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The Effect of Elementary Mathematics Coaching On Student Achievement in Fourth, Fifth, and Sixth Grade

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2013

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Merita Trimuel Stewart

MA, Savannah State University, 2000

BA, St. Leo College 1990

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Teacher Leadership

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Abstract

Due to recent waivers and current expectations of teacher performance, schools have been tasked to close their student achievement gaps in mathematics by 2014. Yet students still have not performed well in mathematics, which may be a direct link to teachers' instructional practices. Identifying a coaching model to improve student achievement and teachers' instructional practices is important to district leaders, school administrators, and teachers. The purpose of this study was to evaluate how a coaching practice with teachers affected student achievement in elementary mathematics. The theoretical foundation of this study was the coaching model, first used by Joyce and Showers, which theorized that teachers who participated in this type of professional development would improve their instructional practices in the classroom, and subsequently, student achievement. A quasi experimental design was employed to test the theory that teachers who were coached would improve student achievement in elementary mathematics. A total of 185 test scores from students were analyzed using an independent measures *t* test and a repeated measures *t* test. Findings suggested that the achievement scores of students whose teachers were coached were statistically higher on both state and local assessments. Fourth grade students showed improvement on both the local and state assessments, while 5th and 6th grade students demonstrated significant differences on the local assessments only, but not on the state assessments. This research contributes to positive social change by providing educators with a coaching model that demonstrates how teacher coaching can increase student achievement in elementary mathematics, Grades 4 through 6.

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Dedication

I dedicate this dissertation to the girls, Kenya, Chassidy, and Franchesca: Thank you for being patient, for continuing to love me through it all, and for always lending a listening ear. I love you girls. You are my heart.

Acknowledgments

Thank you, Dr. Kathleen Maury, the chair of my committee, for reading my drafts numerous of times, for all of your quick, but very detailed responses, for always taking time to talk to me when I would say ”quick question,” and for having such a kindred, loving spirit. Thank you, Dr. Shannon Walker, my second committee member, for all of your support and for being such a great team player. Without both of you, this dissertation would not have happened. I will always be grateful.

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Section 1: Introduction to the Study

According to the National Mathematics Advisory Panel (NMAP, 2008), American students constantly lag behind in mathematics, achieve at average levels, and do not measure up to their peers worldwide. Elfers, Pleki, Knapp, Gahram, & McGowan (2007) further contended that another reason for this gap is because school teachers do not use efficient instructional practices when teaching mathematics. In addition, to achieve positive results and move schools forward, a commitment of time, money, and an unswerving community-wide effort will be necessary (NMAP, 2008).

XYZ Elementary School District, which is a pseudonym for the school and the focus of this study, had a goal to improve student achievement for Grades 4 through 6 from the average TerraNova scores of 50% to 70% or higher in mathematics. To address the district's initiative, several district-wide mathematics coaches were assigned to investigate how teachers teach mathematics and how students learn mathematics. The purpose of this study was to find out how the coaching model affected student achievement at XYZ Elementary School. The independent variable was the pedagogical content coaching (PCC) model, and the dependent variable was student achievement. I hypothesized that PCC would improve student achievement.

After weeks of training and preparing for the coach's role, extensive professional development, and the need to meet the high demands placed on schools by No Child Left Behind (NCLB), the PCC model in mathematics was adopted, modified, and implemented by the district in 2006. The PCC model was executed to help teachers gain more effective instructional practices in mathematics for an overall increase in student achievement. PCC is “based on the premise that throughout their careers, teachers need to continue to grow in their knowledge of content and of pedagogy” (Noyce, 2007, p. 1).

In 2007, the U.S. Department of Education issued a report that stated American students fail to achieve even basic levels of proficiency in mathematics on national tests and perform at low levels on international tests. The National Council for Teachers of Mathematics (NCTM; 2009) set process standards that focus on the need for students to use problem solving skills in everyday situations. Such skills included being able to connect topics, create representations or models, write and verbalize mathematical thinking, and rationalize and defend solutions and conclusions to problems (NCTM, 2009).

Research has shown that the successful acquisition of mathematics knowledge and skills is influenced by numerous environmental and student factors. For example, research has linked teacher expectations for student performance and classroom instructional practices with mathematics related educational outcomes including the cognitive, behavioral, and academic performance of students (Tyler & Boelter, 2008). For this reason, advancing professional learning for educators is an essential step in transforming schools, (Andree, Darling-Hammond, Orphanos, Richardson, & Wei, 2009) and improving standardized achievement scores. Without high quality teachers, districts know student achievement may be at risk. Despite a decade of reform talk, teachers mostly continue to teach as they have in the past (Sparks & Hirsh, 2002). According to

Loucks-Horsley, Stiles, Mundry, Love, and Hewson (2010), teachers can benefit from concrete data on their own instruction as they reflect and change their practice.

Instruction and practice should be informed by knowledge of how students learn and approach specific content (Borko, Jacobs, Eiteljorg, & Pittman, 2008). Through professional development, teachers are encouraged to support students' exploration of mathematics curriculum content, including sense making activities and opportunities to demonstrate what they have learned (Boaler & Staples, 2008).

According to Finn (2008), “Nothing in education reform is easy” (p. 36). In fact, organizations such as schools change very little (Smith, 2008). Yet, in order to reach the goal that has been set forth by the NCTM, mathematics coaches have been strategically placed in elementary schools throughout the United States including the district under study. Coaching, as defined by Boyd (2008), is a form of professional learning that includes a combination of professional development and change management processes which offers continuous growth for people at their levels of understanding (Boyd, 2008). Coaches must undergo rigorous and ongoing professional development and does the essential ground work prior to implementing the initiative. One way to implement standards is through Content-Focused Coaching (West & Staub, 2003). Content Focused Coaching addresses the day-to-day planning, teaching, and building time to reflect on lessons that incorporate standards, curriculum, principles of learning, and lesson design and assessment (West & Staub, 2003).

One researcher compared various coaching designs in five districts. The purpose was to learn which designs were more effective than others. All the districts had described similar objectives. All wished to improve mathematics instruction, and chose coaching to accomplish that goal. The most effective designs found were those that worked on one subject area and in one school (Mangin, 2005).

Mangin found programs that had mathematics coaches working in one subject area and in one school were more effective than programs which had coaches working in two or more subjects or schools. Broad communication was another effective component that outlined the role and responsibilities of the mathematics coach, so all stakeholders worked from a mutual understanding. Such stakeholders include parents and others to make them a part of the educational environment. Effective strategies for communicating with parents include (a) using various modes of communication, (b) inviting parents to visit or attend school events, (c) engaging families in curriculum planning, and (d) providing parents with resources to help their children succeed in school (Salend, 2010). Mangin discovered communication proved to be an essential component for successful implementation of a coaching program. When teachers communicate with each other and ensure they are in agreement regarding interactions with children (Sileo, 2011), all stakeholders can benefit. More detailed discussions on coaching models follow in Section 2.

Problem Statement

The 2003 version of the TerraNova standardized student achievement test was used at XYZ Elementary school for testing students in grades 3, 4, 5, and 6 for school years 2003 through 2008. The MacMillan/McGraw-Hill adopted mathematics series were the textbooks used by third, fourth, and fifth grade. Sixth grade used the Scott

Foresman/Addison Wesley series as their adopted textbook. Students in grades kindergarten through sixth grade were to take a pretest and posttest, each year, using the testing materials from these series. This usually occurred in the fall and spring of the same school year. Only students in grades 3, 4, 5, and 6 were given the TerraNova test. The TerraNova test was administered in February or March.

Past test results for the school under study for years 2003 through 2011 indicated poor performance in mathematics. These scores had remained dormant for the previous several years, and the PCC model was implemented to improve instructional practices so that student achievement in mathematics might improve. The teachers at XYZ were not mathematics specialists, but instead were generalists, and did not have strong quantitative backgrounds, yet in most instances, general educators are considered masters of content (Villa, Thousand, & Nevin, 2008).

Nature of the Study

In this study, I employed a quasi experimental nonequivalent (pretest posttest) control-group design to determine the effect of the mathematics coaching model on student achievement in grades 4, 5, and 6. The quasi experimental nonequivalent design derived logically from examining the independent variable (the coaching program) on the dependent variable (students' standardized test scores). Participants were selected without random assignment. Rather, I used a convenience sample (Creswell, 2009).

The population for this study included students who were 8 to 13-years-old, in grades 4, 5, or 6, and were enrolled in mathematics classes at XYZ Elementary School. The total population for these grade levels consisted of 198 students and 10 teachers. Due to a high turnover rate of students moving in and out of the area, a convenience sample of 185 student test scores was drawn from this population.

For the TerraNova Standardized Test, skills and concepts were tested by CTB (McGraw-Hill, 1996). Items were tested using specific manipulatives in pilots as well as teachers and students being interviewed to determine if the manipulatives were appropriate. Student feedback was considered. A page-by-page usability study with individual students was conducted to determine whether mathematics questions were clearly understood and whether students could find and use charts, graphs, and illustrations on the page. The test was then modified accordingly (CTB/McGraw-Hill, 1996).

