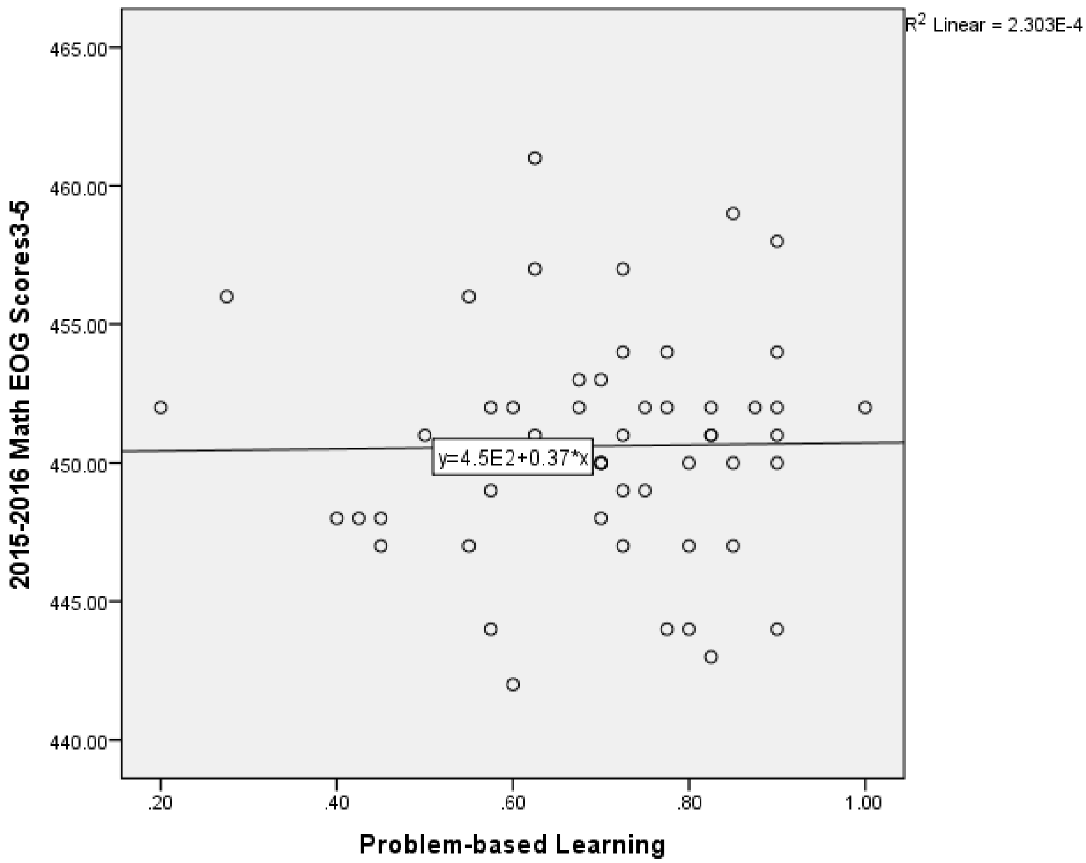

Figure 11. EOG Mathematics Scores as Related to Teacher Self-reported Problem-based Learning Frequency.

The correlation as indicated in Figure 11 reveals that there is no linear relationship between student achievement and teacher self-reported problem-based learning scores, $r(52)=.015$, $p<.913$. The scatterplot shows that >0.01% of the variation of EOG scores can be explained by the teacher self-reported problem-based learning score ($r^2=2.30x10^{-4}$).

As shown in Table 16, the Pearson correlation coefficient illustrates there is no correlation between student achievement (average mathematics EOG scores) and manipulatives, models, and multiple representations. The correlation is illustrated in Figure 12.

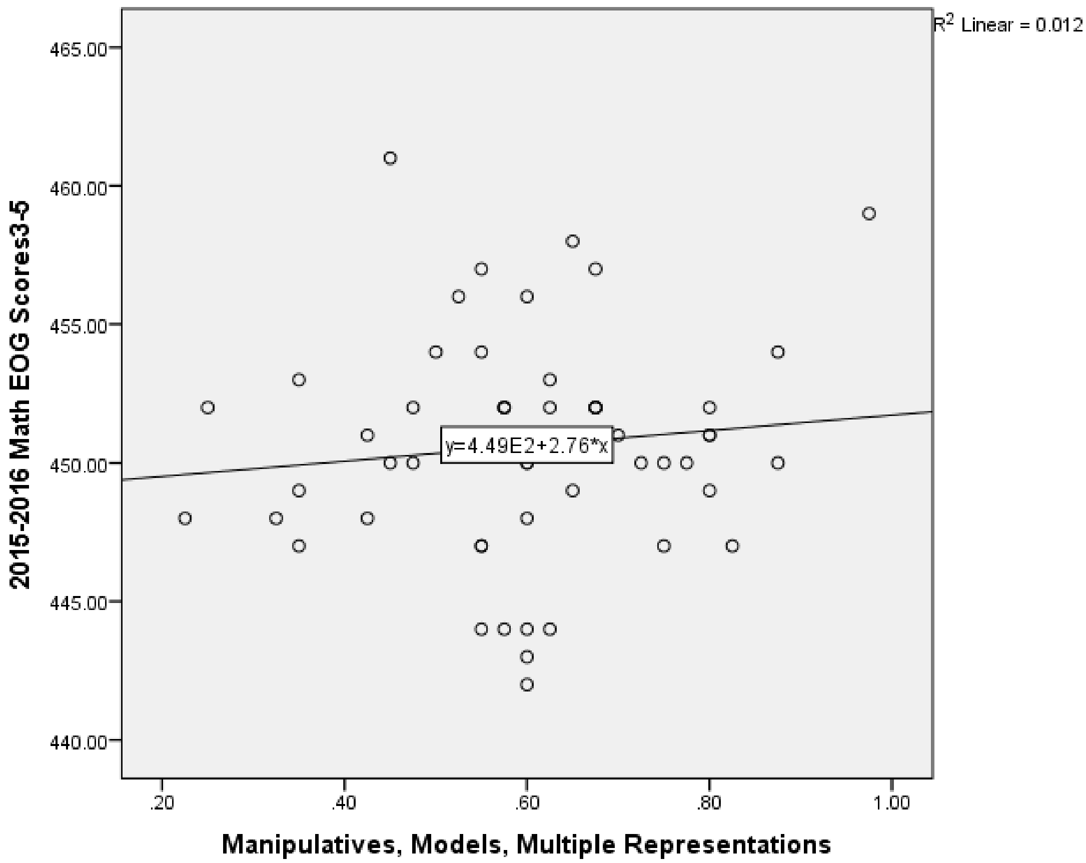

Figure 12. EOG Mathematics Scores as Related to Teacher Self-reported Manipulatives, Models, and Multiple Representation Instruction Frequency.

The correlation as indicated in Figure 12 reveals that there is no linear relationship between student achievement and teacher self-reported manipulatives, models, and multiple representations scores, $r(52)=.109$, $p<.431$. The scatterplot shows that 1.2% of the variation of EOG scores can be explained by the teacher self-reported manipulatives, models, and multiple representations score ($r^2=.012$).

As shown in Table 16, the Pearson correlation coefficient illustrates there is no correlation between student achievement (average mathematics EOG scores) and direct instruction. The correlation is illustrated in Figure 13.

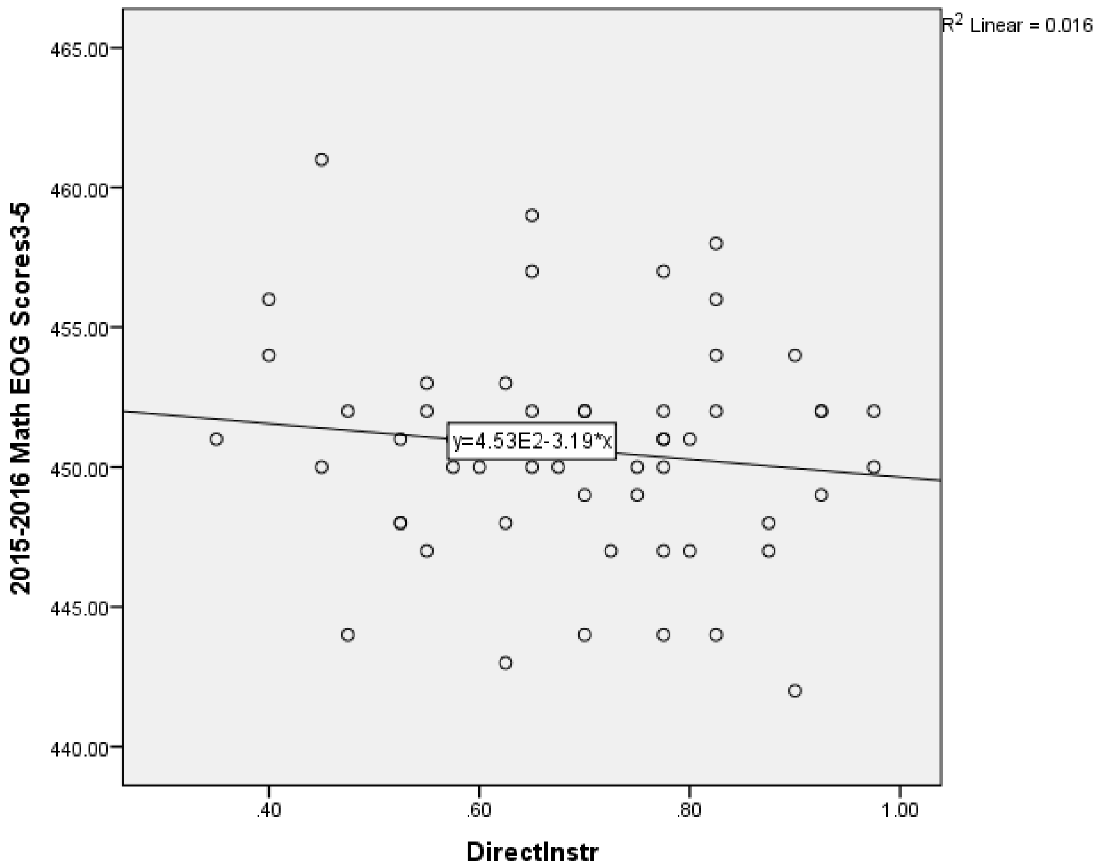

Figure 13. EOG Mathematics Scores as Related to Teacher Self-reported Direct Instruction Frequency.

The correlation as indicated in Figure 13 reveals that there is a negative linear relationship between student achievement and teacher self-reported direct instruction scores, $r(52)=-.127$, $p<.360$. The scatterplot shows that 1.6% of the variation of EOG scores can be explained by the teacher self-reported direct instruction score ($r^2=.016$).

During teacher interviews, participants claimed that direct instruction is an important part of learning for students. Teachers expressed a need to model thinking and solving for students. Another common theme during the teacher interviews was the feeling that not one instructional strategy is more effective or important than another. None of the instructional practices had a correlation to the student achievement.

Teachers noted that choosing an instructional strategy depends on the content being taught, as well as the students and their learning styles.

Table 17 shows the results of the Pearson correlation analysis between student achievement (EOG math test scores) and the six mathematical instructional practices that were reported by the curriculum facilitators on the TIPS.

Table 17

Correlations of EOG Scores and Curriculum Facilitator Mathematical Instructional Practices

		Curriculum Facilitator Cooperative Learning	Curriculum Facilitator Communication and Study Skills	Curriculum Facilitator Technology-aided Instruction	Curriculum Facilitator Problem-based Learning	Curriculum Facilitator Manipulatives, Models, Multiple Representations	Curriculum Facilitator Direct Instruction
EOG Scores	Pearson Correlation	.312	.252	.205	.130	-.078	.355
	Sig. (2-tailed)	.047	.111	.211	.396	.622	.023
	N	41	41	39	45	42	41

As shown in Table 17, the Pearson correlation coefficient shows a moderate positive correlation between student achievement (average mathematics EOG scores) and curriculum facilitator-reported cooperative learning scores. The correlation is illustrated in Figure 14.

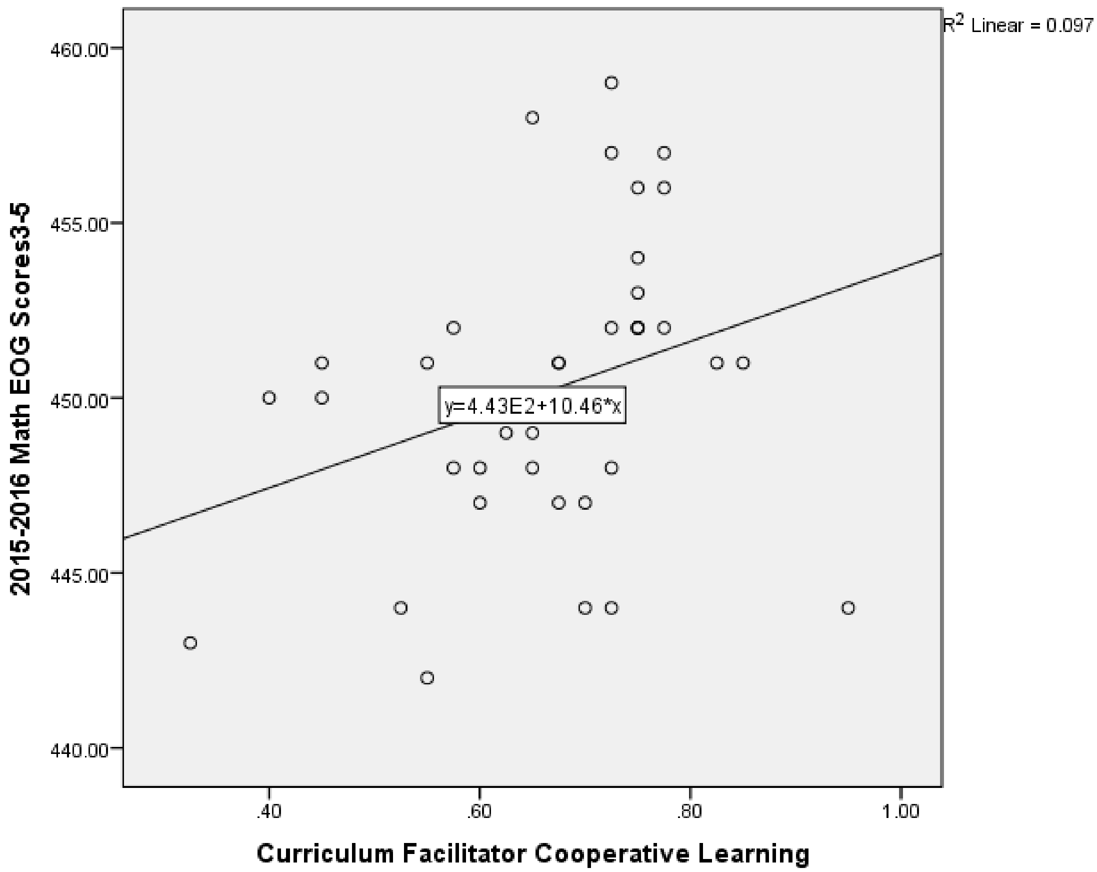

Figure 14. EOG Mathematics Scores as Related to Curriculum Facilitator-reported Cooperative Learning Frequency.

The correlation as indicated in Figure 14 reveals that there is a positive linear relationship between student achievement and curriculum facilitator-reported cooperative learning scores, *r*(39)=.312, *p*<.047. The scatterplot shows that 9.7% of the variation of EOG scores can be explained by the curriculum facilitator-reported cooperative learning score (r^2=.097).

As shown in Table 17, the Pearson correlation coefficient shows a weak positive correlation between student achievement (average mathematics EOG scores) and curriculum facilitator-reported communication and study skills scores. The correlation is illustrated in Figure 15.

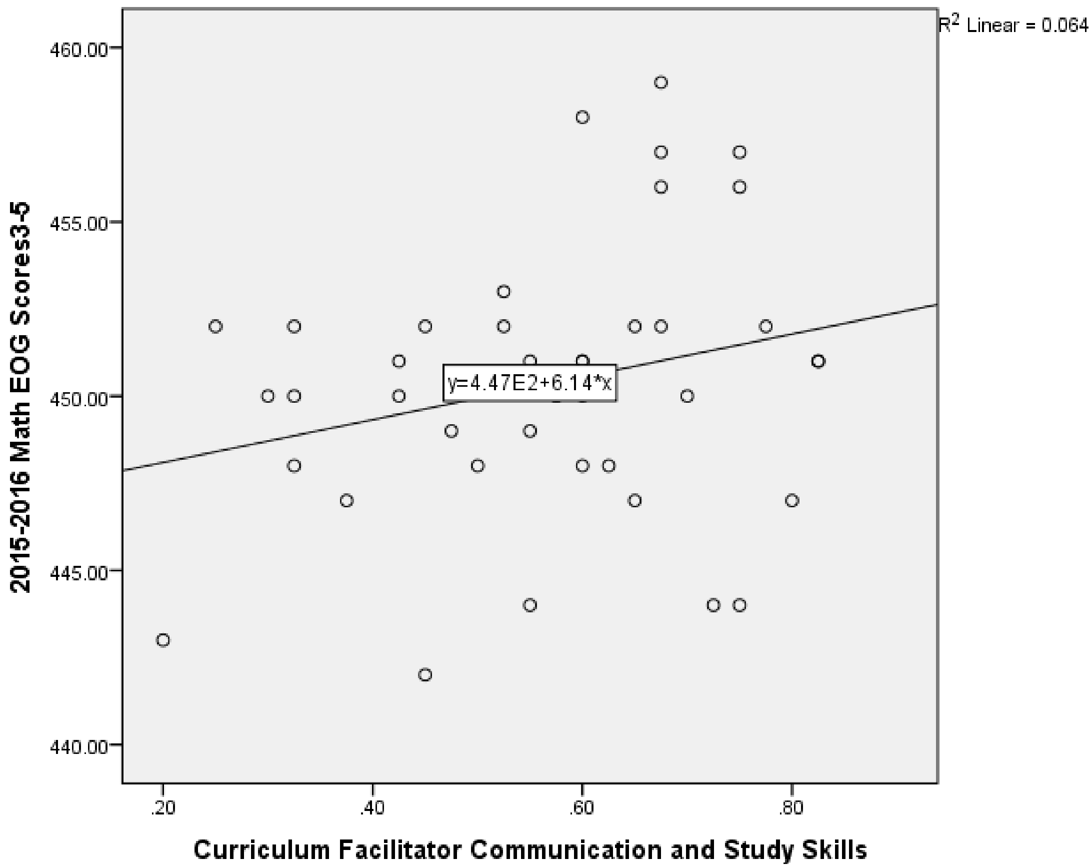

Figure 15. EOG Mathematics Scores as Related to Curriculum Facilitator-reported Communication and Study Skills Frequency.