The MacMillan/McGraw-Hill mathematics assessments were field tested and revised based on input from both teachers and students (McGraw-Hill, 1996). Focus groups and teacher advisory boards help create appropriate items. Scores for the Scott Foresman/Addison Wesley Quarterly assessment were calculated according to how many incorrect responses were given by the participant. A grading scale was used to score each participant response.

Test scores were compared between the treatment group and the control group. I investigated if there were any statistically significant differences in the mean scores. A comparison of performance of the experimental and control groups on the pretest and posttest were determined using a *t* test to measure statistical significance.

Research Questions and Hypotheses

Three research questions were examined in this study. These questions specifically addressed TerraNova test scores and the MacMillan/McGraw-Hill and Scott Foresman/Addison-Wesley local assessment test scores of students in fourth, fifth, and sixth grades. The questions related to test scores of students who were part of the coaching model and the test scores of students who were not part of the coaching model.

Research Question 1: Is there a significant difference between the mean scores of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model?

$H_0$1: There is no significant difference between the mean scores on the TerraNova standardized test of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model.

H_A1: There is a significant difference between the mean scores on the TerraNova standardized test of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model.

Research Question 2: Is there a significant difference between the mean scores on the McMillan/McGraw-Hill pretest and posttest of students whose teachers participated in the mathematics coaching model?

$H_0$2: There is no significant difference between the mean scores on the McMillan/McGraw-Hill pretest and posttest of students whose teachers participated in the mathematics coaching model.

H_A2: There is a significant difference between the mean scores on the McMillan/McGraw-Hill pretest and posttest of students whose teachers participated in the mathematics coaching model.

Research Question 3: Is there a significant difference between the mean scores on the Scott Foresman/Addison-Wesley pretest and posttest of students whose teachers participated in the mathematics coaching model?

$H_0$3: There is no significant difference between the mean scores on the Scott Foresman/Addison-Wesley pretest and posttest of students whose teachers participated in the mathematics coaching model.

H_A3: There is a significant difference between the mean scores on the Scott Foresman/Addison-Wesley pretest and posttest of students whose teachers participated in the mathematics coaching model.

Purpose of the Study

The purpose of this study was to determine whether there was a significant difference between the standardized test scores of students whose teachers participated in the mathematics PCC model and the scores of students whose teachers did not participate in the model. Understanding the effects of the model could help the school in its goal of improving student achievement. Allowing teachers to be active participants in this type of professional development may positively change the way teachers educate students.

In order to help understand PCC in mathematics, Noyce (2008) suggested instructional practices should: (a) focus on high performance expectations for students and educators, (b) examine and analyze students' understandings from assessments, (c) develop effective educational strategies and practices, and (d) tailor instruction to enhance student learning and understanding. According to Schifter (2007), teachers can began changing their pedagogy by participating in discussion groups which allows them to be challenged in their discipline while simultaneously learning new mathematical concepts and amplifying their own mathematical understanding. Likewise, mathematics becomes real to children when they can explore and solve problems that require them to use their mathematical knowledge and skills in context (Sparrow, 2008). Teachers must be persistent in using reflective practice in order to have continuous learning for themselves and their students (Boyd, 2008). After all, improved achievement is the direct result of improved instruction. Improved instruction is an outcome of continuous, comprehensive, intensive professional development (Noyce, 2008).

A significant amount of research has been conducted to determine how teachers learn and apply what they are learning about understanding and teaching mathematics. Pace (2008) established that teachers who participated in the Developing Mathematical Ideas (DMI) coaching model, "felt very confident in teaching elementary mathematics" (p. 55). Specifically, it was reported they used a more exploratory, open-ended approach to inquiry-based instruction and grouped their students with a specific goal in mind. Educators rely on teaching from textbooks and encounter a breadth of different topics throughout the school year, but they may not be clear on the depth of the skills and strategies needed for students to reach their full potential (Felux & Snowdy, 2006). According to Towers (2012), preservice teachers should explore and recognize the meaning of becoming a teacher and learn how to teach before entering classrooms and schools to practice on students. When teachers make effective instructional decisions and work with content coaches to help stay focused, students can gain deeper content knowledge (Neufeld & Roper, 2003).

Theoretical Framework

Joyce and Showers (1982) theory on peer coaching was used by teachers to coach each other in a reciprocal way. Joyce and Showers contended that the peer coaching model would provide companionship and technical feedback, provide analysis of applications of knowledge to instruction, encourage the modification of instruction to meet students' needs, and facilitate the practice of new methods. Joyce and Showers' (1996) study concluded that teachers who were involved in a coaching relationship practiced new skills and strategies more often and applied them more suitably than did teachers who worked in isolation. Schifter (2007) suggested, "Teachers must have a deep understanding of content as well as the skill to implement concept-based pedagogy" (p. 22). The implication of these findings was that content coaching models would have an effect on test scores.

The U.S. Department of Education (2000) reported that group problem solving, advanced degree programs, coaching, and teacher self-assessment were exceptionally high professional development areas where teachers excelled. The National Staff Development Council (2009) contended teachers' personal learning and professional development are detached from their practice. Most of the supported learning opportunities for teachers are normally decided for them which typically consist of externally mandated professional development delivered in fast paced workshops that are designed for large groups, not for the individual teacher (NSDC, 2009). Individual professional development plans can address the specific needs of teachers by supporting and respecting the whole teacher, that is, socially, emotionally, and academically (Sugarman, 2011). However, research on peer coaching and on instructional coaching as a form of professional development is an emerging entity, with coaching being described as an opportunity for teachers to participate in learning about new strategies and techniques, observing how these strategies are demonstrated, and be given the opportunity to practice and receive feedback on these strategies in their own classroom setting (Peterson, Taylor, Burnham, & Schock, 2009).

Coaching is a professional development strategy that provides one-on-one learning opportunities for teachers focused on improving the quality of teaching and student achievement by reflecting on one's own and/or another's practice (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2009). Coaching embeds professional learning in the daily work that teachers do in their classrooms and with their colleagues. More importantly, coaching was designed to improve the knowledge, skill, and practice of teachers. Coaching has received considerable attention as a promising intervention for influencing classroom practice (Boatright & Gallucci, (2008).

There is sufficient research on coaching as a professional development model, yet the definitions and models are different and context-specific (Knight, 2007). The quasi-experimental nonequivalent design planned for this study used the independent variable (the PCC model), to see if it had an effect on the dependent variable (students' standardized test scores) student achievement.

Definition of Terms

Mathematics facilitator: A mathematics facilitator is a person who collaborates with mathematics teachers in search of supporting and improving instruction by providing intense professional development while in the classroom setting (Noyce, 2007). The term *math facilitator* may be used interchangeably with *math coach* in this study.

Collaborative coaching and learning: A community of practice that originated from the Boston Plan for Excellence. It entails a group of teachers observing each other teaching, planning, and collaborating in order to improve literacy and mathematics instruction. Teachers meet for 45 minutes to one hour and discuss the lesson to be taught by the host teacher (Noyce, 2007).

Coaching: In this study, coaching is defined as teaming between teachers and experts for the purpose of improving practice (International Coach Federation, 2011).

Cognitive coaching: As defined by Costa and Garmston (2002), coaching that fosters a person to become a more independent learner when he or she is responsive to his or her own thinking processes. A cognitive coach can construct flexible, positive, problem solving skills by provoking learners to delve into their private, imminent thinking.

Content-focused coaching: Content-Focused Coaching takes place in schools and is defined as a type of professional development that uses precise settings and theoretical instruments to sponsor student learning and success from teachers and coaches working together. This type of coaching is centered on students' learning in the lessons, but is also about teachers' learning from the process (West & Staub, 2003).

Instructional coaching: In this study, instructional coaching is defined as collaborative work with teachers in school settings to improve instructional practice (Knight, 2007).

Coteaching: A content lesson that is taught by both the teacher and specialist who work together while remaining in their respective areas of disciplines (Cameron, Bucther, & Haight, 2012).

Assumptions of the Study

Assumptions that I made prior to initiating this study were that teachers and students would embrace the idea of participating in the coaching model. I assumed that teachers would implement new strategies for teaching mathematics into their classrooms as a result of participating in the coaching model. I expected positive collaborative interactions to occur and for protected time to be given so the coach and teacher could meet and plan lessons.

After modeled lessons and professional development were provided by the coach, I assumed that teachers would adopt new practices for teaching and learning mathematics. I also assumed that students' test scores would increase from fall to spring on the local assessments. Moreover, assumptions also included that the tools used in this study were reliable; that the school would willingly participate without coercion; and that the best methodological processes were used to collect and analyze data. One final assumption was that students would show positive gains in mathematical achievement on the TerraNova test and on the local assessments.

Limitations of the Study

In this study, I did not randomly assign participants into to groups. Both the treatment group and the control group were selected without random assignment of participants to groups. Because this quasi experimental design dealt with intact groups, the existing research setting was not disrupted (Creswell, 2009). However, the setting was limited to one school and thus cannot be generalized to other populations.