The correlation as indicated in Figure 15 reveals that there is a positive linear relationship between student achievement and curriculum facilitator-reported communication and study skills scores, $r(39)=.252$, $p<.111$. The scatterplot shows that 6.4% of the variation of EOG scores can be explained by the curriculum facilitator-reported communication and study skills score ($r^2=.064$).

As shown in Table 17, the Pearson correlation coefficient shows a weak positive correlation between student achievement (average mathematics EOG scores) and curriculum facilitator-reported technology-aided instruction scores. The correlation is illustrated in Figure 16.

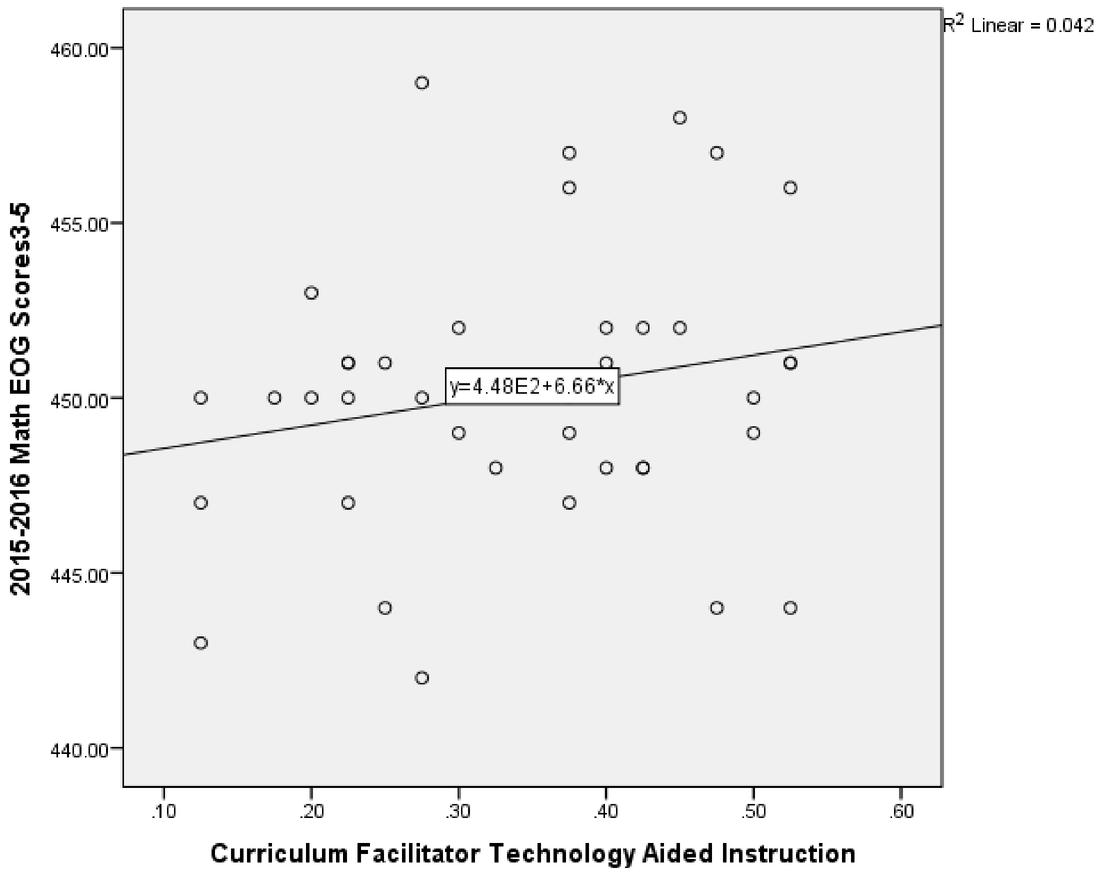

Figure 16. EOG Mathematics Scores as Related to Curriculum Facilitator-reported Technology-aided Instruction Frequency.

The correlation as indicated in Figure 16 reveals that there is a positive linear relationship between student achievement and curriculum facilitator-reported technology-aided instruction scores, $r(37)=.205$, $p<.211$. The scatterplot shows that 4.2% of the variation of EOG scores can be explained by the curriculum facilitator-reported technology-aided instruction score ($r^2=.042$).

As shown in Table 17, the Pearson correlation coefficient shows no correlation between student achievement (average mathematics EOG scores) and curriculum facilitator-reported problem-based learning scores. The correlation is illustrated in Figure 17.

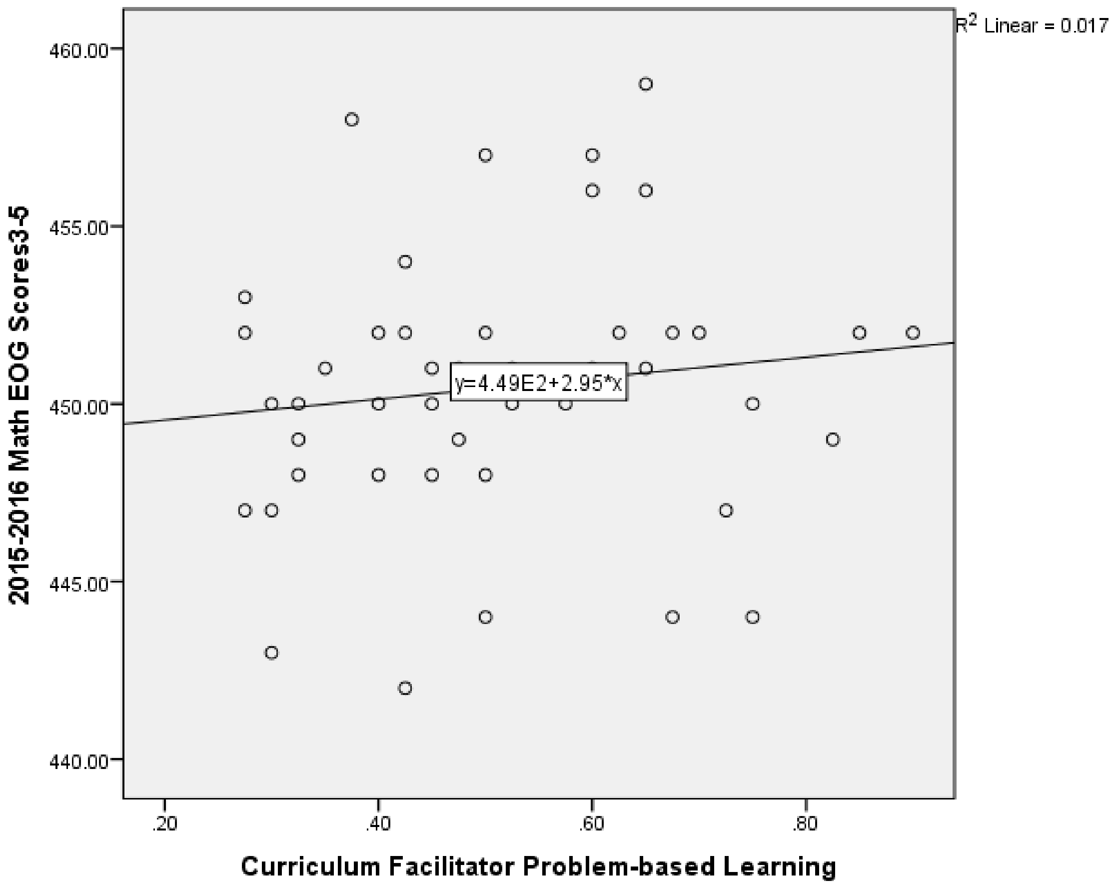

Figure 17. EOG Mathematics Scores as Related to Curriculum Facilitator-reported Problem-based Learning Frequency.

The correlation as indicated in Figure 17 reveals that there is no linear relationship between student achievement and curriculum facilitator-reported problem-based learning scores, $r(43)=.130$, $p<.396$. The scatterplot shows that 1.7% of the variation of EOG scores can be explained by the curriculum facilitator-reported problem-based learning score ($r^2=.017$).

As shown in Table 17, the Pearson correlation coefficient shows no correlation between student achievement (average mathematics EOG scores) and curriculum facilitator-reported manipulatives, models, and multiple representations scores. The correlation is illustrated in Figure 18.

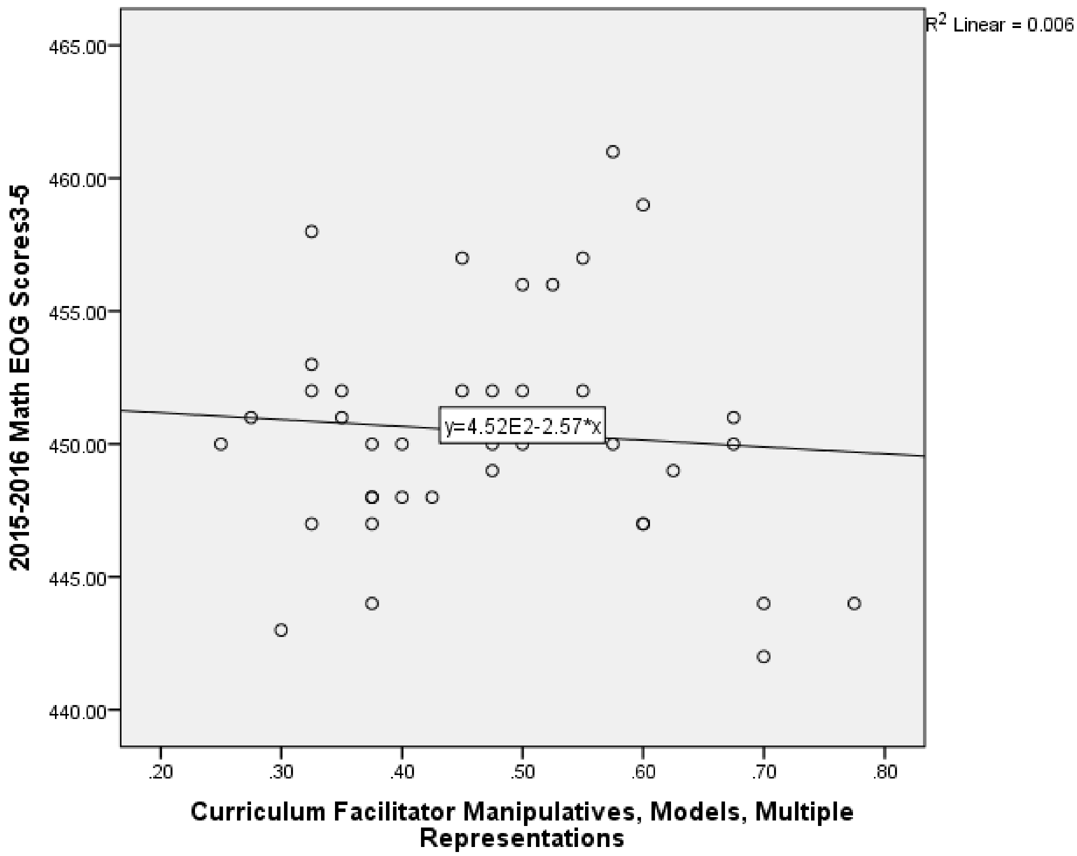

Figure 18. EOG Mathematics Scores as Related to Curriculum Facilitator-reported Manipulatives, Models, and Multiple Representations Instruction Frequency.

The correlation as indicated in Figure 18 reveals that there is a negative linear relationship between student achievement and curriculum facilitator-reported manipulatives, models, and multiple representation scores, $r(40)=-.078$, $p<.662$. The scatterplot shows that 0.6% of the variation of EOG scores can be explained by the curriculum facilitator-reported manipulatives, models, and multiple representation score ($r^2=.006$).

As shown in Table 17, the Pearson correlation coefficient shows a moderate positive correlation between student achievement (average mathematics EOG scores) and curriculum facilitator-reported direct instruction scores. The correlation is illustrated in Figure 19.

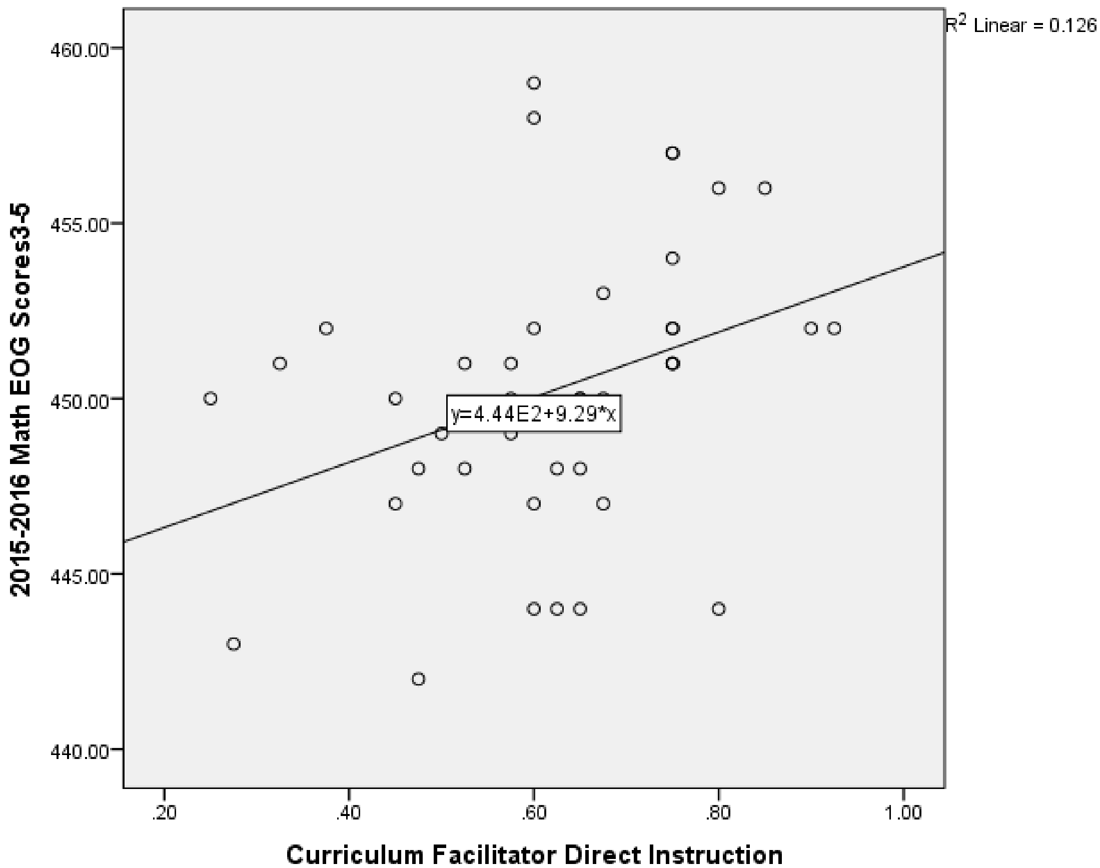

Figure 19. EOG Mathematics Scores as Related to Curriculum Facilitator-reported Direct Instruction Frequency.

The correlation as indicated in Figure 19 reveals that there is a positive linear relationship between student achievement and curriculum facilitator-reported direct instruction scores, $r(39)=.355$, $p<.023$. The scatterplot shows that 12.6% of the variation of EOG scores can be explained by the curriculum facilitator-reported direct instruction score ($r^2=.126$).

Table 18 shows the results of the Pearson correlation analysis between total self-efficacy for teaching mathematics score and the six mathematical instructional practices that were measured on TIPS. These scores were self-reported by participating teachers.

Table 18

Correlations of Total Efficacy and Mathematical Instructional Practices

		Cooperative Learning Score	Communication and Study Skills	Technology-aided Instruction	Problem-based Learning	Manipulatives, Models, Multiple Representations	Direct Instr
Total Efficacy	Pearson Correlation	.436	.582	.432	.576	.548	.408
	Sig. (2-tailed)	.001	.000	.001	.000	.000	.002
	N	54	54	54	54	54	54

As shown in Table 18, the Pearson correlation coefficient shows a moderate positive correlation between total teacher self-efficacy for teaching mathematics and self-reported cooperative learning frequency scores. The correlation is illustrated in Figure 20.

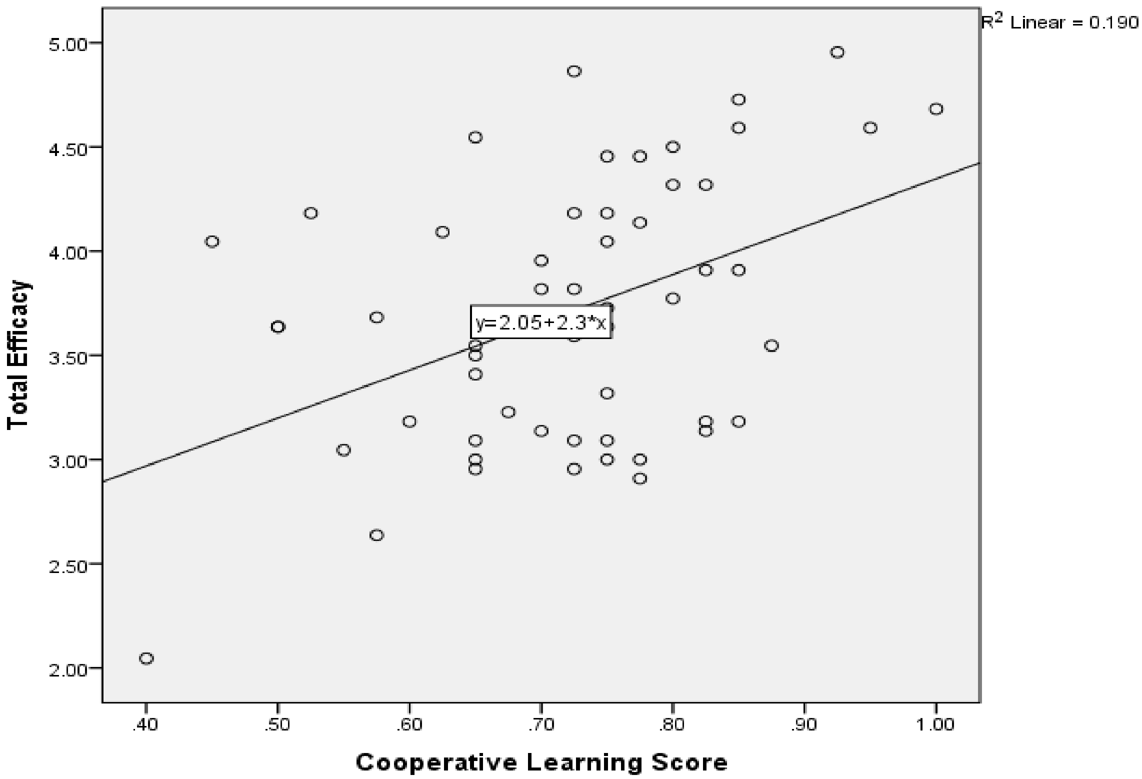

Figure 20. Total Efficacy Scores as Related to Cooperative Learning Frequency.

The correlation as indicated in Figure 20 reveals that there is a positive linear relationship between total teacher self-efficacy for teaching mathematics and self-reported cooperative learning frequency scores, $r(52)=.436$, $p<.001$. The scatterplot shows that 19% of the variation of total teacher self-efficacy scores for teaching mathematics can be explained by the self-reported cooperative learning frequency score, ($r^2=.19$).

As shown in Table 18, the Pearson correlation coefficient shows a strong positive correlation between total teacher self-efficacy for teaching mathematics and self-reported communication and study skills frequency scores. The correlation is illustrated in Figure 21.

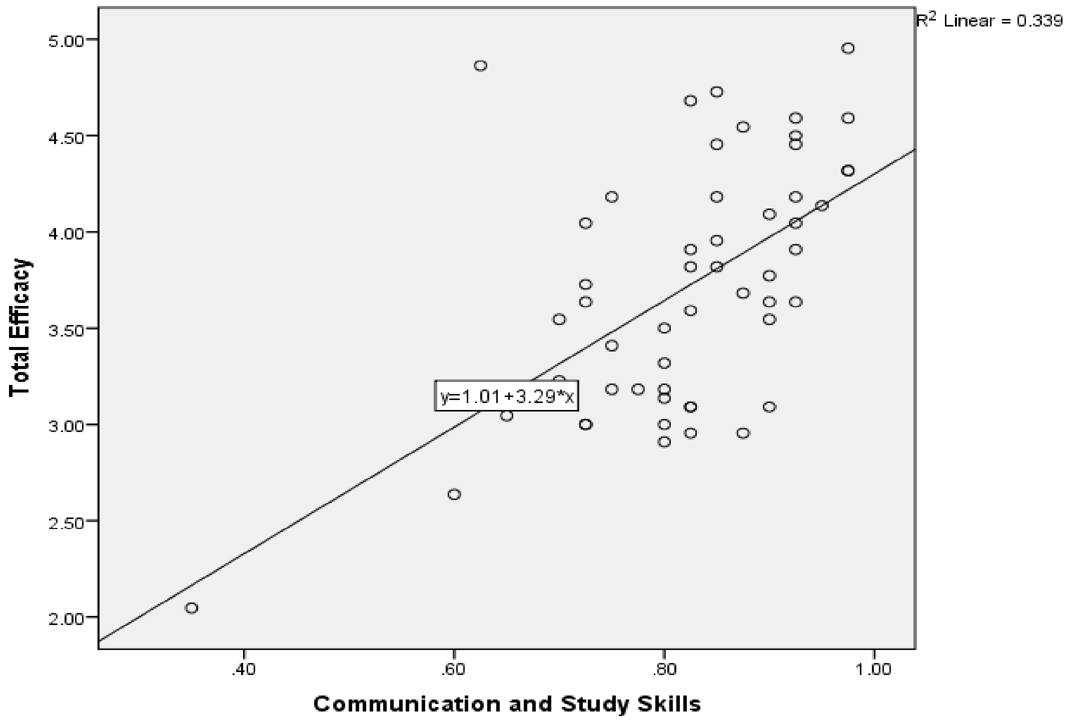

Figure 21. Total Efficacy Scores as Related to Communication and Study Skills Instruction Frequency.

The correlation as indicated in Figure 21 reveals that there is a positive linear relationship between total teacher self-efficacy for teaching mathematics and self-reported communication and study skills frequency scores, $r(52)=.582$, $p<.000$. The scatterplot shows that 33.9% of the variation of total teacher self-efficacy scores for teaching mathematics can be explained by the self-reported communication and study skills frequency score, ($r^2=.339$).

As shown in Table 18, the Pearson correlation coefficient shows a moderate positive correlation between total teacher self-efficacy for teaching mathematics and self-reported technology-aided instruction frequency scores. The correlation is illustrated in Figure 22.

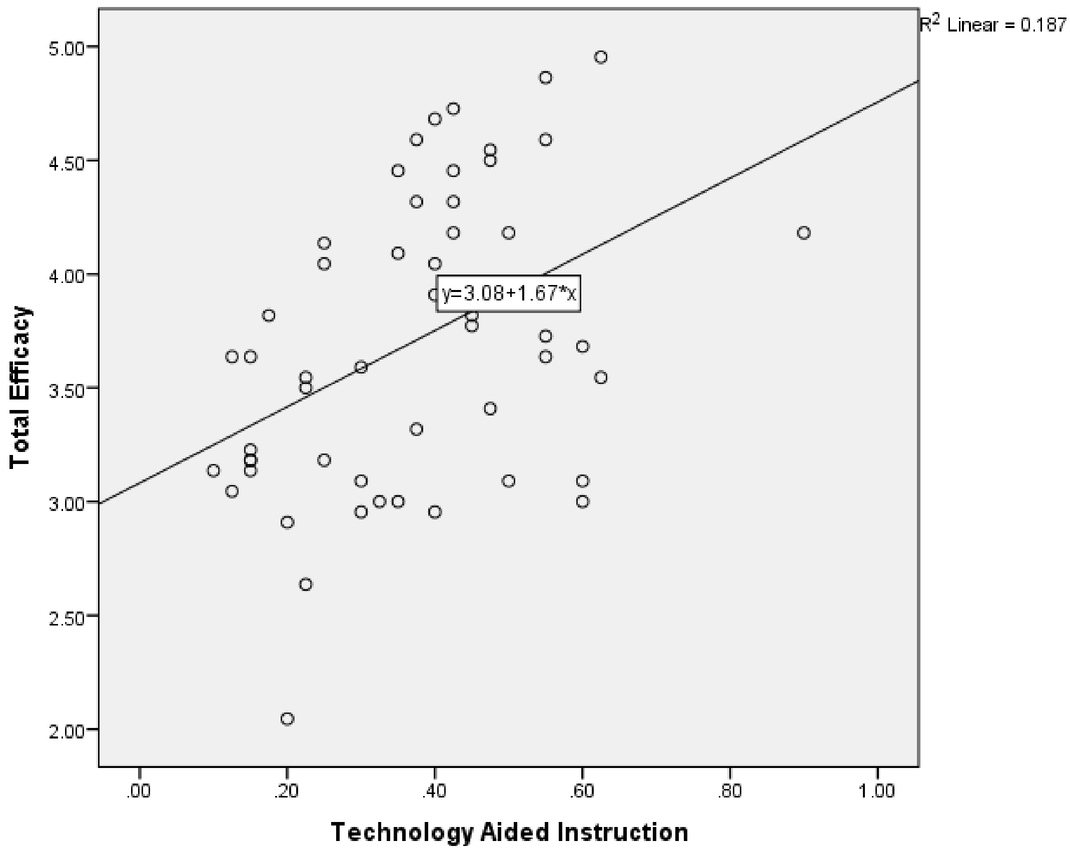

Figure 22. Total Efficacy Scores as Related to Technology-aided Instruction Frequency.

The correlation as indicated in Figure 22 reveals that there is a positive linear relationship between total teacher self-efficacy for teaching mathematics and self-reported technology-aided instruction frequency scores, $r(52)=.432$, $p<.001$. The scatterplot shows that 18.7% of the variation of total teacher self-efficacy scores for teaching mathematics can be explained by the self-reported technology-aided instruction frequency score, ($r^2=.187$).

As shown in Table 18, the Pearson correlation coefficient shows a strong positive correlation between total teacher self-efficacy for teaching mathematics and self-reported problem-based learning frequency scores. The correlation is illustrated in Figure 23.

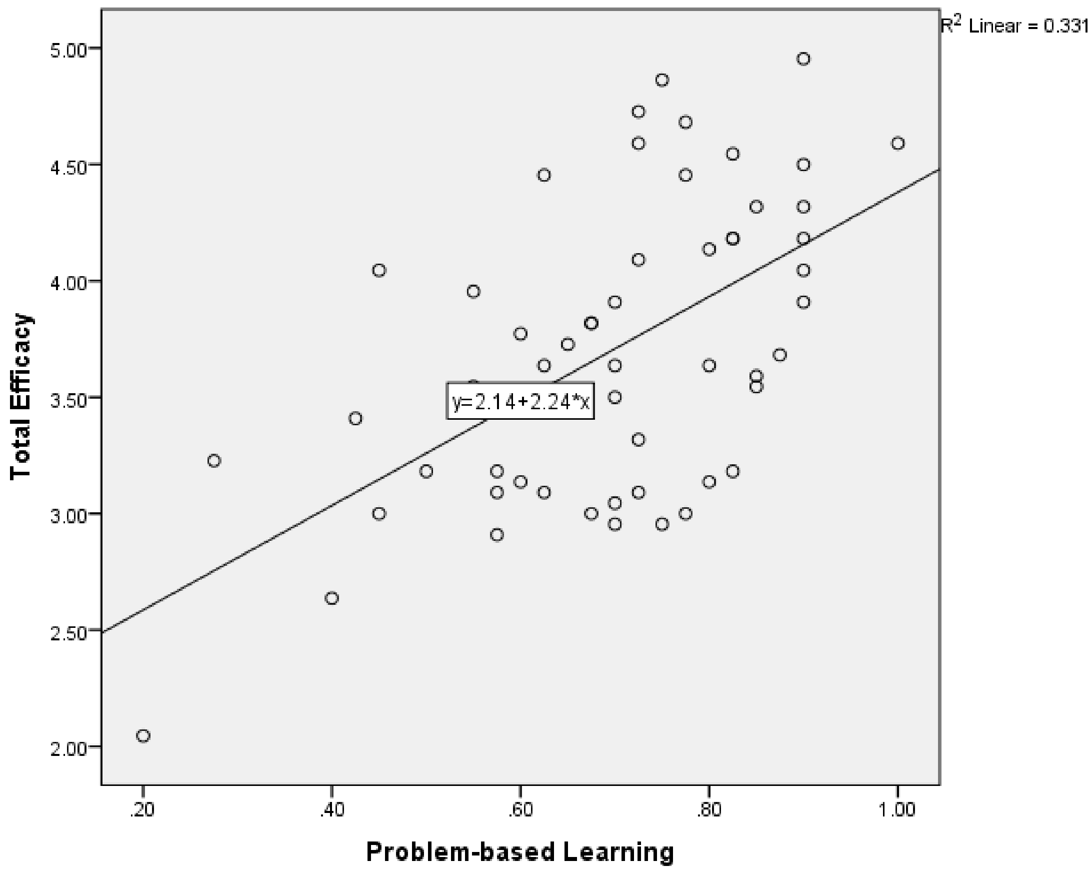

Figure 23. Total Efficacy Scores as Related to Problem-based Learning Frequency.

The correlation as indicated in Figure 23 reveals that there is a positive linear relationship between total teacher self-efficacy for teaching mathematics and self-reported problem-based learning frequency scores, $r(52)=.576$, $p<.000$. The scatterplot shows that 33.1% of the variation of total teacher self-efficacy scores for teaching mathematics can be explained by the self-reported problem-based learning frequency score, ($r^2=.331$).

As shown in Table 18, the Pearson correlation coefficient shows a strong positive correlation between total teacher self-efficacy for teaching mathematics and self-reported manipulatives, models, and multiple representations frequency scores. The correlation is illustrated in Figure 24.

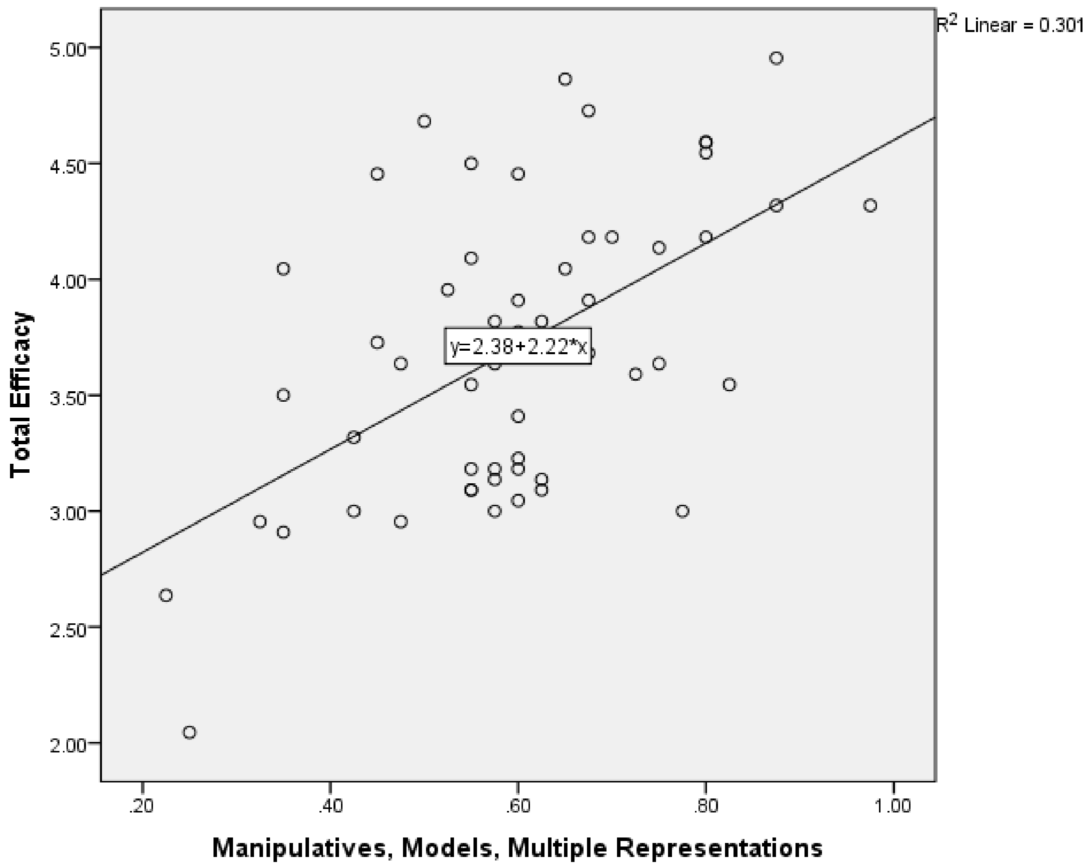

Figure 24. Total Efficacy Scores as Related to Manipulatives, Models, and Multiple Representations Instruction Frequency.

The correlation as indicated in Figure 24 reveals that there is a positive linear relationship between total teacher self-efficacy for teaching mathematics and self-reported manipulatives, models, and multiple representations frequency scores, $r(52)=.548$, $p<.000$. The scatterplot shows that 30.1% of the variation of total teacher self-efficacy scores for teaching mathematics can be explained by the self-reported manipulatives, models, and multiple representations frequency score, ($r^2=.301$).

As shown in Table 18, the Pearson correlation coefficient shows a moderate positive correlation between total teacher self-efficacy for teaching mathematics and self-reported direct instruction frequency scores. The correlation is illustrated in Figure 25.