This population included all fourth, fifth, and sixth grade students and teachers in the school under study. This involved 195 students and 10 teachers. This study may be of interest to teachers of all grade levels, but particularly to elementary teachers of grades 4, 5, and 6. The teachers who were part of the mathematics coaching model did not choose to participate, but were assigned by the principal at the onset of the initiative. Another restriction to this study was that students in fourth, fifth, and sixth grade who had not been at the school for at least one year were not eligible to participate in the study. The teachers and coach were limited to the amount of time they could meet each week for the pre and post conferences. Normally, these coaching conferences were scheduled in 30 to 45 minute intervals. Implementation of the Collaborative Coaching and Learning Model (CCLM) where other teachers could participate (not just the ones being coached) would also be limited due to lack of funding for substitute coverage.

Delimitations of the Study

Participants in this study were students and teachers who attended an elementary school in the Southern United States. A convenience sample was used. The control group consisted of 103 test scores of students whose teachers were not part of the coaching model and the treatment group consisted of 95 test scores of students whose teachers were participants in the coaching model. Third grade students also test each year on the TerraNova, but because they were not part of the coaching model, their scores were excluded from this study.

Significance of the Study

This study is important because the PCC in elementary mathematics could have an effect on student achievement. By placing mathematics coaches in classrooms, the district and others will have the opportunity to embrace the coaching model as a possible means to raise students' mathematics achievement and improve teacher's instructional practices. Whatever the outcome, administrators and district leaders can share information with community leaders and others. This could help in the decision making processes of how funds can best be allocated in adopting and maintaining a coaching model. This study could also add to the existing literature by providing more evidence on the effect of elementary mathematics coaching on student achievement. The National Council of Supervisors of Mathematics (NCSM; 2007) expressed that a creation of structures and practices in every school and district which supports and encourage meaningful professional collaboration among teachers must exist, in order for mathematics teaching and learning to significantly improve. Moreover, teachers must have a sense of professional obligation to collaborate and expand their knowledge for those closest to the classroom (NCSM, 2007).

Closing the achievement gap in mathematics means preservice educators will need to have a solid grasp of mathematics and know how to make it understandable to their students (National Mathematics Advisory Panel, 2008). It is pointless to even converse about pedagogical content knowledge without teachers' first going above and beyond learning and knowing the basic foundation of mathematics (Wu, 2011). Teachers' pedagogical content knowledge and assessment knowledge are vital instruments that work hand-in-hand; therefore, they cannot be segregated from each other in order to classify and focus on student needs (Timperley, 2008). The concern for how well a teacher knows the content of mathematics has been modified in recent years to an alarming need of identifying a body of mathematical knowledge that actually matters for elementary school mathematics teachers (Thames, 2009).

Meaningful professional development and professional learning communities entail having a common purpose in mind and teachers working collaboratively rather than in isolation (DuFour, DuFour, & Eaker, 2005). DuFour, DuFour, and Eaker (2005) suggested effective embedded professional learning promotes cultural change. Teachers, who participate in collegial supported environments, share ideas, examine each other's teaching, jointly critique each other's work, and most importantly, help them gain an understanding of the standards engaged in practice (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010). Coaches help teachers analyze their teaching and its impact on children (Skiffington, Washburn, & Elliott, 2011).

Conclusion

The purpose of this study was to evaluate the effectiveness of PCC in mathematics on student achievement, in order to determine if this method could improve student achievement. XYZ School implemented a coaching model because student academic achievement scores were stagnant. The expectation was for students in Grades 3 through 6 to score higher on the TerraNova Standardized Test. I examined whether there was a significant difference in mathematics achievement on the TerraNova mathematics scores of students whose teachers participated in the coaching model and the TerraNova mathematics scores of students whose teachers did not participate in the coaching model. I also examined whether there was a significant difference in mathematics achievement on the McMillan/McGraw-Hill, and Scott Foresman/Addison-Wesley local assessments of scores of students whose teachers participated in the coaching model.

Students in the United States continue to lag behind in basic levels of proficiency in mathematics on national tests and perform at low levels on international tests (U.S. Department of Education, 2005). A more detailed discussion of the theoretical foundations and current related literature will be presented in Section 2. In Section 3, I will focus on the research methodology and will include descriptions of the participants, as well as, other data collection plans. In Section 4, I will present the results of this study in tables and figures. And in Section 5, I will offer interpretations of the findings, implications for social change, and recommendations.

Section 2: Literature Review

Introduction

The purpose of this study was to determine whether there was a significant difference between the standardized test scores of students whose teachers participated in the PCC model in mathematics and the scores of students whose teachers did not participate in the PCC model. In this study, I closely examined the scores of students whose teachers were coached and the scores of students whose teachers were not coached in Grades 4, 5, and 6 to see if student achievement increased.

In the content of this review, I compared and contrasted relevant studies that have been conducted on mathematics coaching. The organization of this review consisted of the following topics: coaching, coaching models, pedagogical content coaching, the role of the school-level content coach, the principal's role in mathematics coaching, coaching as professional development, coaching and student achievement, literature related to the methods, methodologies and variables review, and the conclusion. Search terms that I used included: *instructional coaching, peer coaching, cognitive coaching, content coaching,* and *pedagogical content coaching and mathematics in elementary schools*. I also explored results of various mathematics coaching models used in elementary schools and the concepts of content coaching.

Coaching

Obara and Sloan (2009) found that educators profit from engaging in long term professional learning communities that tailors content and pedagogical awareness.

Obara and Sloan also noted that teamwork, collaboration, and having a mathematics coach can help bring a school's mathematics program to a reality. Chow (2010) contended that in order to improve student learning, attributes of rigorous and deep learning for both teachers and students are necessary. These attributes include: (a) mastering core academic content, (b) thinking critically and solving problems, (c) working collaboratively in groups, (d) communicating clearly and effectively, and (e) learning how to learn (p. 22).

According to Neufeld and Roper (2003), coaching delves much deeper than advancing content instruction. The level of circumstances, interactions, and performances necessary to implement a successful coaching program can influence the way people think and work in a school system. Felux and Snowdy (2006) found when coaches work to help sustain the improvement of educators teaching mathematics, students mathematical learning is automatically supported.

McGatha (2009) examined the use of mathematics specialists and coaches in schools and found there is not enough research to indicate that mathematics specialists are effective. However, preliminary research on mathematics coaching did indicate the potential for improving instructional practice. McGatha (2009) further noted that the design of the mathematics coaching program is an important feature; yet, the kind and degree of impact mathematics specialists and coaches make is difficult to research. Such professionals are often part of a larger professional development program, and researchers cannot just measure the impact of this component alone (McGatha, 2009).

Coaching Models

Coaching is a relationship and process by which a coach makes possible the success of others through a belief in that person's or team's capability to find their own solutions while improving performance (Thomas & Smith, 2009). In the early 1980's, Joyce and Showers (1982, 1996) examined the history of coaching and used peer coaching to introduce new curriculum and teaching methods. Knight (2011) later found that certain components of coaching needed to be included in order to be able to provide a descriptive view of coaches working relationship with teachers. Such components included having equal partnership, using other alternatives, having all voices heard, having the availability to reflect and discuss, and overall using conceptual language when expressing working with teachers. Morse (2009) found that some instructional coaching models target mathematics and science in upper grades.

Peer coaching, on the other hand, has been examined as a tool for professional development in educational settings (Huston & Weaver, 2008) and is part of a comprehensive professional development program in some schools (Quick, Holtzman, & Chaney, 2009). The role of the superintendent entails making sure money is available for coaches, offering professional development opportunities to coaches, participation in the coach selection process, and assuring that elementary teachers are provided with coaches. The role of the superintendent entails making sure money is available for coaches, offering professional development opportunities to coaches, participation in the coach selection process, and assuring that elementary teachers are provided with coaches (Younghans, 2010).

This study used the PCC model. This research was conducted to further understand if the implementation of PCC in elementary mathematics had a positive impact on student achievement**.** Knight (2011) suggested people with advanced degrees, knowledge and practice, and expertise in their content and pedagogy does not guarantee such traits will be sufficient for people to embrace learning and working together.

Pedagogical Content Coaching

PCC is supported by the theoretical principle that teachers must be life-long learners in order to continue to mature in their content and pedagogical knowledge, as well as expand their perceptive mathematical knowledge and teaching strategies, to be able to evaluate student thinking and lead students through valuable lessons for all students in their classrooms (Noyce, 2009). Hull (2009), explained that a mathematics coach has a deep understanding of mathematics content, knows how to deliver it, and has a mutual relationship with classroom teachers to help facilitate learning and improve student achievement. Pedagogical content knowledge includes knowing which mathematics skills and concepts are complicated for students and why, knowing a variety of ways to create and represent the *big idea,* and knowing how to push students' thinking and understanding of specific concepts (Ball, 2000). In addition, teachers need to know mathematics in ways useful for making mathematical sense of student work (Ball, 2008). A more thorough discussion of PCC will follow in Section 3.