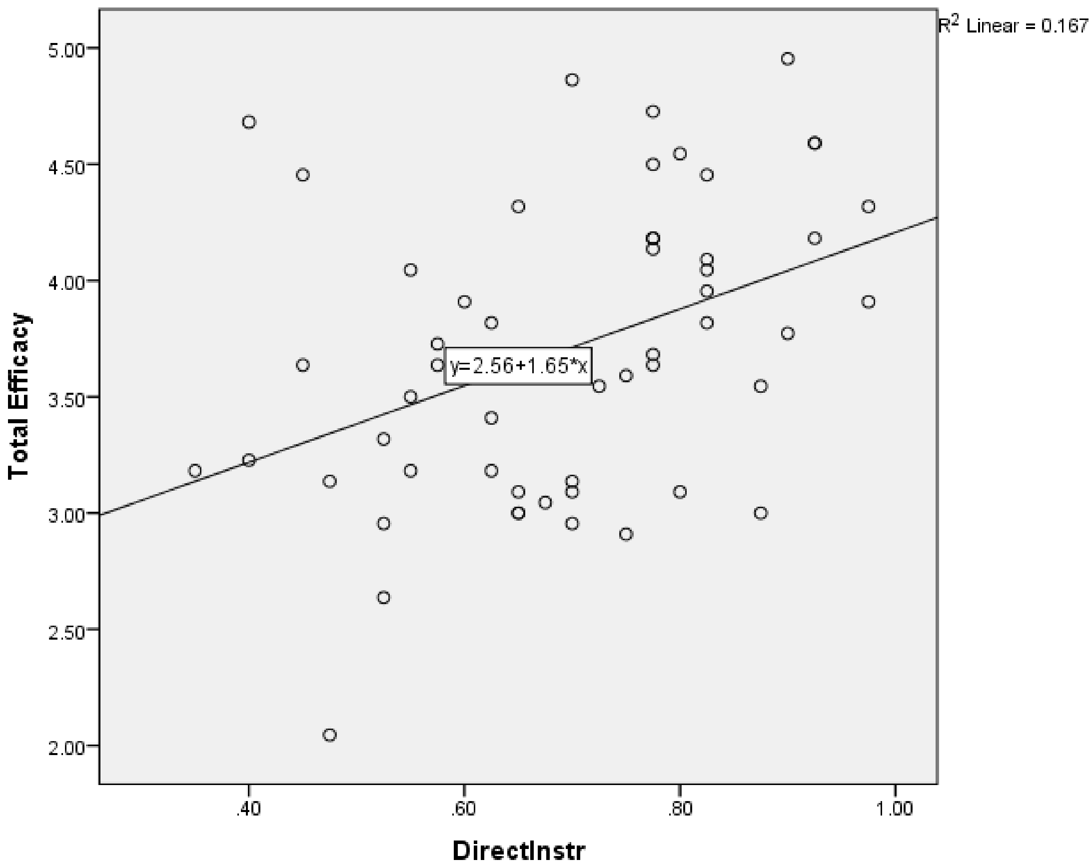

Figure 25. Total Efficacy Scores as Related to Direct Instruction Frequency.

The correlation as indicated in Figure 25 reveals that there is a positive linear relationship between total teacher self-efficacy for teaching mathematics and self-reported direct instruction frequency scores, $r(52)=.408$, $p<.002$. The scatterplot shows that 16.7% of the variation of total teacher self-efficacy scores for teaching mathematics can be explained by the self-reported direct instruction frequency score, ($r^2=.167$).

During interviews, teachers explained that they are uncomfortable with the "new" ways of teaching mathematics. They noted that it is not how they learned to think about mathematics so it is difficult for them to instruct students in such a way. In reflection, teachers noted the importance of teaching students to express their mathematical thinking orally and through writing. A concern was that they do not have enough time to build this instructional practice into their mathematics lessons. Also, teachers noted that they would like more training on how to successfully implement this practice into their lessons.

Table 19 shows the results of the Pearson correlation analysis between self-efficacy for pedagogy in mathematics score and the six mathematical instructional practices that were measured on TIPS. These scores were self-reported by participating teachers.

Table 19

Correlations of Efficacy for Pedagogy in Math and Mathematical Instructional Practices

		Cooperative Learning Score	Communication and Study Skills	Technology-aided Instruction	Problem-based Learning	Manipulatives, Models, Multiple Representations	Direct Instrc
Self-Efficacy Pedagogy	Pearson Correlation	.572	.510	.351	.556	.520	.375
	Sig. (2-tailed)	.000	.000	.009	.000	.000	.005
	N	54	54	54	54	54	54

As shown in Table 19, the Pearson correlation coefficient shows a strong positive correlation between teacher self-efficacy for pedagogy in mathematics and self-reported cooperative learning frequency scores. The correlation is illustrated in Figure 26.

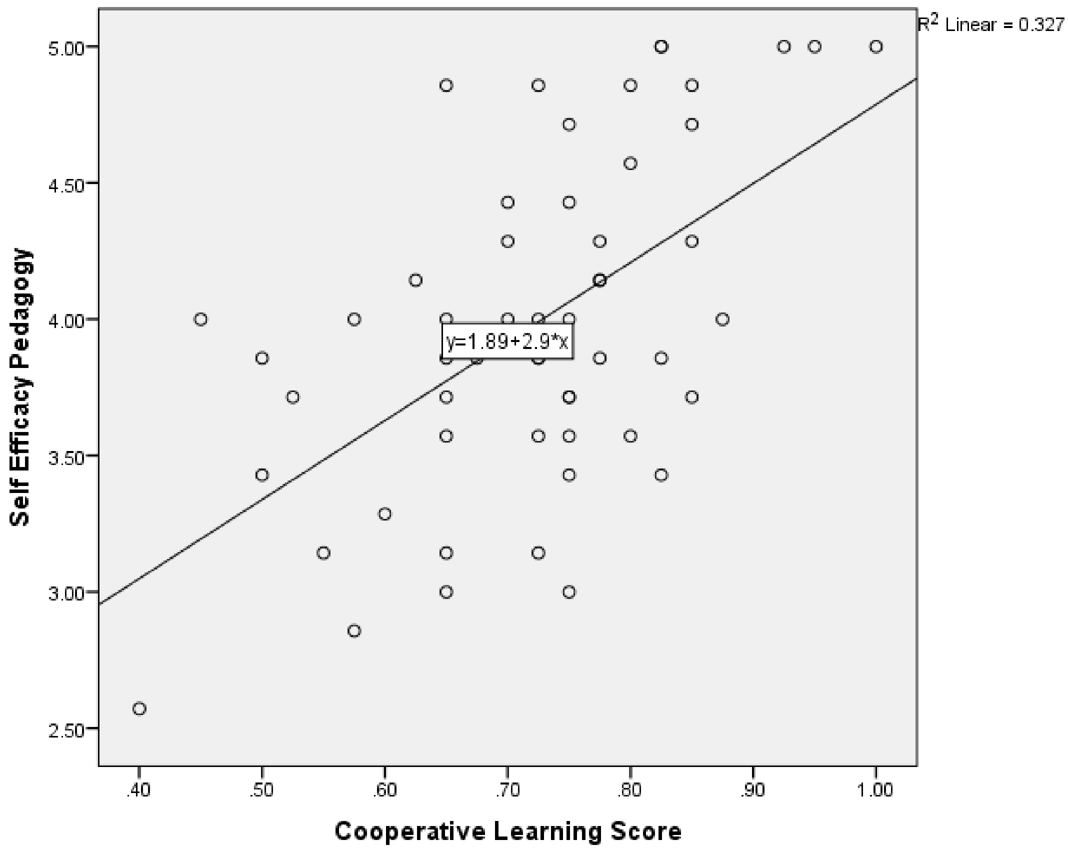

Figure 26. Self-Efficacy for Pedagogy in Mathematics Scores as Related to Self-reported Cooperative Learning Frequency.

The correlation as indicated in Figure 26 reveals that there is a positive linear relationship between teacher self-efficacy for pedagogy in mathematics and self-reported cooperative learning frequency scores, *r*(52)=.572, *p*<.000. The scatterplot shows that 32.7% of the variation of teacher self-efficacy scores for pedagogy in mathematics can be explained by the self-reported cooperative learning frequency score, (r^2=.327).

As shown in Table 19, the Pearson correlation coefficient shows a strong positive correlation between teacher self-efficacy for pedagogy in mathematics and self-reported communication and study skills frequency scores. The correlation is illustrated in Figure 27.

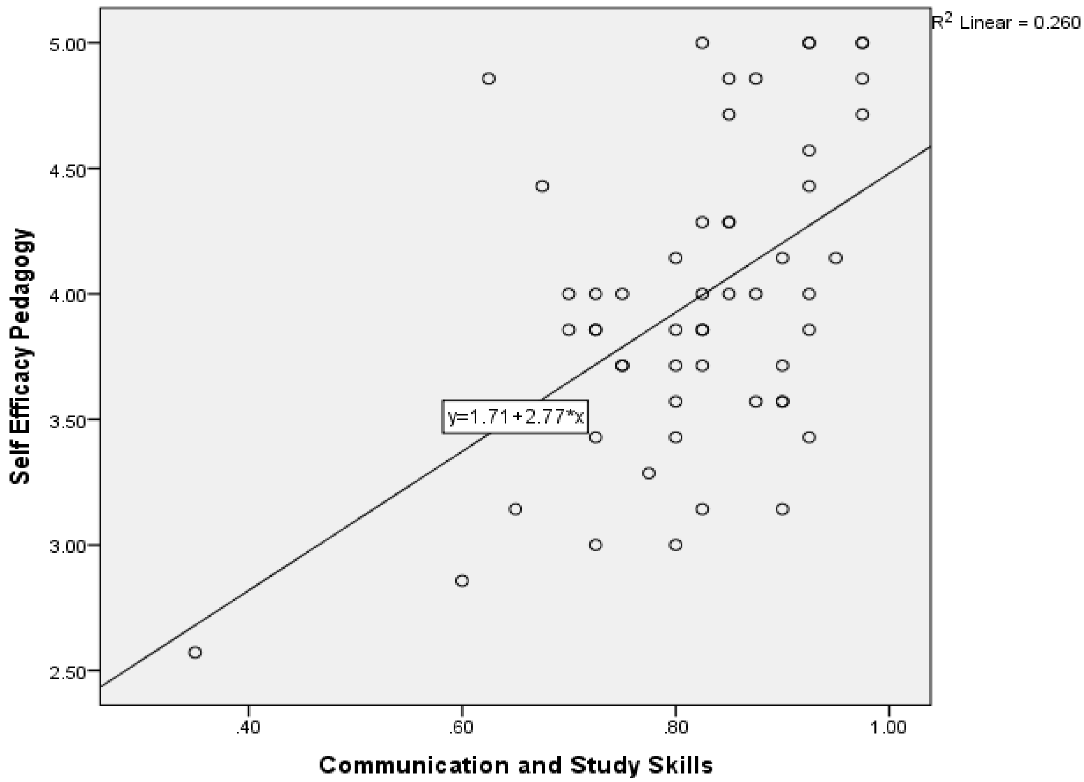

Figure 27. Self-Efficacy for Pedagogy in Mathematics Scores as Related to Self-reported Communication and Study Skills Instruction Frequency.

The correlation as indicated in Figure 27 reveals that there is a positive linear relationship between teacher self-efficacy for pedagogy in mathematics and self-reported communication and study skills frequency scores, $r(52)=.510$, $p<.000$. The scatterplot shows that 26.0% of the variation of teacher self-efficacy scores for pedagogy in mathematics can be explained by the self-reported communication and study skills frequency score, ($r^2=.260$).

As shown in Table 19, the Pearson correlation coefficient shows a moderate positive correlation between teacher self-efficacy for pedagogy in mathematics and self-reported technology-aided instruction frequency scores. The correlation is illustrated in Figure 28.

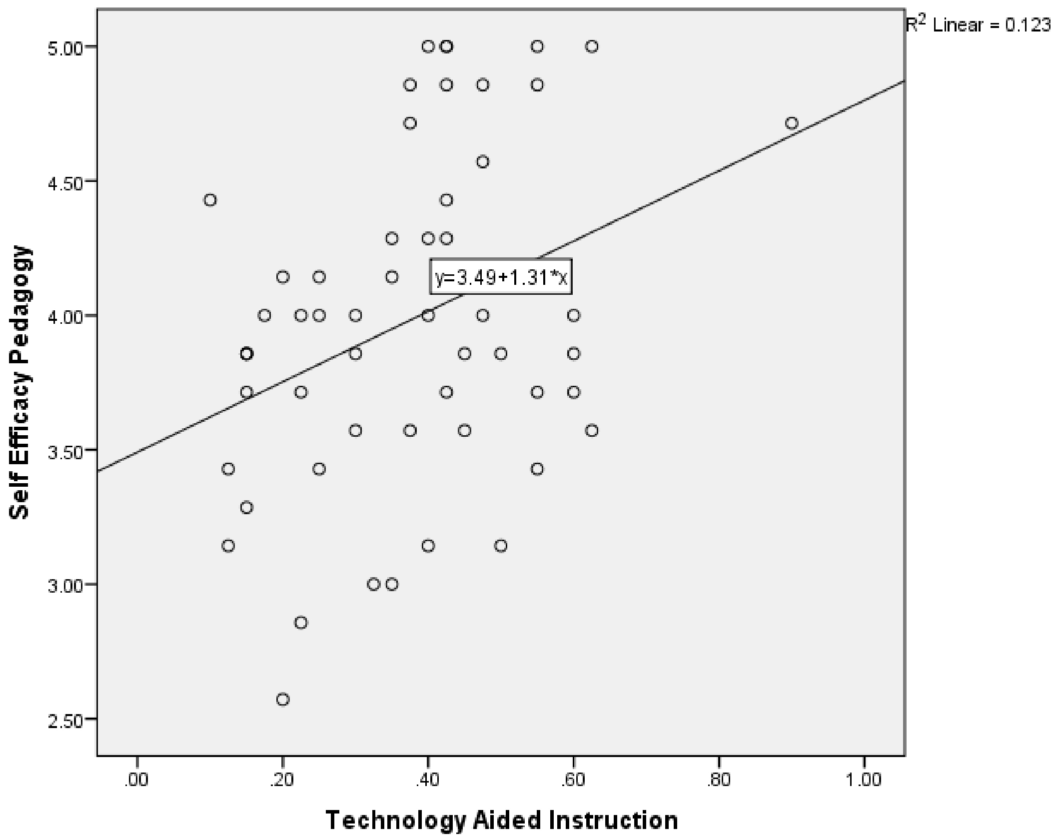

Figure 28. Self-Efficacy for Pedagogy in Mathematics Scores as Related to Technology-aided Instruction Frequency.

The correlation as indicated in Figure 28 reveals that there is a positive linear relationship between teacher self-efficacy for pedagogy in mathematics and self-reported technology-aided instruction frequency scores, $r(52)=.351$, $p<.009$. The scatterplot shows that 12.3% of the variation of teacher self-efficacy scores for pedagogy in mathematics can be explained by the self-reported technology-aided instruction frequency score, ($r^2=.123$).

As shown in Table 19, the Pearson correlation coefficient shows a moderate positive correlation between teacher self-efficacy for pedagogy in mathematics and self-reported problem-based learning frequency scores. The correlation is illustrated in Figure

29.

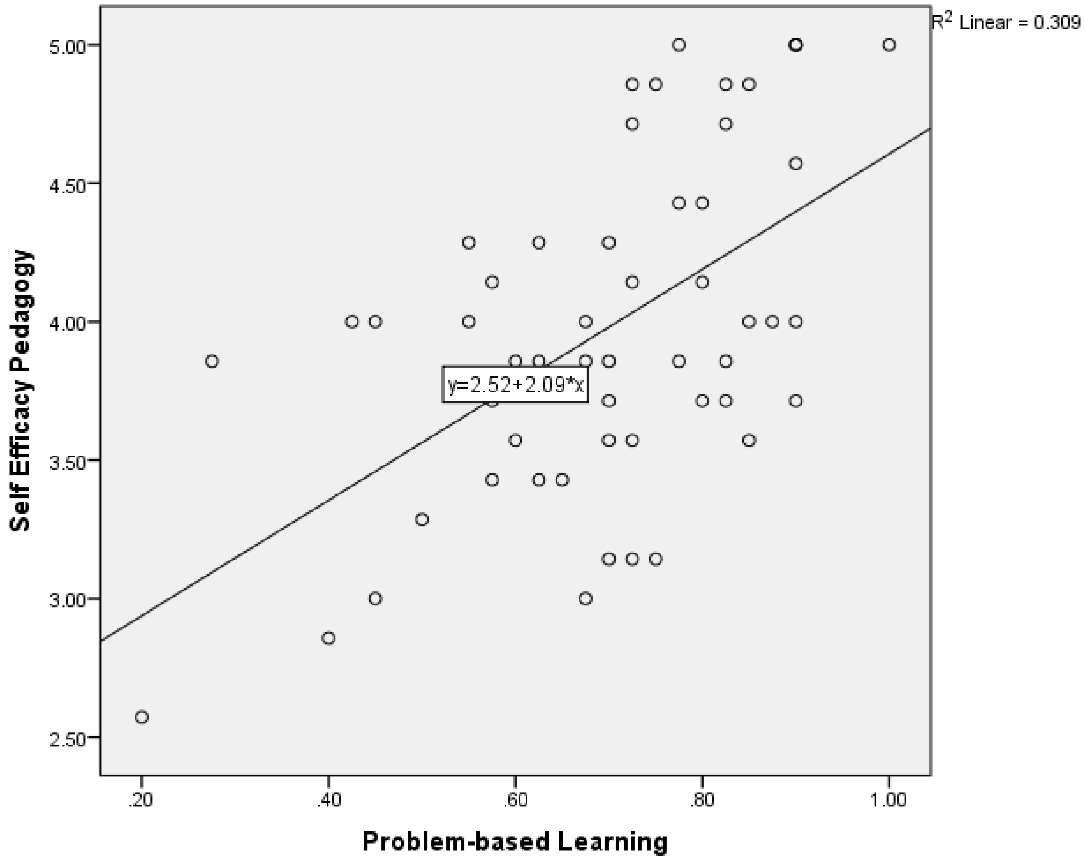

Figure 29. Self-Efficacy for Pedagogy in Mathematics Scores as Related to Self-reported Problem-based Learning Frequency.

The correlation as indicated in Figure 29 reveals that there is a positive linear relationship between teacher self-efficacy for pedagogy in mathematics and self-reported problem-based learning frequency scores, $r(52)=.556$, $p<.000$. The scatterplot shows that 30.9% of the variation of teacher self-efficacy scores for pedagogy in mathematics can be explained by the self-reported problem-based learning frequency score, ($r^2=.309$).

As shown in Table 19, the Pearson correlation coefficient shows a strong positive correlation between teacher self-efficacy for pedagogy in mathematics and self-reported manipulatives, models, and multiple representations frequency scores. The correlation is illustrated in Figure 30.

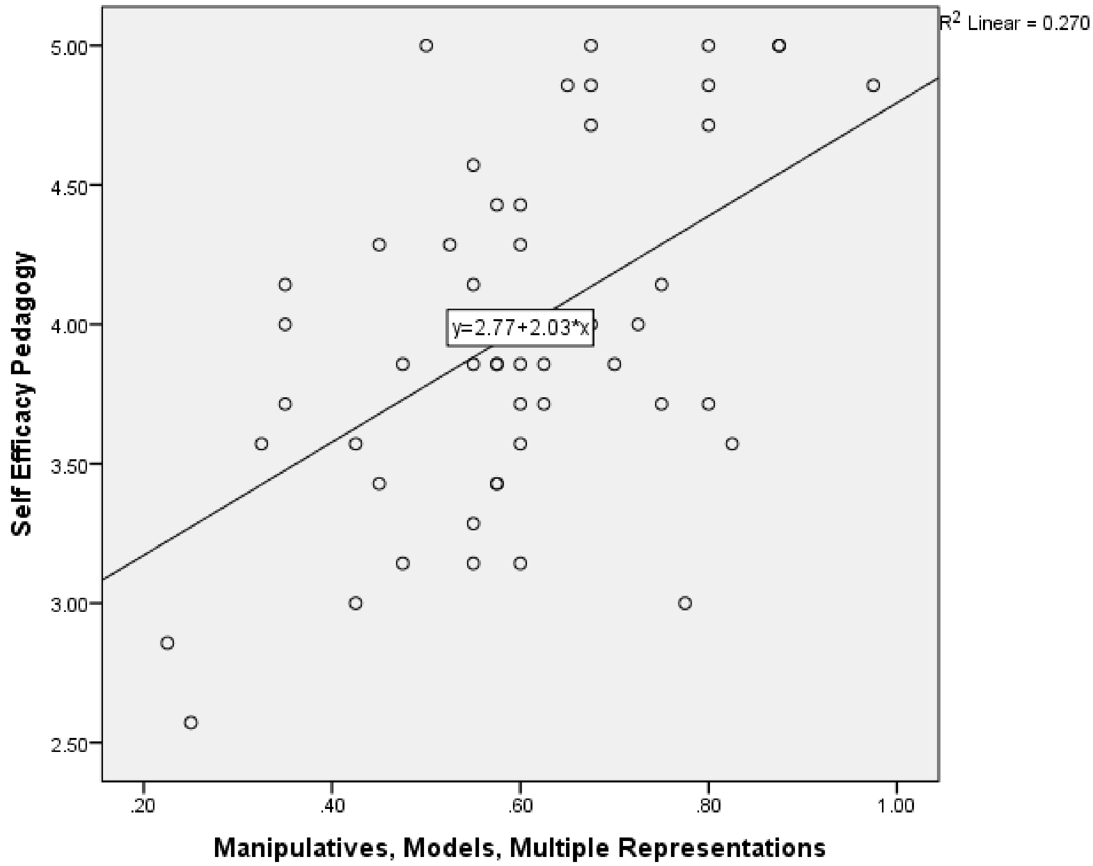

Figure 30. Self-Efficacy for Pedagogy in Mathematics Scores as Related to Self-reported Manipulatives, Models, and Multiple Representation Instruction Frequency.

The correlation as indicated in Figure 30 reveals that there is a positive linear relationship between teacher self-efficacy for pedagogy in mathematics and self-reported manipulatives, models, and multiple representations frequency scores, $r(52)=.520$, $p<.000$. The scatterplot shows that 27.0% of the variation of teacher self-efficacy scores for pedagogy in mathematics can be explained by the self-reported manipulatives, models, and multiple representations frequency score, ($r^2=.270$).

As shown in Table 19, the Pearson correlation coefficient shows a moderate positive correlation between teacher self-efficacy for pedagogy in mathematics and self-reported direct instruction frequency scores. The correlation is illustrated in Figure 31.

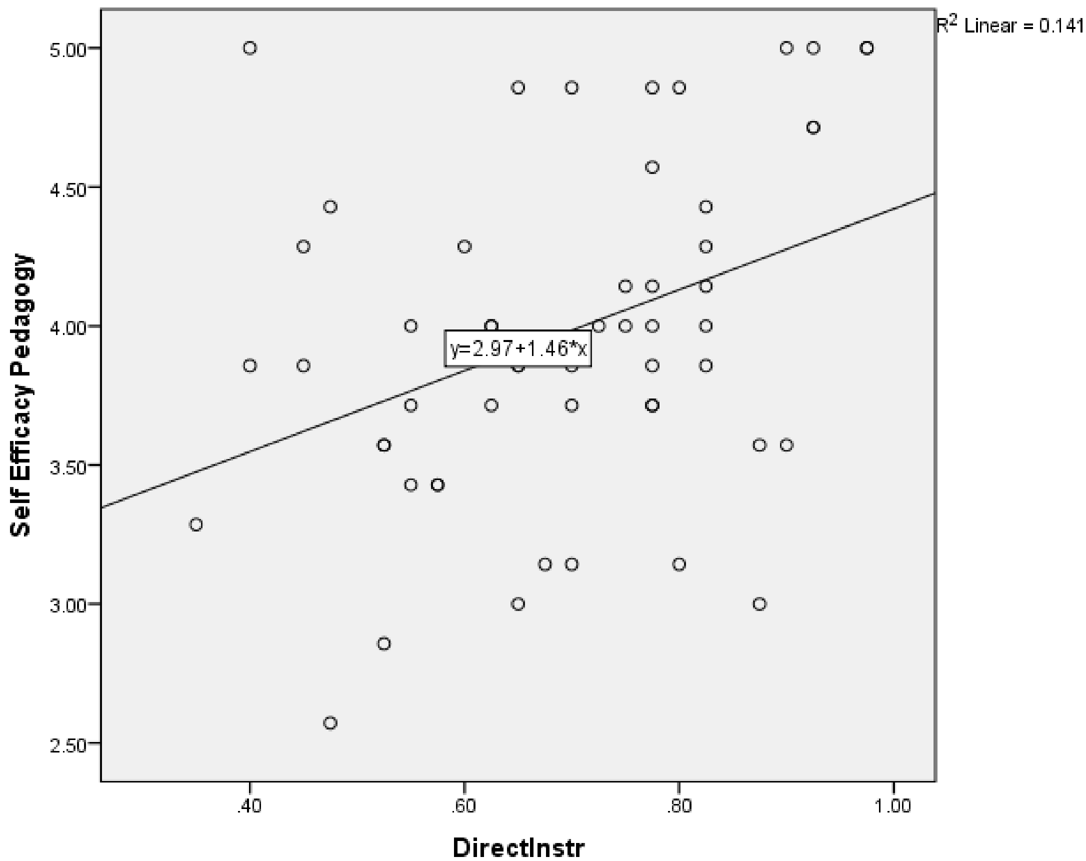

Figure 31. Self-Efficacy for Pedagogy in Mathematics Scores as Related to Self-reported Direct Instruction Frequency.

The correlation as indicated in Figure 31 reveals that there is a positive linear relationship between teacher self-efficacy for pedagogy in mathematics and self-reported direct instruction frequency scores, $r(52)=.375$, $p<.005$. The scatterplot shows that 14.1% of the variation of teacher self-efficacy scores for pedagogy in mathematics can be explained by the self-reported direct instruction frequency score, ($r^2=.141$).

Teacher interviews revealed that teachers felt although all strategies are important with certain lessons, cooperative learning and manipulatives, models, and multiple representations was the most effective instructional practice to implement in a mathematics lesson for low performing students, which correlates with the data in table 19. Teachers felt that these two instructional practices can motivate and engage students who are struggling. Teachers also noted that direct instruction can assist students with their own self-efficacy in mathematics because they are able to see it modeled before attempting the skill on their own.

Table 20 shows the results of the Pearson correlation analysis between self-efficacy for teaching mathematics content score and the six mathematical instructional practices that were measured on TIPS. These scores were self-reported by participating teachers.

Table 20

Correlations of Efficacy for Teaching Mathematical Content and Mathematical Instructional Practices

		Cooperative Learning Score	Communication and Study Skills	Technology-aided Instruction	Problem-based Learning	Manipulatives, Models, Multiple Representations	Direct Instrc
Efficacy for teaching math content	Pearson Correlation	.341	.556	.423	.529	.507	.383
	Sig. (2-tailed)	.012	.000	.001	.000	.000	.004
	N	54	54	54	54	54	54

As shown in Table 20, the Pearson correlation coefficient shows a moderate positive correlation between teacher self-efficacy for teaching mathematics content and self-reported cooperative learning frequency scores. The correlation is illustrated in Figure 32.

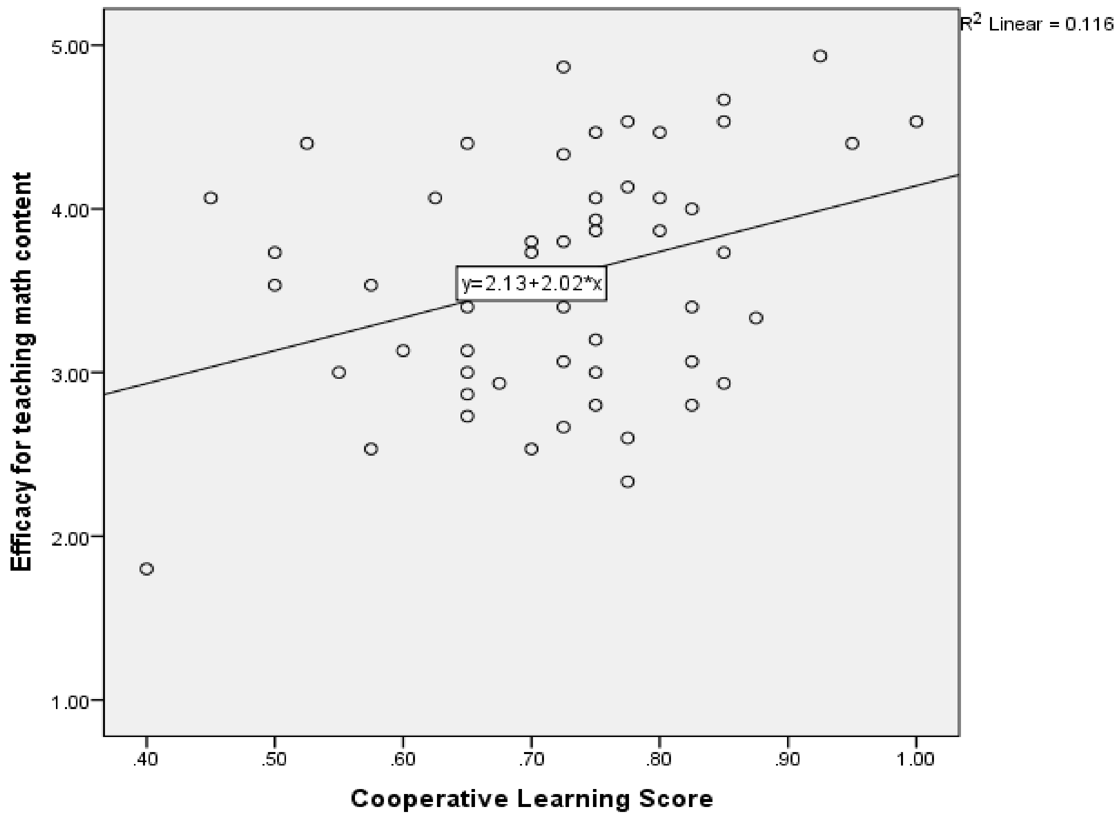

Figure 32. Self-Efficacy for Teaching Mathematics Content Scores as Related to Self-reported Cooperative Learning Instruction Frequency.

The correlation as indicated in Figure 32 reveals that there is a positive linear relationship between teacher self-efficacy for teaching mathematics content and self-reported cooperative learning frequency scores, $r(52)=.341$, $p<.012$. The scatterplot shows that 11.6% of the variation of teacher self-efficacy scores for teaching mathematics content can be explained by the self-reported cooperative learning frequency score, ($r^2=.116$).

As shown in Table 20, the Pearson correlation coefficient shows a strong positive correlation between teacher self-efficacy for teaching mathematics content and self-reported communication and study skills frequency scores. The correlation is illustrated in Figure 33.

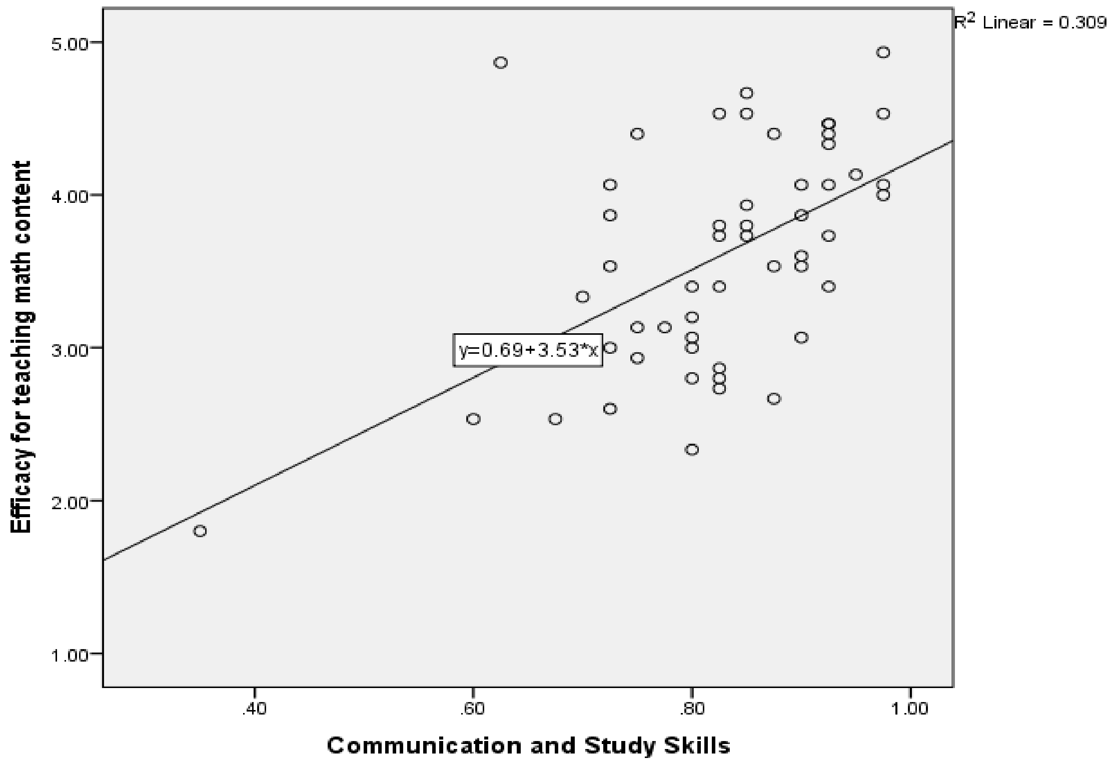

Figure 33. Self-Efficacy for Teaching Mathematics Content Scores as Related to Self-reported Communication and Study Skills Instruction Frequency.

The correlation as indicated in Figure 33 reveals that there is a positive linear relationship between teacher self-efficacy for teaching mathematics content and self-reported communication and study skills frequency scores, $r(52)=.556$, $p<.000$. The scatterplot shows that 30.9% of the variation of teacher self-efficacy scores for teaching mathematics content can be explained by the self-reported communication and study skills frequency score, ($r^2=.309$).

As shown in Table 20, the Pearson correlation coefficient shows a moderate positive correlation between teacher self-efficacy for teaching mathematics content and self-reported technology-aided instruction frequency scores. The correlation is illustrated in Figure 34.

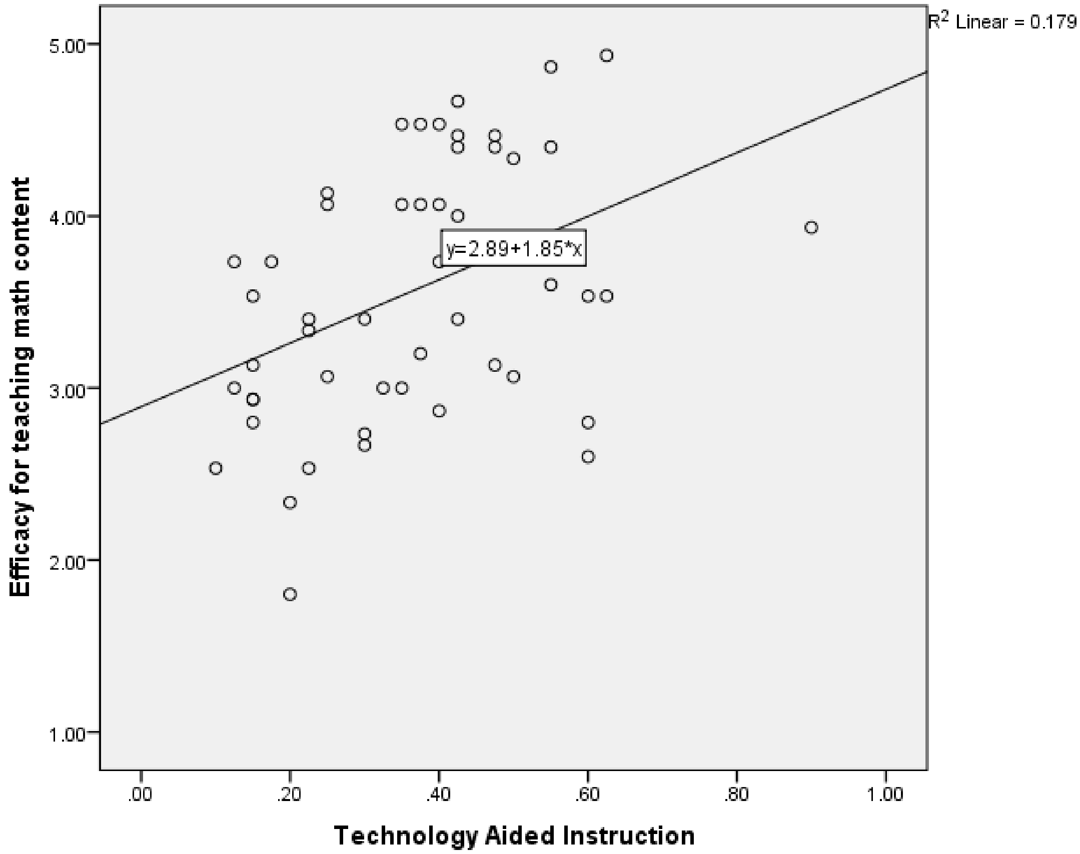

Figure 34. Self-Efficacy for Teaching Mathematical Content Scores as Related to Self-reported Technology-aided Instruction Frequency.