Role of the School-Level Coach

Because mathematics coaches are considered professional developers and staff developers, they must be clear about their mission and role (Felux & Snowdy, 2006).

Accordingly, Grant, Nelson, Davidson, Sassi, Weinberg, and Bleiman (2003) contended that schools should help staff developers have a greater impact by focusing their work on one or two goals within the school's overall mission. Furthermore, they suggested that schools seek external support for the content, process, and implementation of coaching from colleagues such as school district administrators (long term) or outside consultants (short term). Further, Grant et al. (2003) stated the coaches need to be creative in setting stages for collaboration and feedback. Districts need to focus resources on training coaches in both the knowledge of the curriculum content and in the coaching process (Grant et al.). Finally, they stated that novice coaches need to receive guidance from mentor staff developers, including teacher leaders and veteran staff developers (Grant et al.).

The Boston Public Schools (BPS) have been instrumental in developing knowledge about coaching and professional development (Grant & Davenport, 2009; Neufeld & Roper, 2003). For example, the BPS invested heavily in professional development to improve literacy and mathematics instruction (Grant & Davenport, 2009; Neufeld & Roper, 2003). The BPS developed and implemented the Boston Plan for Excellence. This plan provided literacy and mathematics coaches for teachers and money to hire substitutes so that teachers could meet during the school day to learn together (Levy & Murnane, 2005). Boston Public Schools implemented the Collaborative Coaching and Learning (CCL) model which demonstrated that instruction was sufficiently powerful and mandated in 2002 that all schools adopt it (Levy & Murnane, 2005). Boston has made tremendous progress in strengthening mathematics teaching and learning in its elementary schools (Grant & Davenport, 2009).

West and Staub (2003) warned, however, that content-focused coaching takes time in working with low performing teachers and provides avenues for continuous professional development. Such learning communities could aid teachers in devising and executing lessons which would enhance students' learning. West and Staub also suggested that structures should have specific goals where teachers' plans, strategies, and methods are discussed in terms of students' learning and understanding. Content-focused coaching helped to develop professional habits of mind and general teaching expertise. Content coaches know both their subject and best pedagogical practices and how to bring this information to students and teachers (West & Staub, 2003). Darling-Hammond (2003) noted:

> It may be that the positive effects of subject matter knowledge are augmented or offset by knowledge of how to teach the subject. That is, the degree of pedagogical skill may interact with subject knowledge to bolster or reduce performance. (p. 6)

Ross and Bruce (2006) measured the effects of peer coaching and related in-service teachers' instructional practices and their beliefs about their instructional capacities teaching mathematics in Grades 3 and 6. In that study, teachers observed their partners teaching mathematics, provided feedback to their partners on the lessons observed, reflected on their own teaching, and assisted their colleagues in setting teaching related goals for themselves. The results revealed that teachers moved their mathematics teaching toward reform. Loucks-Horsley, Love, and Stiles (2009) concurred that teachers do need time to learn challenging mathematics and reflect on their own learning and teaching in supporting collegial communities.

Later, however, in a 3-year randomized control study, Campbell (2010) viewed how mathematics coaches established leadership roles and how they created in school learning communities. Such learning communities focused professional development as an avenue to delve into mathematics discipline, professional teaching, and the make up of the curriculum. By examining these three components, perhaps teacher instructions and student mathematical achievement would improve. Campbell found that, over time, coaches had a positive effect on student achievement in Grades 3, 4, and 5. There was no evidence at the end of the first year of the placement of coaches in schools, but substantial findings arose as knowledgeable coaches gained experience and school instructional and administrative staff learned and worked as a team.

Principal's Role in Mathematics Coaching

Grant and Davenport (2009) concluded that "principals have a significant role to play in enabling coaches to support the implementation of a sound math curriculum" (p. 36). In order to implement a school and coaching partnership, schools can mimic the following four steps laid out by Grant and Davenport: setting priorities, support strategies, setting norms, and participation as learner.

Setting Priorities

The first recommendation of Grant and Davenport (2009) was that the principal should work with the mathematics coach to set priorities. This entails setting up regular meetings to discuss priorities, assessments, promoting teacher leadership, and sustaining continuous support for new teachers and struggling teachers. It also means getting to know what is happening in classrooms during math lessons by jointly conducting classroom walk throughs, observing lessons, and attending grade-level team meetings focused on math. During these processes, not only should the coach examine quantitative and qualitative data, verify who the grade level teams are, and identify how to strengthen mathematics teaching and learning, but the coach and principal must work together and become experts in assessments and data analysis (Wren & Vallejo, 2009). Strong collegial interactions are vital in making this model work. Robbins (1991) suggested that protected time should be reserved during faculty meetings to talk about coaching practices and experiences.

Support Strategies

The second strategy suggested by Grant and Davenport (2009) was that the principal should be strategic about putting support structures into place that are designed to strengthen math teaching practice and student performance. A strategic support structure is imperative (Teague, 2012) in order to reinforce math teaching practice and student performance. One way to accomplish this is to ensure teachers engage in professional development such as seminars and institutes which focus on specific mathematical content of the elementary grades, how students think about this content, and instructional practices and structures to support their learning. Furthermore, the learning fostered in the seminars and institutes should be shared with their math coach and demonstrated in their own classroom practice.

Bickel, Garnier, Matsumura, and Sartoris (2009) found that principals who participated in a new coaching program, supported coaches in connecting with teachers and gaining access to their classrooms. Teachers and grade levels identified as priorities should have ongoing access to the support of a math coach through individual and team planning and debriefing meetings. There should be opportunities for collegial classroom observations with previsit and postvisit discussions which are facilitated by the math coach. In such a setting, logistic support such as substitute coverage is essential. At times, the principal can substitute for teachers while they coach their peers (Robbins, 1991).

Setting Norms

The third suggestion of Grant and Davenport (2009) was the principal should work with the coach to set norms for teachers' participation in mathematics professional development and set an agenda for teachers to collaborate with the coach and with each other. These norms suggest that principals:

- be aware that they express strong messages to teachers about the importance of mathematics teaching and learning through their presence in classrooms, their involvement in professional development, and their participation in structures that involve collaboration among teachers and the mathematics coach,
- be clear on their expectations of teachers (Bickel et. al., 2009), (i. e., be certain teachers are fully participating in professional learning opportunities,

prepared with any needed materials, and are actively and thoughtfully engaged during small-group and whole-group discussions, and,

- take notice of teachers who were non participants in these communities of learning exercises and address any barriers they may be experiencing.

Participation as a Learner

Finally, Grant and Davenport (2009) recommended that the principal should also participate as a fellow learner. He or she should seize the opportunity to extend their own understanding of elementary mathematics, children's mathematical thinking, and mathematics instruction. Griffin and Jitendra (2009) agreed that all learners should engage in mathematical thinking and reasoning when an opportunity presents itself. These types of opportunities are vital in order to produce and sustain successful problem solving.

Principals need to model being a learner. They need to develop insights into the strengths, needs, and dynamics of the faculty. Finally, principals, schools, and district leaders should involve themselves in more specialized training so that they can boldly share this information with teachers and other district administrators about the teaching and learning of mathematics (Grant & Davenport, 2009).

According to Perrin (2009) coaches also need to have funding in order to purchase professional development books and appropriate manipulatives. Therefore, principals need to provide a budget for mathematics coaches. Furthermore, principals should keep open lines of communication, build rapport and show open respect to each other's positions, compromise and work towards long term and short term goals, and plan to meet either weekly or monthly to discuss successes, review plans, and make changes if necessary.

Neuberger (2010) conducted a study in a New York school system that described the collaboration between one mathematics coach and one teacher. The researcher observed and videotaped a lesson and interviewed the teacher, coach, and principal. The study revealed that (a) the teacher's beliefs about mathematics teaching had changed because of the coaching process, (b) the teacher's practices echoed the teacher's beliefs, (c) the coach helped the teacher learn mathematics and watch more closely the mathematics learning of her students, and (d) the teacher was in a state of transition in many of her emerging beliefs. The principal played a vital role by actively participating in the coaching process (Neuberger, 2010).

Coaching as Professional Development

Across the country, many schools and districts are turning to instructional coaches as a means of improving classroom instruction and increasing the likelihood that reform efforts will be successful and lasting (Annenberg Institute, 2008). The ultimate goal of any coaching program is to institutionalize reflective practice and continuous improvement among staff as part of collaborative, collegial learning environments for the purpose of improving student achievement (Boyd, 2008; DuFour, DuFour, & Eaker, 2005). Hull (2009) proposed "When there is evidence of increased learning, then it is also more likely a change effort can be sustained" (p. 49).