The correlation as indicated in Figure 34 reveals that there is a positive linear relationship between teacher self-efficacy for teaching mathematics content and self-reported technology-aided instruction frequency scores, $r(52)=.423$, $p<.001$. The scatterplot shows that 17.9% of the variation of teacher self-efficacy scores for teaching mathematics content can be explained by the self-reported technology-aided instruction frequency score, ($r^2=.179$).

As shown in Table 20, the Pearson correlation coefficient shows a strong positive correlation between teacher self-efficacy for teaching mathematics content and self-reported problem-based learning frequency scores. The correlation is illustrated in Figure 35.

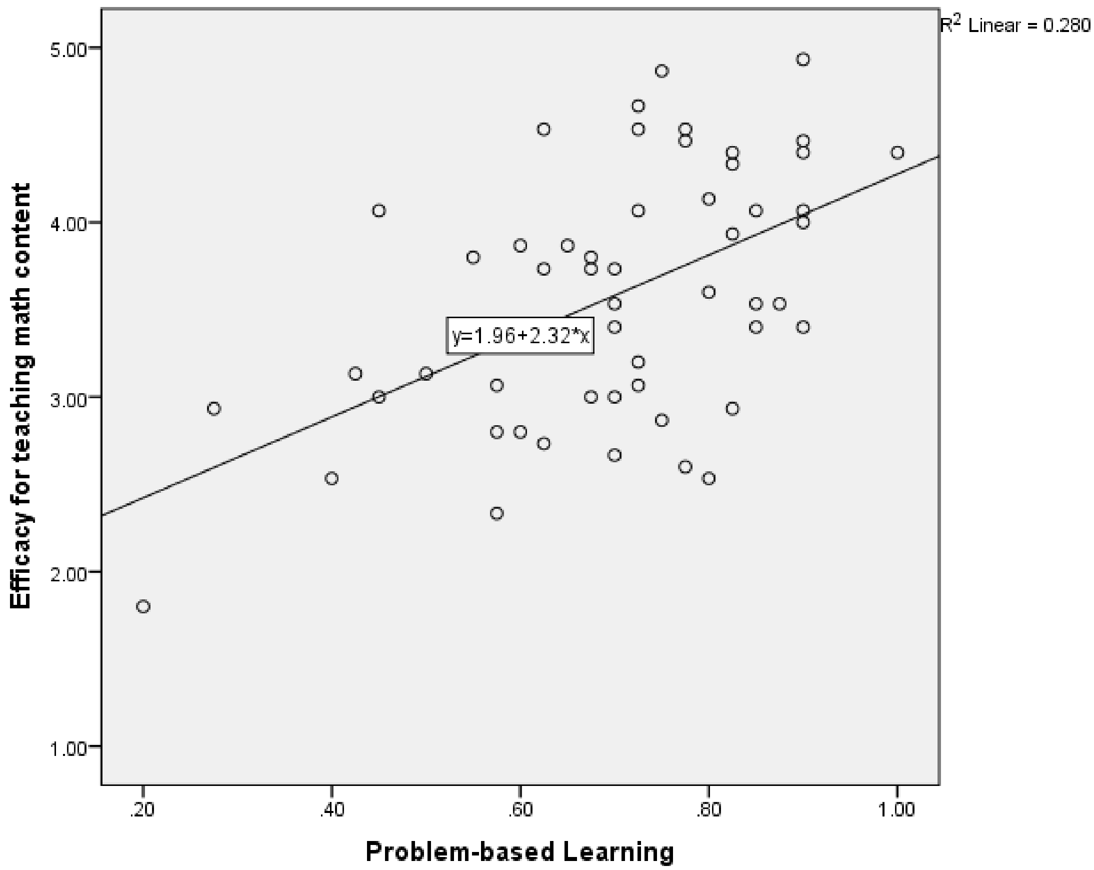

Figure 35. Self-Efficacy for Teaching Mathematical Content Scores as Related to Self-reported Problem-based Learning Frequency.

The correlation as indicated in Figure 35 reveals that there is a positive linear relationship between teacher self-efficacy for teaching mathematics content and self-reported problem-based learning frequency scores, $r(52)=.529$, $p<.000$. The scatterplot shows that 28.0% of the variation of teacher self-efficacy scores for teaching mathematics content can be explained by the self-reported problem-based learning frequency score, ($r^2=.280$).

As shown in Table 20, the Pearson correlation coefficient shows a strong positive correlation between teacher self-efficacy for teaching mathematics content and self-reported manipulatives, models, and multiple representations frequency scores. The correlation is illustrated in Figure 36.

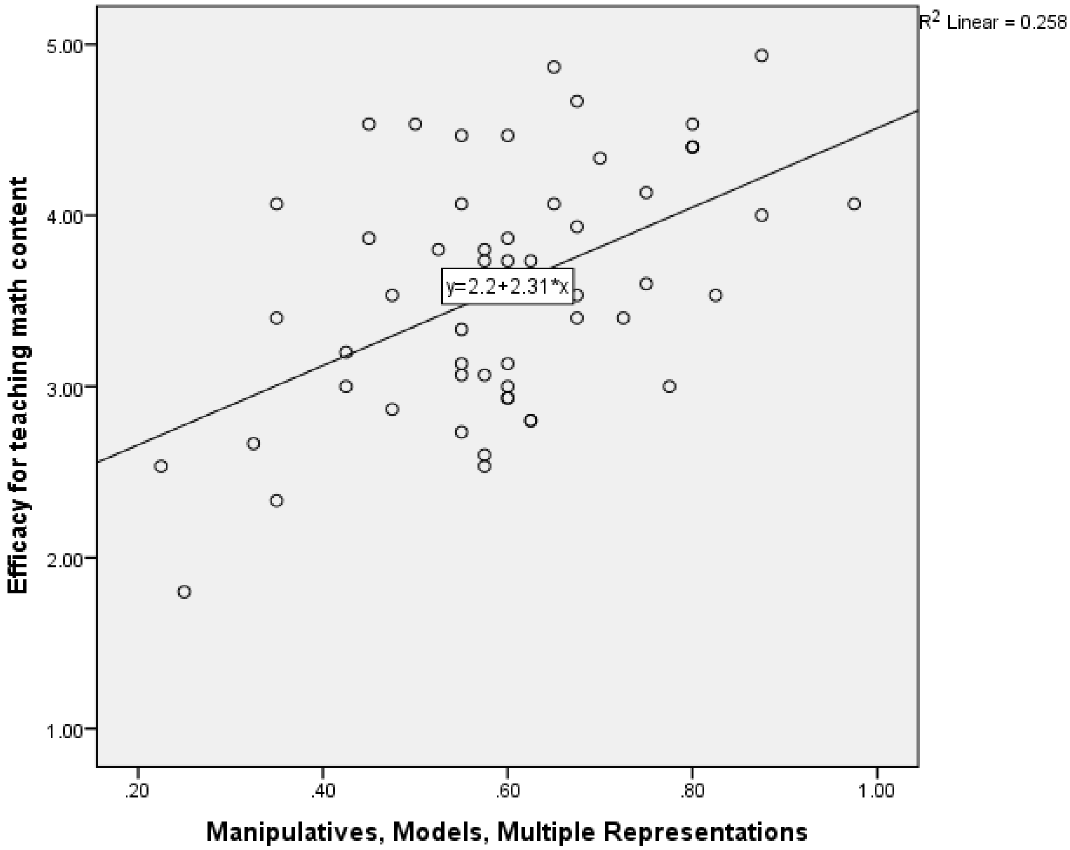

Figure 36. Self-Efficacy for Teaching Mathematical Content Scores as Related to Self-reported Manipulatives, Models, and Multiple Representations Instruction Frequency.

The correlation as indicated in Figure 36 reveals that there is a positive linear relationship between teacher self-efficacy for teaching mathematics content and self-reported manipulatives, models, and multiple representations frequency scores, *r*(52)=.507, *p*<.000. The scatterplot shows that 25.8% of the variation of teacher self-efficacy scores for teaching mathematics content can be explained by the self-reported manipulatives, models, and multiple representations frequency score, (r^2=.258).

As shown in Table 20, the Pearson correlation coefficient shows a moderate positive correlation between teacher self-efficacy for teaching mathematics content and self-reported direct instruction frequency scores. The correlation is illustrated in Figure

37.

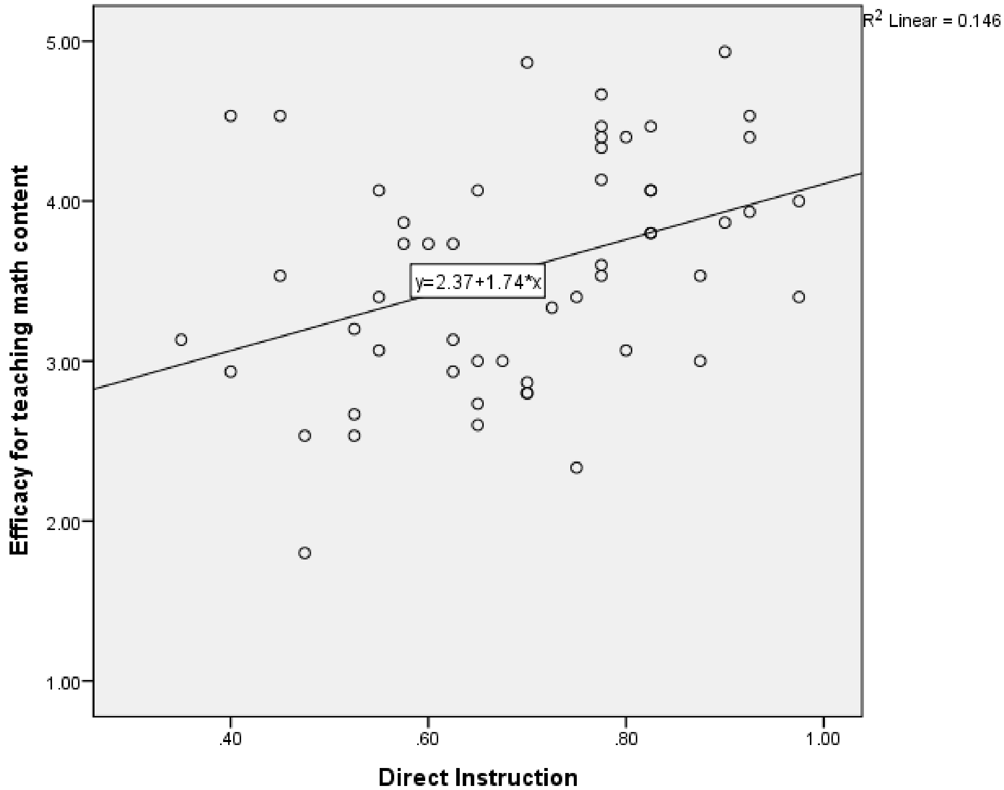

Figure 37. Self-Efficacy for Teaching Mathematical Content Scores as Related to Self-reported Direct Instruction Frequency.

The correlation as indicated in Figure 37 reveals that there is a positive linear relationship between teacher self-efficacy for teaching mathematics content and self-reported direct instruction frequency scores, $r(52)=.383$, $p<.004$. The scatterplot shows that 14.6% of the variation of teacher self-efficacy scores for teaching mathematics content can be explained by the self-reported direct instruction frequency score, ($r^2=.146$).

Table 21 shows the model summary of the multiple regression procedure. According to Creswell (2012), “multiple regression is a statistical procedure for examining the combined relationship of multiple independent variables with a single dependent variable" (p. 350). In this study, the dependent variable was student achievement as measured by the mathematical EOG scale scores. The independent variables were total self-efficacy and mathematical instructional practices categorized as cooperative learning; communication and study skills; technology-aided instruction; problem-based learning; manipulatives, models, and multiple representations; and direct instruction.

Table 21

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.389[a]	.152	.022	3.95675

Note. a. Predictors: (Constant), DIT, CLT, MMMT, TAIT, Total Efficacy, PBLT, CommT.

R^2 for the overall model was 15.2% with an adjusted R^2 of 2.2%.

Table 22 shows the regression coefficients and standard errors of the independent variables.

Table 22

Coefficients and Standard Errors

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	T	Sig.	Lower Bound	Upper Bound
1	(Constant)	448.052	4.262		105.126	.000	439.473	456.632
	Total Efficacy	2.375	1.126	.381	2.109	.040	.109	4.641
	CLT	-.238	1.021	-.038	-.233	.816	-2.293	1.817
	CommT	-.039	1.156	-.006	-.033	.973	-2.365	2.288
	TAIT	.474	.782	.099	.606	.548	-1.101	2.049
	PBLT	-.302	.783	-.071	-.386	.701	-1.878	1.274
	MMMT	.191	.896	.038	.213	.832	-1.612	1.994
	DIT	-1.578	.834	-.348	-1.893	.065	-3.256	.100

Note. a. Dependent Variable: 2015-2016 Math EOG Scores3-5.

Total self-efficacy for teaching mathematics was statistically significant to the prediction of student achievement, as measured by mathematics EOG scores, $p<.05$. All other independent variables were found to be statistically insignificant to the prediction of the dependent variable.

Table 23 shows the model summary of the multiple regression procedure. The dependent variable was student achievement as measured by the mathematical EOG scale scores. The independent variables were self-efficacy for teaching mathematics content and mathematical instructional practices, categorized as cooperative learning; communication and study skills; technology-aided instruction; problem-based learning; manipulatives, models, and multiple representations; and direct instruction.

Table 23

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.361[a]	.131	-.002	4.00546

Note. a. Predictors: (Constant), DIT, CLT, Efficacy for teaching math content, TAIT, MMMT, PBLT, CommT.

R^2 for the overall model was 13.1% with an adjusted R^2 of -0.2%.

Table 24 shows the regression coefficients and standard errors of the independent variables.

Table 24

Coefficients and Standard Errors

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	T	Sig.	Lower Bound	Upper Bound
1	(Constant)	449.248	4.198		107.025	.000	440.798	457.697
	Efficacy for teaching math content	1.740	.968	.314	1.797	.079	-.209	3.688
	CLT	-.012	1.021	-.002	-.012	.991	-2.067	2.043
	CommT	-.121	1.183	-.020	-.102	.919	-2.503	2.261
	TAIT	.445	.795	.093	.560	.578	-1.154	2.045
	PBLT	-.190	.785	-.045	-.242	.810	-1.771	1.391
	MMMT	.324	.898	.065	.361	.720	-1.484	2.133
	DIT	-1.537	.844	-.339	-1.823	.075	-3.235	.160

Note. a. Dependent Variable: 2015-2016 Math EOG Scores3-5.

All independent variables were found to be statistically insignificant to the prediction of the dependent variable.

Table 25 shows the model summary of the multiple regression procedure. The dependent variable was student achievement as measured by the mathematical EOG scale scores. The independent variables were self-efficacy for pedagogy in mathematics and mathematical instructional practices, categorized as cooperative learning; communication and study skills; technology-aided instruction; problem-based learning; manipulatives, models, and multiple representations; and direct instruction.

Table 25

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.390[a]	.152	.024	3.95465

Note. a. Predictors: (Constant), DIT, CLT, MMMT, TAIT, Self-Efficacy Pedagogy, PBLT, CommT.

R^2 for the overall model was 15.2% with an adjusted R^2 of 2.4%.

Table 26 shows the regression coefficients and standard errors of the independent variables.

Table 26

Coefficients and Standard Errors

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	446.526	4.529		98.587	.000	437.409	455.643
	Self-Efficacy Pedagogy	2.484	1.171	.384	2.122	.039	.128	4.841
	CLT	-.637	1.069	-.102	-.596	.554	-2.790	1.516
	CommT	.496	1.145	.081	.433	.667	-1.808	2.800
	TAIT	.667	.780	.139	.855	.397	-.903	2.237
	PBLT	-.332	.786	-.078	-.422	.675	-1.913	1.250
	MMMT	.093	.906	.019	.102	.919	-1.731	1.916
	DIT	-1.665	.835	-.367	-1.993	.052	-3.346	.016

Note. a. Dependent Variable: 2015-2016 Math EOG Scores 3-5.

Self-efficacy for pedagogy in mathematics was statistically significant to the prediction of student achievement, as measured by mathematics EOG scores, $p<.05$. All other independent variables were found to be statistically insignificant to the prediction of the dependent variable.

Overall, teachers expressed a concern with student evaluation being closely tied with their proficiency level on the EOG. They noted that while scale scores are important, the Department of Public Instruction modifies the scale scores needed for a student to be considered proficient, so there are concerns over proficiency levels. Teachers strongly emphasized that they are more concerned with growth levels than proficiency levels. They noted that they value growth over state-reported proficiency levels.

Summary

Chapter 4 provided the results of this research study. Overall, the data collected in this study indicate a strong degree of teacher self-efficacy for teaching mathematics. Additionally, teachers reported frequent use of communication and study skills. The data revealed that generally the teachers self-reported a higher usage of the six mathematical instructional strategies than the curriculum facilitators. The data indicated a weak positive correlation between student achievement and teacher self-efficacy for teaching mathematics. A correlation between student achievement and the six mathematical instructional practices, as self-reported by the teachers was not found. Moderate to strong correlations were found between total teacher self-efficacy and the six mathematical instructional practices, as self-reported by the teachers. Finally, total self-efficacy for teaching mathematics was statistically significant to the prediction of student achievement. Upon further investigation, the subscale teacher self-efficacy for pedagogy in mathematics was also found to be statistically significant to the prediction of student achievement. Chapter 5 discusses the findings of the study, addresses the research questions, and provides recommendations for future study.

Chapter 5: Discussion

The purpose of this research was to examine and analyze the relationships among teacher self-efficacy in mathematics, instructional practices in mathematics, and student achievement. Teacher self-efficacy in mathematics was measured using SETMI. Mathematical instructional practices were measured by TIPS. Student achievement was determined by the EOG assessment in mathematics. This chapter draws conclusions and discusses implications from the data in Chapter 4 as well as provides recommendations for further study.

Discussion

This chapter uses the data from Chapter 4 to address the following research questions:

1. What mathematical instructional practices do teachers in Grades 3-5 use to promote mathematical knowledge and student achievement as measured by TIPS?
2. What is the level of these teachers' self-efficacy of teaching mathematics as measured by SETMI?
3. What are the relationships among teacher self-efficacy in teaching mathematics, the use of certain mathematical instructional practices, and student achievement as measured by the North Carolina EOG test?

Data from this study provide information on each variable as well as the relationships among certain mathematical instructional practices, teacher self-efficacy for teaching mathematics, and student achievement.

Mathematical instructional practices. The first research question dealt solely with mathematical instructional practices. To gather data on the instructional practices that elementary mathematics teachers use in their teaching, the participants completed TIPS developed by Haas in 2002. Haas grouped teaching methods in six categories resulting from a meta-analysis he conducted (Haas, 2002). As addressed in Chapter 2, these categories are (1) cooperative learning; (2) communication and study skills; (3) technology-aided instruction; (4) problem-based learning; (5) manipulatives, models, and multiple representations; and (6) direct instruction.

As shown in Table 5, the frequency of the six measured mathematical instructional practices varied. Hanushek et al. (2010) posited that the United States' innovative prowess depends on our educational system graduating highly effective scientists and engineers. Hall and Ponton (2005) reported that a student's opinion and ultimately mathematical career choice is directly tied to their past experiences with mathematics. The experiences young students have in elementary mathematics have a long-lasting impact on future opinions of mathematics. This study's results imply that the teachers are providing students with multiple instructional practices which will reach multiple learning styles and interests.

Communication and study skills was rated as being used the most frequently at 4.2 times per week. See Table 5. This was surprising since communication and study skills instruction was not a theme that emerged during phone interviews. The interviewed teachers commented on the use and importance of cooperative learning. It was interesting, however, that the interviews yielded a pattern of communication being considered a part of cooperative learning. It can be implied that teachers consider student communication a part of cooperative learning, which could explain why teachers did not explicitly name communication and study skills as a frequent classroom practice during teacher interviews.

Technology-aided instruction was reported as being used the least frequently (1.9 times per week). See Table 5. During phone interviews, teachers noted that they do not often implement technology-aided instruction, as shown in the quantitative data. They felt that technology-aided instruction is mostly remediation-type online games. NCTM (2000) reported that the right technology can assist students with decision making, reasoning, problem solving, and reflection. This study, however, reflected a finding that technology-aided instruction is not a common instructional practice.

The other four measured mathematical instructional practices' frequency of usage varied. Cooperative learning was reported as being implemented an average of 3.69 times per week. This correlates with the interview data. Teachers reported implementing and enjoying cooperative learning strategies in their classroom. A theme of student engagement emerged as they discussed this instructional practice. Problem-based learning was reported as being implemented an average of 3.60 times per week. Direct instruction was reported as being implemented an average of 3.56 times per week. Manipulatives, models, and multiple representations was reported as being implemented an average of 3.00 times per week. This was surprising because during teacher interviews, participants reported this instructional strategy being used as remediation and/or extended learning for students who struggle to comprehend the mathematical content.

Overall, teachers self-reported higher incidences of use than the curriculum facilitators. During phone interviews, teachers stated that a variety of instructional practices is needed in order to help students succeed in mathematics. An overarching theme from the phone interviews was that teachers choose the instructional practice(s) based on their students' needs and learning styles as well as the content being taught, which corresponds with the quantitative data that were collected. A study conducted by Lee and Olszewski-Kubilius (2006) found that time and the teacher's perception of the student's capabilities affected the usage of certain instructional practices. This is important because NCTM (2000) suggested that the instructional practices teachers choose to use with their students during mathematics lessons influences the students' understanding of the content, their confidence in solving problems, their ability to apply knowledge to unfamiliar situations, and their attitudes towards mathematics.

The interviewed teachers reported that they do not implement "fun" instructional practices such as cooperative learning as often as they wish because of the EOG test. They feel pressure to make sure students are familiar with the multiple choice format. In studies conducted by Nichols and Berliner (2005) and Au (2007), it was reported that high-stakes testing increases teaching to the test, narrowing the curriculum, and subject areas being split into test-related pieces. The research corresponds with the data collected in this study.

Teacher self-efficacy. The second research question dealt strictly with teacher self-efficacy. Teacher self-efficacy is defined as a belief of his or her abilities to bring out preferred student engagement and learning in all students as well as their beliefs surrounding the ability to teach their subject matter even to difficult students (Bandura, 1977; Holzberger et al., 2013; Tschannen-Moran & Hoy, 2001, 2007). The instrument used to measure teacher self-efficacy was SETMI, developed in 2010 by McGee and further revised by McGee in 2012. The 22-item survey uses a 5-point Likert-scale response: 1–none at all, 2–very little, 3–strong degree, 4–quite a bit, and 5–a great deal. The item questions fall into two subscale constructs of teacher self-efficacy: efficacy for pedagogy in mathematics and efficacy for teaching mathematics content. Teachers completed the survey in early 2016.

The average total efficacy score was 3.71. See Table 12. Multiple studies regarding student achievement and teacher effectiveness revealed that teachers have a direct impact on student success (Darling-Hammond, 2007; Darling-Hammond & Youngs, 2002; Goldhaber, 2002; Hanushek, 2010; Rivkin et al., 1998; Williams, 2009). Furthermore, Rowan et al. (1997) stated that a teacher's effect can be credited to three variables: teaching ability, as defined as a teacher's knowledge of subject matter and teaching strategies; teacher motivation, as defined as teacher efficacy; and the school environment in which the teacher works. The subscale, efficacy for teaching mathematics content, had an average self-reported score of 3.56. See Table 14. The subscale, efficacy for pedagogy in mathematics, had an average score of 3.98. See Table 13. Each fell between "strong degree" and "quite a bit" on the Likert scale.

Interviews revealed that teachers felt confidence in mathematical pedagogy. They felt that they are able to motivate students as well as help them value mathematics. Helping low-performing students through projects, collaboration, and real-life examples emerged as a common theme. According to teacher interviews, an important part of helping students in mathematics is the teacher's ability to provide alternative ways of solving or thinking about a problem. Teachers, however, expressed low efficacy in this area during the interviews. They reported needing more training and practice with this important practice.

A theme of teacher subject knowledge emerged from the interviews. Interviewed teachers noted that they struggle teaching skills and areas that they themselves struggled with as a young student (or still struggle with). The same held true for areas teachers felt were easy to teach. Teachers stated that they are more comfortable teaching skills and content that they "completely understand" and/or exceled at while a grade-school student.

Mathematical instructional practices and teacher self-efficacy. Gagnon and Maccini (2007) reported that a teacher's knowledge of mathematical content, teacher preparation, and teacher beliefs about mathematics affect the teacher's selection and usage of instructional strategies. This study found strong positive correlations between total teacher self-efficacy and each of the following mathematical instructional practices: communication and study skills; problem-based learning; and manipulatives, models, and multiple representations. Moderate positive correlations were revealed between total teacher self-efficacy and the following mathematical instructional practices: cooperative learning, technology-aided instruction, and direct instruction. See Table 18.

Data revealed strong positive correlations between teacher efficacy for pedagogy in mathematics and each of the following mathematical instructional practices: cooperative learning; communication and study skills; problem-based learning; and manipulatives, models, and multiple representations. Moderate positive correlations were revealed between teacher efficacy for pedagogy in mathematics and the following mathematical instructional practices: technology-aided instruction and direct instruction. See Table 19. Kahle (2008) found a positive relationship between a high level self-efficacy and conceptually oriented teaching, which corresponds to the findings of this study. Teachers felt more effective and confident as mathematical educators when teaching with cooperative learning strategies; communication and study skills; problem-based learning; and manipulatives, models, and multiple representations. These types of instructional strategies are hands-on, real-life and collaborative in nature.

Data revealed strong positive correlations between teacher efficacy for teaching mathematical content and each of the following mathematical instructional practices:

communication and study skills; problem-based learning; and manipulatives, models, and multiple representations. Moderate positive correlations were revealed between teacher efficacy for teaching mathematical content and the following mathematical instructional practices: cooperative learning, technology-aided instruction, and direct instruction. See Table 20. These findings correlate very closely with the data regarding teacher self-efficacy for pedagogy in mathematics and mathematical instructional practices. This finding indicates that when implementing communication and study skills; problem-based learning; and manipulatives, models, and multiple representations into instruction, the teachers in the study yield a high level of teaching self-efficacy. They are more confident and feel more effective.

Winheller et al. (2013) reported that teachers with positive self-efficacy have a large influence on the use of certain instructional practices as well as the level of student engagement. This corresponds with this study's finding of strong and moderate correlations between teacher self-efficacy and the use of certain mathematical instructional practices.

Mathematical instructional practices and student achievement. In a study conducted by House (2005), it was reported that students from Japan and the United States showed a positive correlation between outlooks towards mathematics and three instructional strategies (practical application for learning, teacher demonstration, and cooperative learning). House found that students who were consistently taught using these three strategies scored high on TIMSS. Two of the three instructional strategies stated above were measured in this study–cooperative learning and teacher demonstration (direct instruction). The data unexpectedly found no correlations between student achievement and the teacher-reported six instructional practices measured by TIPS. See

Table 16. Data collected in this study did, however, reveal moderate positive correlations between student achievement and the curriculum facilitator reported scores in cooperative learning and direct instruction. See Table 17. Cross-tabulations showed that overall, teachers chose a higher number of weekly incidences in all six instructional practices than the curriculum facilitators. See Tables 6-11.

Qualitative data reveal that teachers find cooperative learning to be a very important part of student motivation and engagement. They stated that they incorporate cooperative learning strategies into multiple facets of their mathematical standards. Teacher interviews also revealed that teachers feel a variety of instructional practices are important to student achievement. One strategy is not necessarily better than the others; rather, it depends on student learning styles and the content being taught.

Teacher self-efficacy and student achievement. Data collected in this study indicate weak positive correlations between student achievement and teacher self-efficacy. See Table 15. Teacher interviews reflected the belief that the teachers feel a strong sense of self-efficacy when teaching mathematics. They explained that they feel able to motivate and engage all students, especially low-performing students.

This study did find, however, that total teacher self-efficacy was statistically significant to the prediction of student achievement, as defined by student scores on the mathematics EOG assessment. See Table 22. Data in the study also reveal that the subscale, efficacy for pedagogy in mathematics, was statistically significant to the prediction of student achievement, as defined by student scores on the mathematics EOG assessment. See Table 26. The literature review correlates these findings. Strong self-efficacy can affect student performance (Bandura, 1997; Cantrell et al., 2003; Tschannen-Moran & Hoy, 2001; Woolfolk et al., 1990).

According to the data in this study, teacher self-efficacy for pedagogy in mathematics plays a role in student achievement. The literature review in Chapter 2 supports this finding. Researchers found a significant relationship between teachers' sense of efficacy and increased standardized reading scores in Los Angeles (Ashton et al., 1984).

Conclusions

The data in this study indicate that given the setting, participants, and measures, there were a number of interesting findings. Surprisingly, student achievement and teacher self-efficacy were found to have weak positive correlations. The research states that a teacher's efficacy has a direct effect on student achievement (Bandura, 1997; Cantrell et al., 2003; Darling-Hammond & Youngs, 2002; Goldhaber, 2002; Rowan et al., 1997; Tschannen-Moran & Hoy, 2001; Willliams, 2009). Teachers who do not expect to be successful with particular students are likely to put forth less work in planning and instructing and are more likely to give up quickly at the first sign of struggle, even if they know of strategies that could support these students (Tschannen-Moran & Hoy, 2007), which could explain the study's finding that that the total teacher self-efficacy scores were statistically significant to predicting student achievement. Moreover, the subscale efficacy for pedagogy in mathematics also was found to have statistical significance when predicting student achievement.

Unexpectedly, this study found no correlation between student achievement and the mathematical instructional practices measured on TIPS. The lack of correlation does not indicate unimportance of the variables. These findings are inconsistent with previous research. NCTM (2000) asserted that the instructional strategies teachers choose to use in the mathematical classroom affect student understanding, problem-solving confidence, application of knowledge, and attitudes towards mathematics which do not support the noncorrelation finding in this study. Moreover, House (2005) found students taught with cooperative learning and direct instruction as well as real-life application performed consistently better on TIMSS. The study did, however, find that the more frequently a teacher implements communication and study skills; problem-based learning; cooperative learning; and manipulatives, models, and multiple representations, the higher the teacher self-efficacy.

Overall, this study found an interesting statistical significance between teacher self-efficacy and student achievement scores. Further, this study found that the instructional practices of communication and study skills; problem-based learning; cooperative learning; and manipulatives, models, and multiple representations raise teacher self-efficacy. It can be recommended that instructional leaders in this district should implement teacher training on the aforementioned instructional strategies so teacher self-efficacy improves. According to this study, the improved teacher self-efficacy should improve student achievement scores. Teachers with high levels of self-efficacy will work hard to reach goals, will persevere during problems, and will recover quickly from temporary setbacks (Cantrell et al., 2003) as well as have more involvement in learning/training activities and show lower signs of stress (Lohman, 2006). The research suggests a number of experiences that could enhance teacher self-efficacy. Tschannen-Moran and Hoy (2007) suggested observing another teacher of similar background and experiences modeling a target activity. This could improve teacher self-efficacy. Verbal exchanges regarding performance and success from significant individuals can also enhance teacher self-efficacy (Tschannen-Moran & Hoy, 2007).

Recommendations for Further Study

One area of recommendation for further study includes the variables of student achievement and mathematical instructional practices, due to the lack of correlation found in this study. Teacher interviews revealed that teachers highly value student growth which was not measured in this study. Future study should define student achievement as a growth model. Also, through the course of this research, a correlation between communication and study skills; problem-based learning; cooperative learning; and manipulatives, models, and multiple representations and teacher self-efficacy emerged. There is not much research exploring these correlations. Additionally, demographic information was gathered but not used in the data analysis of this study. Future study should investigate teacher self-efficacy, the types of degrees teachers hold, and past professional development in mathematics. This could be of great benefit when researching what type of degrees and trainings contribute to self-efficacy levels. Finally, a recommendation for further study is to expand the study to a larger population of grades 3-5 teachers so the findings can be generalized.

Summary

The purpose of this research was to examine and analyze the relationships among teacher self-efficacy in mathematics, instructional practices in mathematics, and student achievement. Overall, the data collected in this study indicate a strong degree of teacher self-efficacy for teaching mathematics. The data revealed that generally the teachers self-reported a higher usage of the six mathematical instructional strategies than the curriculum facilitators. The data indicated a weak positive correlation between student achievement and teacher self-efficacy for teaching mathematics. A correlation between student achievement and the six mathematical instructional practices, as self-reported by the teachers was not found. Moderate to strong correlations were found between total teacher self-efficacy and the six mathematical instructional practices, as self-reported by the teachers. Finally, total self-efficacy for teaching mathematics was statistically significant to the prediction of student achievement. Upon further investigation, the subscale teacher self-efficacy for pedagogy in mathematics was also found to be statistically significant to the prediction of student achievement. The findings in this study add to the current body of knowledge regarding the variables of teacher self-efficacy in mathematics, instructional practices in mathematics, and student achievement.

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Appendix A

Superintendent Consent Form

Permission to Conduct Study:

Kristi Day has permission to conduct the study, "Teacher Self-Efficacy, Instructional Practices, and Student Achievement in Mathematics: A Correlational Study" with [redacted]. This research will serve as a dissertation study through Gardner-Webb University.

[redacted]

7-23-15
Date

[redacted]

[redacted]

7-23-15
Date

Appendix B

Self-Efficacy for Teaching Mathematics Instrument Consent

Appalachian
STATE UNIVERSITY
151 College St. Boone, NC 28608

College of
Education Department of Curriculum
and Instruction
[redacted]

You have my permission to use the Self Efficacy for Teaching Mathematics Instrument in your research. Please reference the validity information and scoring guide when publishing your findings.

Sincerely,

Jennifer R. McGee, Ed.D.
College of Education
Appalachian State
University 151 College St.
Boone, NC 28608
[redacted]

Appendix C

Teachers' Instructional Practices Survey Consent

Matthew Haas <mhaas@[redacted]>

To:
Kristi Day;

Mon 7/7/2014 11:51 AM

Hi Kristi:

I apologize for the delay in responding!