Opportunities for professional development should connect teachers in carrying out teaching related tasks (Darling-Hammond & McLaughlin, 1995). As such, teachers should be able to manifest themselves in teaching, assessing and observing, while clarifying and practicing what they have experienced (Darling-Hammond & McLaughlin, 1995). Professional development should allow for creative investigations and time to reflect and participate in shared discussions (Lambert, 2002). As such, each person should contribute to the discussion by sharing knowledge. (Donaldson, 2006) noted that educators have hectic schedules, yet, working together makes each person more successful. This helps to build communities of practice within their school culture. As professional development is highly favored in professional learning communities, so is the continuous learning that is nurtured through collaboration among teachers (Hord, 2004). Furthermore, looking at students' work helps connect teachers' work with their students. As a final point, professional development must be thorough, ongoing, serious, and sustained by replicating coaching and focusing on explicit problems (Darling-Hammond & McLaughlin, 1995).

Joyce and Showers (1982, 1987, & 1996) explored peer coaching and noted that using this type of job-embedded professional development helped 90% of teachers who were involved transfer new skills and strategies into practice. Later, Neufeld and Roper (2003) noted that professional development must be grounded in inquiry as well as sustained and ongoing. However, Knight (2007) contended that coaching models vary, and they must be context-specific. Coaching can occupy a space on a continuum from extremely intense (personal, daily access to classrooms) to much looser, structured relationship building activities (Walpole & Blarney, 2008). Teachers can experiment and master new teaching techniques and ideas with their coaches' support to extend the effects of professional development by promoting reflection (Knight, 2009). These researchers found positive elements within their framework of mathematics coaching.

Grant and Davidson (2003) found teachers were more likely to accept the idea of mandatory professional development if their school administrators understood and supported the intent, the organization, and the content of the changes being envisioned (Grant & Davidson, 2003). Many school districts spend a substantial amount of money and resources to institute professional development they believe will yield higher student achievement (Pradere, 2007). In order to produce lifelong mathematics learners, professional learning communities must investigate to offer specific types of professional development that promotes and sustains mathematics teachers in adopting and applying new strategies of learning (Patterson, 2009).

Roberts (2006) conducted a study (a) to identify issues first-year middle grades mathematics teachers have as they attempt to implement reform-based mathematics instruction and (b) to design a model for professional development using coaching and support groups to help beginning teachers experience success in implementing reform-based mathematics instruction. Five first-year middle grades mathematics teachers participated in professional development, including a support group and individual classroom coaching, designed to support them as they implemented reform-based mathematics instruction in their classrooms. Data was gathered from surveys, individual interviews, classroom observations, and videotapes/audiotapes of support group meetings and coaching sessions. The findings suggested teachers' believed that identifying strategies (Noyce, 2009; West & Staub, 2003; & Patterson, 2009), having a connection with other teachers (Dobbins, 2010; Grant et al., 2003), observing modeled lessons (Ross & Bruce, 2006; Grant & Davenport, 2009; Darling-Hammond & McLaughlin, 1995; Murray, 2009) by the coach were helpful aspects of the professional development model.

Bodie (2009) followed with a qualitative case study which examined the effect the first year of an elementary mathematics induction program had on the mathematics content knowledge and pedagogy, confidence, classroom practice, and student achievement for six new elementary teachers in a suburban school district was conducted. The study also examined which components of this job-embedded professional development program influenced the teachers' practice the most.

Data were collected from six volunteer teachers through semi-structured interviews, questionnaires, journals, and student assessment results. Findings revealed that (a) teachers' perception of their instructional practice, particularly their ability to question student thinking, mathematics content knowledge, and confidence to teach mathematics improved as a result of the program; and (b) like Roberts (2006) teachers benefited from the opportunity to regularly observe a modeled mathematics lesson, but Bodie also found teachers who had the opportunity to discuss mathematics and related pedagogical issues with their cohort and mentor was quite beneficial.

In a similar study, (Murray, 2009) examined peer coaching in a Mentored Implementation Program that was developed in the Appalachian Mathematics and Science Partnership. The experimental design involved 6 teachers receiving peer coaching with their 202 students and 5 teachers in the control group with their 105 students. The findings showed teachers considered peer coaching a positive experience that entailed organization of learning, management of classroom, and mathematical content and pedagogy, but identified scheduling and distance as barriers. Collaboration during post-classroom-observation conferences was concise, but showed lack of analysis, positive support, a proportional pattern of talk, and a deficiency in depth of discussion. This study also found no increase in student achievement using peer coaching.

Using a qualitative case study, Ash (2010) examined the mathematics coaching program in a local school district on elementary school mathematics mentee teachers. Ten mathematics teachers were interviewed and a qualitative within-case analysis was used. The research found that professional development programs should focus on increasing the awareness of the necessity of additional mentoring of math programs which focused on improving instructional practices. Both the Roberts' (2006) and Bodie (2009) studies showed that observing modeled lessons or mentors teaching was beneficial, as well as having a connection with other teachers and cohorts. Murray's (2009) study however, revealed there were no in depth discussions and no indications of student achievement, but similar to one of Bodie's findings, teachers' mathematics content knowledge did improve, while as a result of the Erchick et al., (2007) study, it was the students' mathematics content knowledge that improved. Thames and Ball (2010) believed that the promotion of teacher education and professional development should center more directly on the mathematical knowledge on which effective teaching draws.

Coaching and Student Achievement

Nationally, close to 170,000 fourth-graders and over 160,000 eighth-graders in all 50 states including the District of Columbia and the Department of Defense school system participated in the National Assessment of Educational Progress (NAEP, 2009) mathematics assessments. NAEP uses Scale scores that range from 0 to 500 for mathematics to report how well students do in mathematical content such as numbers and operations, measurement, geometry, data analysis, statistics, and probably, and algebra. Established standards are set for *Basic*, *Proficient*, and *Advanced* performance. At grade four, the average scale score for students in 2009 was not significantly different from 2007, but was higher than previous assessments for the first time since the assessments began in 1990, but there was no score increase at grade four.

Erchick, Brosnan, Forrest, Douglass, Grant, and Hughes (2007), reported findings from the first year of a three-year mathematics coaching project. The purpose of this study was to understand the effectiveness of the mathematics coaching project as a professional development intervention in schools and its effect on student achievement in those schools. For the first year of the study, student achievement was tracked in grades three and four only. Students took a pretest in January when the mathematics coaches began their work in schools and a posttest in May. Even within this short time, modest gains in student mathematics content knowledge at both grade levels were achieved. Specifically, students who were part of the coaching classes scored higher than the state average.

In a mixed method study conducted in Chicago, Edmondson (2007) examined the impact of the instructional support coach on student achievement, teacher efficacy and teacher's pedagogy. Two hundred thirty-four participants were surveyed at 10 elementary schools. The research questions examined how teachers perceived coaches support as they executed 7 unique coaching strategies that coincided with number of years teaching, type of degree, and teaching assignment. Findings indicated instructional coaches impacted teacher's pedagogy, student learning, and teacher efficacy. Over eighty percent of the teachers surveyed felt that coaching resulted in a positive change in student achievement.

Later, in a case study, Dobbins (2010) evaluated the relationship between staff development and teacher efficacy and its impact on mathematics student achievement. Like Edmondson (2007), the study used instructional coaching, but Dobbins examined this type of coaching as a basis for teachers' professional development. A *t*-test was used to analyze the district's quarterly mathematics data. The analysis revealed a significant increase in mathematics achievement from third to forth quarter for 400 students in grades five through eight. The line-by-line analysis revealed the need to develop the role of the coach (Felux & Snowdy, 2006), increase teacher learning through observation (Ross & Bruce, 2006), schedule sufficient time for the teachers to collaborate (Grant et al., 2003), on student learning (West & Staub, 2003; Neuberger, 2010), and work to improve teacher efficacy.

Literature Related to the Methods

There are some quantitative investigations, qualitative studies, and inquiries using mixed methods that have been reported in formal education settings on various types of coaching. For example, Bodie (2009) used a qualitative case study to see if the mathematics program had an effect on math content knowledge, confidence, classroom practice, and student achievement. Murray (2009) used an experimental design that examined peer coaching. Roberts' (2006) design used experimental approaches and gathered data from multiple sources such as surveys, interviews, observations, and video and audio tapes. Neuberger (2010) like Roberts conducted research using similar data sources. Dobbins (2010) employed a *t*-test to analyze quarterly mathematics data. Campbell (2010) engaged in a 3-year randomized control study of elementary mathematics coaches' effect on student achievement. These types of studies were reviewed and discussed because coaching is innovative and because the variations of coaching tend to overlap.

Methodologies and Variables Review

The independent variable in this study was the coaching model and was also the treatment variable. The dependent variable was students' standardized test scores. This study was conducted to see if the independent variable has any effect on the dependent variable.

Quantitative research is deductive and is used to test theory, whereas qualitative research is inductive and generates theory (Creswell, 2009). Quantitative research lends itself to using variables and is objective. Such research uses data in the form of numbers and statistics, and the results can be generalized (Creswell, 2009). Qualitative research, on the other hand, is subjective, reports data in a less generalized manner, and uses images, categories, and a narrative to help report findings. Mixed methods research involves mixing both quantitative and qualitative methods and uses multiple forms of data sources such as interviews, journals, and audio and video taping.