Yes, of course, please feel free to use the survey. I'm just pleased someone besides me has read the dissertation!

This looks like a very promising study you are doing.

I wish you the best, and if you have any questions, please call me at the number below.

Matt Haas

Good afternoon Dr. Haas,

My name is Kristi Day and I am a Ed.D student with Gardner-Webb University in NC. My dissertation is focused on looking at teacher self-efficacy, mathematical instructional practices, and student achievement on the NC End of Grade tests. I am emailing to request the use your instrument (TIPS) that you developed in your dissertation. I plan on using this with Grades 3-5 teachers so I would not modify your instrument but I would need to delete some of the middle school specific questions, with your permission. I would also add demographic information at the beginning of the survey. I appreciate your time!

Thank you!
Kristi Day

Matt

Matthew S. Haas, Ed.D.

[redacted]

Appendix D

Teachers' Instructional Practices Survey Modification Consent

Matthew Haas <mhaas@[redacted]>

To:

Kristi Day;

Sat 4/11/2015 9:44 AM

Good Morning, Kristi:

That sounds like a great plan.

Please feel free to proceed.

Thanks for asking.

Matt

Matthew S. Haas, Ed.D.

[redacted]

To:

Matthew Haas <mhaas@[redacted]>;

Fri 4/10/2015 7:46 PM

Sent Items

Good evening Dr. Haas!

I hope that this finds you well. I wanted to check with you about modifying the TIPS. For my study, I would like to use the TIPS as is for the teachers to complete. I would also like to have the curriculum facilitators at each school to fill out a version of the TIPS on each teacher, depending on what they observed in the classroom. I would like to use each statement as is but change the directions and wording to fit their role such as, "To what degree I see (teacher) doing this in the classroom." This will help me validate the use of the instructional practices. I would like to leave the Likert Scale of 0-5. This will let me know if the curriculum facilitators agree or disagree with the teachers' self assessment of their practices. I look forward to hearing from you soon!

Thank you!

Kristi Day

Appendix E

Principal Consent

Title: Teacher Self-Efficacy, Instructional Practices, and Student Achievement in Mathematics:
A Correlational Study

Hello!

My name is Kristi Day and I am a former [redacted] teacher. I am in the final year of study for my Doctor of Education degree at Gardner-Webb University. In this program, I am required to complete a research dissertation as the final stage of my degree. I would like to complete my dissertation work within your school district because I feel that my study will go along great with work that is already being done in your district.

The following information is being provided to help you decide whether you wish for your school to participate in this study. You should be aware that you are free to decide whether or not to participate. You may also withdraw at any time without affecting your relationship with the district or researcher.

The purpose of the study is to examine teacher self-efficacy in mathematics and the use of specific mathematical instructional practices in grades 3-5 classrooms in your district. I will also examine the relationships among teacher self-efficacy of teaching mathematics, the use of specific mathematical instructional practices, and student achievement on the North Carolina End-of-Grade test.

Data collection will take place through surveys, student EOG scores, and focus groups. Third through fifth grade math teachers will be asked to take 20-25 minute survey about their mathematical instructional practices, as well as their beliefs regarding teaching mathematics. Your curriculum facilitator will fill out a survey regarding mathematical instructional practices that he or she has observed in their classrooms and planning sessions. I will conduct three focus groups that your school may or may not be invited to participate in. Finally, the Mathematics EOG assessment will be administered and I will collect student test scores. I will collect all data using teacher codes without their name. All digital data will be password protected.

Please do not hesitate to ask questions about the study before or during participation. Upon completion of the study, data will be forwarded to the district as a means to share the research findings. Teacher names and schools will not be associated with the research findings in any way.

There are no known risks and/or discomforts associated with this study. The expected benefits associated with your participation are the information about teacher self-efficacy, mathematical instructional practices, and student achievement.

Kristi Day
Doctoral Student, Gardner-Webb University
[redacted]

Appendix F

Teacher Consent

Title: Teacher Self-Efficacy, Instructional Practices, and Student Achievement in Mathematics:
A Correlational Study

Hello!

My name is Kristi Day and I am a former [redacted] teacher. I am in the final year of study for my Doctor of Education degree at Gardner-Webb University. In this program, I am required to complete a research dissertation as the final stage of my degree. I would like to complete my dissertation work within your school district because I feel that my study will go along great with work that is already being done in your district.

The following information is being provided to help you decide whether you wish to participate in this study. You should be aware that you are free to decide whether or not to participate. You may also withdraw at any time without affecting your relationship with the school, district, or researcher.

The purpose of the study is to examine teacher self-efficacy in mathematics and the use of specific mathematical instructional practices in grades 3-5 classrooms in your district. I will also examine the relationships among teacher self-efficacy of teaching mathematics, the use of specific mathematical instructional practices, and student achievement on the North Carolina End-of-Grade test.

Data collection will take place through surveys, student EOG scores, and focus groups. You will be asked to take 20-25 minute survey about your mathematical instructional practices, as well as your beliefs regarding teaching mathematics. Your curriculum facilitator will fill out a survey regarding mathematical instructional practices that he or she has observed in your classroom and planning sessions. I will conduct three focus groups that you may or you may not be invited to participate in. Finally, the Mathematics EOG assessment will be administered and I will collect student test scores. I will collect all data using teacher codes without your name. All digital data will be password protected.

Please do not hesitate to ask questions about the study before or during participation. Upon completion of the study, data will be forwarded to the district as a means to share the research findings. Your name and school will not be associated with the research findings in any way.

There are no known risks and/or discomforts associated with this study. The expected benefits associated with your participation are the information about teacher self-efficacy, mathematical instructional practices, and student achievement.

A survey link will be sent to you shortly. By completing the survey, you are consenting to participating in the study with the full knowledge of the nature and purpose of the procedures and research.

Kristi Day
Doctoral Student, Gardner-Webb University
[redacted]

Appendix G

Teacher Survey

Math Survey for Teachers
Please complete the survey. The demographic information is for research purposes only.
* Required
Please enter your unique code. *
Your answer

What is your gender? *
Male
Female
What grade level or levels do you currently teach? *
Your answer

How many years you have taught your current grade level? *
0-5
6-10
11-15
16-20
21-25
26-30
31+
What grades have you previously taught? *
Your answer

In all, how many years you have taught? *
0-5
6-10
11-15
16-20
21-25
26-30
31+
What is your highest level of degree? *
Bachelor
Masters
Ed.D
Ph.D
Other :

Are you Nationally Board Certified? *
Yes
No

For each of the statements listed in this section, please select the choice that best indicates the number of times you use this teaching method, given a typical classroom period. For example, if you use this method every class period, please select 5. If you never use this method, please select 0.

I collaborate with the whole class in finding a solution to a problem. *

Never

0
1
2
3
4
5

Every class period

I allow students to engage in cooperative problem solving. *

Never

0
1
2
3
4
5

Every class period

I allow students to discuss solutions to problems with peers. *

Never

0
1
2
3
4
5

Every class period

I allow students to begin homework in class with peer assistance. *

Never

0
1
2
3
4
5

Every class period

I allow students to work as peer tutors. *
Never
0
1
2
3
4
5
Every class period

I reward group performance in a cooperative setting. *
Never
0
1
2
3
4
5
Every class period

I assign students to work in homogeneous groups. *
Never
0
1
2
3
4
5
Every class period

I assign students to work in heterogeneous groups. *
Never
0
1
2
3
4
5
Every class period

I encourage students to use mathematics vocabulary terms in class discussions. *
Never
0
1
2
3
4
5
Every class period

I have students describe their thought processes orally or in writing during problem solving. *

Never

0
1
2
3
4
5

Every class period

I require students to share their thinking by conjecturing, arguing, and justifying ideas. *

Never

0
1
2
3
4
5

Every class period

I have students write about their problem solving strategies. *

Never

0
1
2
3
4
5

Every class period

I encourage students to ask questions when difficulties or misunderstandings arise. *

Never

0
1
2
3
4
5

Every class period

I encourage students to explain the reasoning behind their ideas. *

Never

0
1
2
3
4
5

Every class period

I use reading instructional strategies to help students with comprehension. *
Never
0
1
2
3
4
5
Every class period
I provide students with study skills instruction. *
Never
0
1
2
3
4
5
Every class period
I have students use calculators during tests or quizzes (given five typical test or quiz administrations). *
Never
0
1
2
3
4
5
Every class period
I have students use calculators for problem solving instruction and activities. *
Never
0
1
2
3
4
5
Every class period
I have students use calculators to help them develop problem-solving strategies. *
Never
0
1
2
3
4
5
Every class period

I have students use calculators for computations. *
Never
0
1
2
3
4
5
Every class period
I have students use graphing calculators to explore linear relationships. *
Never
0
1
2
3
4
5
Every class period
I have students use computer spreadsheets, such as Microsoft Excel, for problem solving instructions. *
Never
0
1
2
3
4
5
Every class period
I assign students calculators as a requirement for class participation. *
Never
0
1
2
3
4
5
Every class period
I use computer software to provide practice opportunities. *
Never
0
1
2
3
4
5
Every class period

I have students create their own rules in new problem solving situations. *
Never
0
1
2
3
4
5
Every class period
I draw mathematical concepts from “real-life” situations. *
Never
0
1
2
3
4
5
Every class period
I have students pursue open-ended and extended problem solving projects. *
Never
0
1
2
3
4
5
Every class period
I create problems from the interests of individual students. *
Never
0
1
2
3
4
5
Every class period
I recognize many alternative problem-solving practices. *
Never
0
1
2
3
4
5
Every class period

I emphasize the problem-solving process, rather than the solution. *
Never
0
1
2
3
4
5
Every class period
I anchor problem-solving skills instruction within situations meaningful to the students. *
Never
0
1
2
3
4
5
Every class period
I encourage students to experiment with alternative methods for problem-solving. *
Never
0
1
2
3
4
5
Every class period
I have students use cubes or blocks to represent equations. *
Never
0
1
2
3
4
5
Every class period
I illustrate mathematical concepts for students with pictures. *
Never
0
1
2
3
4
5
Every class period

I teach students to represent equations with graphs. *
Never
0
1
2
3
4
5
Every class period
I teach students to represent problems with tables. *
Never
0
1
2
3
4
5
Every class period
I teach students to represent problems with charts to break down the information into smaller pieces. *
Never
0
1
2
3
4
5
Every class period
I emphasize the use of multiple representations: words, tables, graphs, and symbols. *
Never
0
1
2
3
4
5
Every class period
I provide math games for students to practice skills. *
Never
0
1
2
3
4
5
Every class period

I use diagrams to help students learn to solve equations. *

Never

0
1
2
3
4
5

Every class period

I grade homework and provide feedback. *

Never

0
1
2
3
4
5

Every class period

I close instruction by reviewing concepts with students, emphasizing comparisons to previously covered concepts. *

Never

0
1
2
3
4
5

Every class period

When I provide feedback, I target incorrect responses and error patterns. *

Never

0
1
2
3
4
5

Every class period

I identify a new skill or concept at the beginning of instruction and provide a rationale for learning it. *

Never

0
1
2
3
4
5

Every class period

I provide graduated sequences of instruction, moving students from concrete to abstract concepts in defined steps. *

Never

0
1
2
3
4
5

Every class period

I require students to indicate a one-step-at-a-time process in working equations. *

Never

0
1
2
3
4
5

Every class period

I use pre-worked examples to introduce or reinforce topics. *

Never

0
1
2
3
4
5

Every class period

When assigning practice work, I ensure that the majority of the problems review previously covered material. *

Never

0
1
2
3
4
5

Every class period

Please choose the answer that matches your response.

1 - None at All 2 - Very Little 3 - Strong Degree 4 - Quite a Bit 5 - A Great Deal

To what extent can you motivate students who show low interest in mathematics? *
None at all
1
2
3
4
5
A great deal
To what extent can you help your students value learning mathematics? *
None at all
1
2
3
4
5
A great deal
To what extent can you craft relevant questions for your students related to mathematics? *
None at all
1
2
3
4
5
A great deal
To what extent can you get your students to believe they can do well in mathematics? *
None at all
1
2
3
4
5
A great deal
To what extent can you use a variety of assessment strategies in mathematics? *
None at all
1
2
3
4
5
A great deal

To what extent can you provide an alternative explanation or example in mathematics when students are confused? *

None at all

1
2
3
4
5

A great deal

How well can you implement alternative teaching strategies for mathematics in your classroom? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to describe characteristics of numbers (i.e. whole numbers, rational/irrational numbers)? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to perform strategies for composing and decomposing numbers by manipulating place value in addition and subtraction? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to perform strategies for composing and decomposing numbers by manipulating place value in multiplication and division? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to convert a fraction to a decimal and vice versa? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to compare equivalence of fractions and decimals? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to interpret inverse relationships between operations (i.e. +, -, *, and /)? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to manipulate coordinate planes? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to collect, plot, and interpret data (on any type of graph)? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to measure area and perimeter? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to convert between units in the same system (i.e. grams to kilograms, inches to yards)? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to convert between units in a different system (i.e. kilograms to pounds, inches to centimeters)? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to measure the length of objects? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to discover and create mathematical patterns? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to interpret variables in an algebraic equation? *

None at all

1
2
3
4
5

A great deal

How well can you teach students to interpret probability of outcomes? *

None at all

1
2
3
4
5

A great deal

Appendix H

Curriculum Facilitator Survey

Survey for Curriculum Facilitators

Please complete one TIPS for CF for each 3-5 math teacher in your school. For each of the statements listed, please select the choice that best indicates the number of times the teacher uses this teaching method, given a typical classroom period. For example, if the teacher uses this method every class period, please select 5. If they never use this method, please select 0.

Please enter your name.
Your answer

Please enter the teacher's unique code.
Your answer

The teacher collaborates with the whole class in finding a solution to a problem.
Never
0
1
2
3
4
5
Every class period

The teacher allows students to engage in cooperative problem solving.
Never
0
1
2
3
4
5
Every class period

The teacher allows students to discuss solutions to problems with peers.
Never
0
1
2
3
4
5
Every class period

The teacher allows students to begin homework in class with peer assistance.
Never
0
1
2
3
4
5
Every class period
The teacher allows students to work as peer tutors.
Never
0
1
2
3
4
5
Every class period
The teacher rewards group performance in a cooperative setting.
Never
0
1
2
3
4
5
Every class period
The teacher assigns students to work in homogeneous groups.
Never
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Every class period
The teacher assigns students to work in heterogeneous groups.
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Every class period

The teacher encourages students to use mathematics vocabulary terms in class discussions.

Never

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Every class period

The teacher has students describe their thought processes orally or in writing during problem solving.

Never

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Every class period

The teacher requires students to share their thinking by conjecturing, arguing, and justifying ideas.

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Every class period

The teacher has students write about their problem solving strategies.

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Every class period

The teacher encourages students to ask questions when difficulties or misunderstandings arise.

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Every class period

The teacher encourages students to explain the reasoning behind their ideas.

Never

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Every class period

The teacher uses reading instructional strategies to help students with comprehension.

Never

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Every class period

The teacher provides students with study skills instruction.

Never

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Every class period

The teacher has students use calculators during tests or quizzes (given five typical test or quiz administrations).

Never

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Every class period

The teacher has students use calculators for problem solving instruction and activities.
Never
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Every class period
The teacher has students use calculators to help them develop problem-solving strategies.
Never
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Every class period
The teacher has students use calculators for computations.
Never
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Every class period
The teacher has students use graphing calculators to explore linear relationships.
Never
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Every class period
The teacher has students use computer spreadsheets, such as Microsoft Excel, for problem solving instructions.
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Every class period

The teacher assigns students calculators as a requirement for class participation.

Never

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Every class period

The teacher uses computer software to provide practice opportunities.

Never

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Every class period

The teacher has students create their own rules in new problem solving situations.

Never

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Every class period

The teacher draws mathematical concepts from “real-life” situations.

Never

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Every class period

The teacher has students pursue open-ended and extended problem solving projects.

Never

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Every class period

The teacher creates problems from the interests of individual students.

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Every class period

The teacher recognizes many alternative problem-solving practices.

Never

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Every class period

The teacher emphasizes the problem-solving process, rather than the solution.

Never

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Every class period

The teacher anchors problem-solving skills instruction within situations meaningful to the students.

Never

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Every class period

The teacher encourages students to experiment with alternative methods for problem-solving.

Never

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Every class period

The teacher has students use cubes or blocks to represent equations.
Never
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Every class period
The teacher illustrates mathematical concepts for students with pictures.
Never
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Every class period
The teacher teaches students to represent equations with graphs.
Never
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Every class period
The teacher teaches students to represent problems with tables.
Never
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Every class period
The teacher teaches students to represent problems with charts to break down the information into smaller pieces.
Never
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Every class period

The teacher emphasizes the use of multiple representations: words, tables, graphs, and symbols.

Never

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Every class period

The teacher provides math games for students to practice skills.

Never

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Every class period

The teacher uses diagrams to help students learn to solve equations.

Never

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Every class period

The teacher grades homework and provides feedback.

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Every class period

The teacher closes instruction by reviewing concepts with students, emphasizing comparisons to previously covered concepts.

Never

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Every class period

When the teacher provides feedback, he or she targets incorrect responses and error patterns.

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Every class period

The teacher identifies a new skill or concept at the beginning of instruction and provides a rationale for learning it.

Never
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Every class period

The teacher provides graduated sequences of instruction, moving students from concrete to abstract concepts in defined steps.

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Every class period

The teacher requires students to indicate a one-step-at-a-time process in working equations.

Never
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Every class period

The teacher uses pre-worked examples to introduce or reinforce topics.

Never

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Every class period

When assigning practice work, the teacher ensures that the majority of the problems review previously covered material.

Never

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Every class period