The nonequivalent group design uses a pretest and posttest and is not randomized. Intact groups are used which have similarities and are considered the treatment and control groups (Creswell, 2009). In this study, the Treatment Groups are students of teachers who participated in the mathematics coaching program and the Control Groups are students of teachers who did not participate in the coaching program. These groups are similar in that a comparison was made of students' test scores within grade level of 4^{th} through 6^{th} grade. This design was chosen because only student' test scores will be analyzed.

Summary

Section 2 included a detailed discussion of the recent literature about instructional coaching, types of coaching, pedagogical content coaching, the role of the school-level content coach, the principal's role in mathematics coaching, and coaching as professional development, coaching and student achievement, literature related to the methods, and the methodologies and variables review, was presented. In order to have an effective mathematics coaching program, all stakeholders, including teachers, students, principals, coaches, and parents must build a community of trust and understanding. It is vital the whole school understands the importance of teaching and learning mathematics.

Eliciting positive, cohesive relationships in a school environment will encourage social change. Section 3 of this thesis presents the research design and a description and justification for the design. The setting and sample will be presented, as well as, the data collection tools, hypotheses, and research questions. In addition, protections for human subject participants are discussed.

Chapter 3: Research Method

Introduction

I used a quantitative study to examine the effects of the mathematics coaching model on student mathematics achievement. Furthermore, I employed a quasi experimental, nonequivalent (pretest and posttest) control group design in this study. The study took place at XYZ Elementary School in the southern United States. I used a convenience sample which consisted of 185 test scores. The instruments and materials I used were the local mathematics assessments which consisted of the pretest and posttest and the TerraNova which is the school's standardized state assessment. A discussion of these assessments will follow to help determine its reliability and validity. The data collection and the data analysis procedures for this research will be addressed. A full discussion of the anonymity of the participants will be disclosed. My role in the study will be explained along with potential biases that may be brought into the study.

Research Design and Approach

The quasi experimental, nonequivalent (pretest and posttest) control group design used in this study assisted in determining the effect of the mathematics coaching model on students' mathematics achievement. Quasi experimental designs are commonly employed in the evaluation of educational programs when random assignment is not possible or practical (Gribbons & Herman, 1997). According to Creswell (2009), if the problem calls for (a) identifying factors that influence an outcome, (b) the service of an intervention or (c) understanding the best of outcomes, then a quantitative approach is best. It is also the best approach to use to test a theory or explanation. The design accommodated this study because there were existing theories available that this research problem could draw on, a mathematics coaching model was implemented and needed to be tested, and two data sources were available which could help to understand the effects of this intervention on student achievement.

In this study, the experimental group and the control group were selected without random assignment of participants in the groups. Because this design deals with intact groups, the existing research setting was not disrupted. The preexperimental designs were not used because they involved using one group exposure and comparison groups (Creswell, 2009). True experimental designs were not used because the procedures involved random assignment of participants to groups and manipulation of an internal variable.

The design derived logically from examining the independent variable (the coaching model) on the dependent variable (students' standardized test scores), and its effect on student achievement. The experimental group, A (the coaching model), and the control group, B (students' standardized test scores), were selected without random assignment. Both groups took a pretest and posttest. Only the experimental group received the treatment as Creswell (2003).

Setting, Population, and Sample

The population for this study was mathematics students at XYZ Elementary School who were 8 to 13 years old and in Grades 4, 5, or 6. The total population consisted of 198 students and 10 teachers. I drew a convenience sample of 185 test scores from this population.

Participants were assigned to the control and treatment groups according to which classrooms they were assigned. If students were enrolled in a classroom where the teacher was not participating in the coaching model, they were assigned to the control group. If they were enrolled in a classroom where the teacher was participating in the coaching model, then they were assigned to the treatment group. The sample size from this population consisted of 103 test scores from the control group and 95 test scores from the treatment group and was represented as N= 198. A significance level of $p \leq .05$ was established for all analyses. This sample size accounted for 100% of the population for Grades 4 through 6. The results from the sample can be generalized to the population (e.g. Gravetter & Wallnau, 2005).

The sample and population for this study was chosen for many reasons. First, XYZ Elementary School has a high turnover student population. Therefore, I estimated the total population for these grade levels and assumed that at least half of the population remained constant at XYZ. Second, the coach was specifically assigned to work with fourth through sixth grade classes, but sixth grade was only assigned if they were a part of the school. Some schools in the district were only pre-k through fifth grade schools. Third, group size was chosen based on participants who took both the TerraNova standardized test and the local assessment. Fourth, the prekindergarten through second grade population do not take the TerraNova. The third, fourth, fifth, and sixth graders are the only students who take the TerraNova exam. Finally, students in this study must have been enrolled at XYZ for at least one school term.

In 2007 through 2008, the total enrollment of students at XYZ Elementary School was 701. The number of students who received free or reduced lunch was 273. There were 3 American Indians or Alaskan Native, 4 Asians, 165 Black or African American, 4 who declined to state their race, 3 Hawaiian or Pacific Islanders, 95 Hispanic or Latino, 341 Caucasians, 86 Multi- Race, and 16% of the total enrollment of students received special education services.

Treatment

The Mathematics Coaching Model

Phase I (Preparation). The PCC model in elementary mathematics was a pilot program implemented in the XYZ Elementary School. Its overall purpose was to improve student achievement. Some components of this model were adopted from the Silicon Valley Mathematics Initiative which was founded by the Noyce Foundation (2006). The model was also a comprehensive effort to improve mathematics instruction and student learning in the elementary school for grades 4 through 6. According to Noyce the model was based on two concepts:

1. Positive change in education that occurs through a continuous loop of focusing on high performance expectations for students and educators, examining and analyzing students’ understandings from assessments, developing effective educational strategies and practices, and tailoring instruction to enhance student learning and understanding.

2. Improved achievement is an outcome of improved instruction. Improved instruction is an outcome of ongoing, comprehensive, intensive professional development (2006).

At the onset of the program, PCC involved several interrelated components that included pedagogical content coaching, ongoing professional development, networking, leadership training, assessment for and of learning, and student support. Mathematics coaches in the district began their journey by participating in two consecutive weeks of intensive summer/fall workshops which included the Developing Mathematical Ideas (DM1) program (Borko, 2004). The PCC model was designed for fourth, fifth, and sixth grade classes. XYZ Elementary School serves prekindergarten through six grade students. Once the initial, two week training was over, coaches were assigned classes by the principal. The principal randomly selected the teachers without criteria and the principal and coach introduced the program to the teachers and staff.

The principal granted the coach the latitude of making up her own daily schedule. Mathematics classes were scheduled in increments of one hour time slots. Additional time was put in the schedule for teachers to meet with the coach to plan lessons, reflect on a lesson, work with math content, or possibly look at student work. Coaches focused on assisting teachers to understand important mathematical concepts and student thinking about those concepts (Noyce, 2010). They also helped teachers develop techniques to support all students. Coaches employed a variety of strategies to engage teachers. Typically, coaching involved an ongoing process of pre teaching conferences, in-class experiences, and post conferences.

One focus of the mathematics coaching model was on students' thinking, understandings, and work (Noyce, 2007). The coach took on various roles such as modeling, team-teaching, and leading and can change roles within a single lesson. One advantage to becoming an effective coach was having the wherewithal to listen and pose meaningful questions to build the teachers' own capacity. This means working with teachers externally, sometimes in small groups, and at other times one-to-one, discussing student work and mathematical concepts, planning lessons, planning data collection and analysis activities, and providing other professional development opportunities.

Phase II (Roles of the Coach). The roles of coaches are determined by the needs or status of the coach-teacher relationship. Becker (2001) studied coaching styles and developed the following three descriptions of the role of a coach:

1. Coach as Collaborator: The coach acts as a resource to the teacher. In partnership with the teacher, this type of coach provides materials, information, and encouragement and works collaboratively with the teacher in planning lessons. The coach gives feedback focused on what the students seem to know and understand from the lesson.
2. Coach as Model: The coach prepares a long-range plan of working with teachers to include modeling instruction. The instruction actively involves children in high level tasks, as well as modeling effective instructional strategies with the coach as the teacher. The coach may provide follow-up lessons for the teachers to use after the model lesson.

3. Coach as Leader*:* The coach is a guide to the teachers. The direct guidance is provided on content issues and pedagogy. Debriefing is grounded in observations focused on students' understanding. The coach and teachers work collaboratively and find ways to solve problems that may arise while devising the next steps in instruction.

Becker (2001) described the coach's characteristics that included having the skills and knowledge required by a coach in order to fill the varied roles. To facilitate effectiveness, the mathematics coach had to be content specific in mathematics, know how to teach mathematics, and know about the teaching of mathematics. Additionally, coaches need to know how to teach adult learners; and they need good interpersonal skills in order to develop professional relationships with the teachers they coached. Coaches use a variety of strategies in order to build relationships with administrators, teachers, and students. Teachers need knowledge and skills in assessment in order to maintain a student focus and be equipped to identify exactly what students know and can do, which is a prerequisite for teaching that is responsive to each student's needs (Timperley, 2008).

Phase III (Building Trust and Relationships). Noyce (2007) suggested that, in order to be successful in facilitating this type of learning, administrators, teachers, students, and the facilitator must build a trusting relationship which promotes mutual respect and safety. It is not an easy task to build a positive relationship; it requires a lot of time, patience, and much effort (Noyce, 2007). However, to build these relationships, all parties involved need to believe that working together is valuable and that as a result of having a cohesive relationship, teachers' instructions and content knowledge would improve. The expectations of the coach and teacher must be succinct and understandable when designing their roles.

One purpose of the mathematics coaching initiative was to build teacher capacity. This could be accomplished by inquiring about what students are doing and listening and watching students' actions in the classroom — what they understood and their misconceptions. Trust can be built through actions and experiences. A coach can develop a trusting, open relationship by focusing on students' thinking, understandings and misconceptions, and student work. This focus allows a discussion of the learning process without directly examining teacher moves or teacher talk. These conversations allow issues around mathematics and learning strengths, as well as the needs of the student, to emerge.

Another method of establishing a positive coach-teacher relationship is the use of demonstration lessons. Demonstration lessons were conducted by the coach and took place during early coaching sessions. These lessons assisted in setting the tone for relationship building. In some cases it may take a demonstration or two for a teacher to understand or picture a different learning environment or technique that the facilitator is advocating. Focusing questions to ensure all students are making progress is a key technique of an effective coach. The post lesson discussion was designed to support the goals or purpose for doing demonstration lessons. Following a demonstration lesson and post- conference, the teacher may teach the following lesson or expand upon the Coach's lesson. Post-conferencing was a time set aside where the coach reflected and shared information from the lesson, provided feedback, and encouraged teachers to reflect on the lesson in order to build teachers' capacity. The post conference is also an excellent opportunity to examine student thinking and work. Conversations about students' understandings and work generate ideas regarding issues, strategies, and next steps the teachers might take. The post conference is an open window to assess learning, inform instruction, and adjust educational plans. Effective mathematics coaches are able to focus on the connection between the intended content and student learning through effective questioning and feedback.

By focusing on students' thinking, work, and work ethics, teachers can see how their role as a teacher must adapt. When teachers examine student thinking, including the students' understandings and misconceptions of mathematical concepts, they can then develop strategies to address those needs. This is fundamental to good teaching. Students' work is, therefore, at the center of what happens during coaching. It is a tool for evaluating the effectiveness of changes in curriculum, instruction, and pedagogy. Collaboratively, coaches and teachers design goals for students and plan different assessment tasks to help meet those goals and instructional experiences. Examination of collaboratively produced assessments provides a powerful way to evaluate the progress of instruction.

Coaches use an array of questioning techniques to explore thinking, encourage reflection, inform teaching, and build internal capacity. The questions a coach asks serve as a model for the kinds of questions a teacher should be asking of him or herself. Questions also invite the teachers to seek advice or brainstorm ideas. Through questions, a coach focuses the discussion on student thinking, misunderstandings, and their work.

By focusing on student work, the coach and teacher can get to the heart of the mathematics and begin to assess the understanding and skills students possess. These types of discussions created a window of opportunity to probe the teacher's mathematical depth, the ability to connect the content to students' learning needs or styles, and to focus future instruction. Teachers' misunderstandings and exclusions are frequent issues a coach must address. Considerable expertise is needed for these questioning methods (Foster, 2007).

Phase IV (Implementation). The mathematics coach should first set goals for himself or herself, the teachers being coached, and the students. For example, a goal for the coach might be to build trust by creating a non threatening environment. A goal set for the teacher might be to meet weekly to reflect on a lesson that is being taught. A goal set for students might be to learn how to explore several solutions to a problem. As such, other objectives included the following:

1. Meet with the principal and assigned teachers and discuss the plan for the school year.
2. Set up a time to meet with the principal weekly. This is vital because the principal has to be part of the implementation in order for the mathematics coaching model to work.
3. Have a prepared agenda daily.
4. Keep a journal (write your reflections of a lesson, your coaching moves, strategies, etc)

5. For the first couple of weeks, observe and script what students are saying and doing. Share this information with the teacher by post conferencing or just leave your note pad with the teacher. This allows students and the teacher time to adjust to the coach coming into the classroom. This also gives the teacher and coach time to talk and reflect on the students' work and create a non-threatening environment.
6. Have pre conferences with each of your teachers to plan a lesson weekly if not more often. Find out what objectives they are trying to meet and their plan of action. Ask clarifying questions and see what the coach can do to help with the lesson (i.e. supply materials, work with a small group, do a demonstration lesson). Work through the mathematics together before teaching the lesson. This helps to clarify problems that students may grapple with in advance.
7. Have post conferences to reflect on the lesson and plan next steps. Sometimes a lesson may need to be refined and presented again in a different way.
8. Once the coach feels that a relationship has been established with the teacher, plan to model a lesson. This will allow the teacher the opportunity to see the lesson from a different perspective. This is a way to introduce new strategies and show the teacher the importance of allowing students to have wait time. If a problem solving task is being modeled and is not completed in the time frame given, use a large piece of self adhesive paper and post the problem on the wall for further discussion. This discussion may happen the next day or on

a future day. The coach should focus on problems that are rich and that will introduce many skills.

9. Once the coaching model is established, invite the principal in to observe a co-taught lesson and set a time to meet for feedback.

An electronic weekly log was filled out by the coach and submitted to the principal and the mathematics instructional support person. The log included the amount of time spent observing students, teaching or coteaching in classrooms, planning a lesson or unit with teachers, reflecting on a lesson with teachers, analyzing student work alone, analyzing student work with teachers, preparing student data, meeting with an administrator, conducting professional development, teaching struggling math students, and other tasks. The log also could also include writing a description of an observed best practice, questions that the coach may be thinking about, and/or plans for the upcoming week.

Instrumentation and Materials

Instrument 1 (TerraNova, Second Edition)

According to the California Testing Bureau (CTB/McGraw-Hill 2011), the TerraNova is a standardized, norm-referenced achievement test that compares students' scores to scores from a *norm group*. The norm group for TerraNova is a national sample of students representing all gender, racial, economic, and geographic groups. TerraNova was administered to all students from Grades 3 through 11, except those students who have been approved for an alternate assessment, such as students who may have disabilities, students who may need a small setting, or some other special accommodation. All students in the treatment group and control group took the TerraNova assessment.

The mathematics objectives and subskills measured on the TerraNova were: (1) Number and Number Relations, (2) Computation and Estimation, (3) Measurement, (4) Geometry and Spatial Sense, (5) Data, Statistics, and Probability, (6) Patterns, Functions and Algebra, (7) Problem Solving and Reasoning, and (8) Communication. All TerraNova scores were reported in percentiles. TerraNova uses a battery of norms such as scale score (SS), Grade Equivalent (GE), National Percentile (NP), National Stanine (NS), Normal Curve Equivalent (NCE), and the Objectives Performance Index (OPI).

In this study, I used test results from the OPI. OPI is a *criterion-referenced* score that is reported for each of the objectives measured by TerraNova. The OPI is a weighted average of: a) the student's percent-correct raw score on the objective, and b) an estimate of the student's performance on the objective, based on that student's overall test performance. The OPI is an estimate of the number of items a student would be expected to answer correctly if there had been 100 similar items for that objective.

Furthermore, OPI can be used to help identify content area objectives that need further instruction to satisfy mastery. OPI subtests are broken down into diminutive units to increase manageability and add instructional value to test outcome. The procedure used on OPI looks at the number of items related to the objective that the student answered correctly, as well as the student’s performance on the rest of the subtest in which the objective is found. This information was then placed on a common mastery scale. The scale runs from 0, indicating complete lack of mastery of the objective, to 100, indicating the highest level of mastery. All directions for the TerrNova were scripted and teachers do not score the test.

Threats to Validity

One initial, internal threat to the experimental validity of this study was the time lapse between pretest and posttest (Yu & Ohlund, 2010). Also the longer the lapse of time involved in a treatment, the more events which could occur before the final posttest was administered. Also, some participants may have viewed the mathematics coach as an authority figure and may become resistant to changing their practices. Participants may have improved teaching performance regardless of the treatment (Yu & Ohlund, 2010). Participants could have also dropped out of the study before it is complete. The research outcomes of this study were not generalized beyond the population and setting, in turn, minimizing threats to external validity (Creswell, 2003).

TerraNova used the Curriculum and Evaluation Standards for School Mathematics that was developed by the NCTM for the development of the objective structure and overall approach to the mathematics. Skills and concepts were tested by CTB. Items were tried using specific manipulatives in pilots, as well as teachers and students being interviewed to determine if the manipulatives were appropriate. Students' feedback on what topics appealed to them, were considered. A page-by-page usability study with individual students was conducted to determine whether mathematics questions were clearly understood and whether students could find and use charts, graphs, and illustrations on the page. The test was then modified accordingly.

In administering the TerraNova, Second Edition (2001) at XYZ Elementary School, the multiple assessments of TerraNova in mathematics were given to students in a 90 minute time frame. The test started with a few sample problems for participants to complete. Part 1 consisted of a short selection of computation problems, followed by simple word problems requiring just a single computation, and finally a few questions that assessed participants' estimation skills. Participants had 10 minutes to complete this section. Part 2 covered questions that test participants' core mathematics skills in diverse settings. This meant participants used a variety of ways and strategies to derive a solution. There were several problems in this section and students had 30 minutes to complete this section.

After the time allowed had expired for Part 2, participants then took a break for a few minutes. Before Part 3 began, the final section, participants were given the opportunity to complete a few more sample questions. Once this process was over, participants had 50 minutes to complete the rest of the test. Part 3 covered open-ended assessment activities. As such, participants had to describe a solution strategy or evaluate a problem situation and demonstrate their ability to communicate mathematically (CTB/McGraw-Hill, 2001).

Data results from the administration of the TerraNova, Second Edition were housed in the counselor's office in a locked room and file. In order for me to access this data, permission was given from the principal and data was coded removing all participants' names. Since TerraNova scores are reported in percentiles, I compared the scores of Group A and Group B to see if the coaching model had an effect on student achievement. The results of the data were displayed in the form of tables in section 4 of this study and will address the following research question:

Is there a significant difference between the mean scores on the TerraNova Standardized Test of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model?

Instrument 2 (MacMillan /McGraw-Hill Pretest and Posttest)

The MacMillan/McGraw-Hill mathematics series was adopted by XYX Elementary School in 2005. The Inventory Test (pretest) was administered to students in Grades 3 through 5 in the fall of each year and again in the spring. The Inventory Test measures class level of performance and established a baseline. The inventory Test for each grade is the equivalent of the final test of the grade previous to it. There were 40 questions on the test (MacMillan/McGraw-Hill, 2005). Using a grading scale, scores were calculated according to how many incorrect responses are given by the participant. A numeric grade was then given to each participant.

The MacMillan/McGraw-Hill mathematics assessments were field tested and revised based on input from both teachers and students (McGraw-Hill). Focus groups and teacher advisory boards helped to create materials to meet the constant changes of modern day classrooms. Furthermore, a team of experts in content areas and special needs, such as specialists of differentiated instruction, cognitive development, and English Language Learners, reviewed and revised lesson manuscript. Data were triangulated through a research cycle that included program development research, formative research, and summative research (McGraw-Hill, 2011).

The MacMillan/McGraw-Hill Inventory test (pretest) was given in a 1 hour time frame. The assessment was also administered and scored by the mathematics resource teacher. Any participants who were absent on the day of testing were allowed to make their test up at another time outside of the classroom environment. In Section 4, I present tables to help define these results. A *t* test was employed to help answer the following research question:

Is there a significant difference between the mean scores on the McMillan/McGraw-Hill pretest and posttest of students whose teachers participated in the mathematics coaching model?

Instrument 3 (Scott Foresman/Addison Wesley Pre-Posttest)

The Scott Foresman/Addison Wesley Quarterly Test is an alternate mathematics pretest and posttest that was given to sixth graders because the MacMillan/McGraw-Hill series did not include an assessment for sixth grade. The pretest was administered to students in Grades 6 in the fall of each year and again in the spring. There were 36 questions on the assessment. The pretest and posttest was a comprehensive, fifth grade quarterly exam that included problems from all twelve chapters.

Scores for the Scott Foresman/Addison Wesley Quarterly assessment were calculated according to how many incorrect responses were given by the participant. A grading scale was used to score each participant response. A numeric grade was then given to each participant by the mathematics resource teacher. The Scott

Foresman/Addison Wesley comprehensive exam was administered in a 1 hour time frame. Any participants who were absent on the day of testing were allowed to make their test up at another time outside of the classroom environment. Tables have been displayed in section 4 of this study to help define the results. A *t*-test was employed to help answer the following research question:

Is there a significant difference between the mean scores on the Scott Foresman/Addison-Wesley pretest and posttest of students whose teachers participated in the mathematics coaching model?

To help assure reliability and validity of the material, Scott Foresman/Addison Wesley mathematics conducted two studies that fell within the scope of the Elementary School Math review protocol that met What Works Clearinghouse (WWC, 2011) evidence standards, and one study met WWC evidence standards with reservations. The studies included more than 2,800 elementary students from Grades 1 through 5, in 49 schools. Based on these studies, the WWC considered the extent of evidence for Scott Foresman–Addison Wesley Elementary Mathematics on elementary students to be medium to large for math achievement. Reviews of seven other studies have been released since 2005. Of these studies, three were not within the scope of the protocol and two were within the scope of the protocol, but did not meet evidence standards (WWC). All instruments and materials used in this study have assisted in exploring the overarching question: What effect, if any, does the mathematics coaching model have on student achievement?

Data Collection Procedures

The Terra Nova standardized test was administered in February or March of each year and test results were kept in the counselor's office. The MacMillan/McGraw-Hill and the Scott Foresman/Addison Wesley local assessment (pretest and posttest) raw data were housed with the mathematics resource teacher**.** A professional staff member disaggregated the data by classrooms and then by individual students. Each student's name was then coded by assigning a number and letter to protect confidentiality, and students were then assigned to either Group A or Group B. The letters and numbers represented student grade level and teacher. Group A and Group B represented the treatment and control group, respectively. The Terra Nova scores consisted of three lists of students by code names for each grade level (4, 5, and 6). The lists were for spring 2007 (pretest) and the other lists were for spring 2008 (posttest). The local assessment consisted of three lists also. These lists were from the 2007 fall mathematics test scores of students (pretest). The same format applied for spring 2008 (posttest), which were the mathematics test scores of the same students. All lists were then made available to me. The lists were labeled Group A (treatment group) and Group B (control group). I collected the data and analyzed individual scores of a treatment group of 95 students who have been part of the mathematics coaching model and 103 students who did not participate in the model. Data was then compiled using the SPSS statistics program.

Data Analysis Procedures

The CTB/McGraw-Hill's Terra Nova standardized test scores and the pretest and posttest scores produced by Macmillan/McGraw-Hill, which is the local assessment for XYZ Elementary School, were utilized. A quasi-experimental nonequivalent (pretest and posttest) control group design was used. The experimental group A and the control group B were selected without random assignment. Both groups took the pretest and posttest, but only group A received the treatment (Creswell, 2003). During this phase in the study, student's names were removed from the raw data list and coded by the counselor and mathematics resource teacher, or other available staff member. A distribution table was used to show how students did on both the pretest and posttest. The frequency distribution allowed for a comparison of the experimental group and control group through relevant variables. The central tendency scale measured the position of the frequency distribution which showed the arrangement of test scores from lowest to highest. From this scale, the mode, median, and range of scores were determined. The summation of how students' scores are distributed was established to show the variance and standard deviation.

From the results of this data, I used inferential statistics to draw on the sample of 185 test scores to make generalizations about the performance of all 198 students in grades 4, 5, and 6. Since test scores were compared between the treatment group and the control group, I used SPSS to investigate if there were any statistically significant differences in the mean scores. A comparison of performance of the experimental and control groups on the pretest and posttest was made using a *t*–test to measure statistical significance. A significance level of $p \leq .05$ was established for all analyses. These students had attended XYZ Elementary School for at least one year.

Protection of Human Participants

A letter was written to XYZ Elementary School to inform administrators that research would be conducted on the PCC model in mathematics and that data would be used from students' test scores for grades 4, 5, and 6 for the 2007/2008 school year. I used Walden University's consent forms to collect and analyze data. A letter to participate was sent to the school principal by me. Permission to conduct research was granted by the research evaluation department and school principal. The analysis procedure form was coded by a transcriber so that identifiers were completely protected even from me, the researcher. Full disclosure about the study and its purpose was explained. Anonymity of the participants was guaranteed by assigning numbers to individuals (Creswell, 2007).

Hard copies of personal data were stored in a locked file cabinet by a professional staff member at XYZ Elementary School. Individuals who had access to the data included school counselors and administrators. The report of research findings did not use language that was biased against participants because of gender, sexual orientation, racial or ethnic group, disability, or age (Creswell, 2003). The data that was used in this study was of public domain; therefore, permission from teachers, students, and parents was not necessary. A professional staff member coded all items numerically assuring that a participant's name or other identifying information was not known to the researcher, or others, and was not reported. Data set descriptors were reported and only aggregated data was reported. Data will continue to be stored at XYZ Elementary School once the research is completed at the administrators' discretion.

The research from this study can contribute to society because it may identify ways to help teachers, examine various models of coaching, look at coaching as a form of professional development, allow ways to share expertise with other professionals, bring an awareness of teacher practices into school systems, make teachers aware of the importance of mathematical pedagogy and content, demonstrate that collegial interactions amongst teachers are vital in order to take an organization forward, and provide an example of how to implement a mathematics coaching program in a school environment.

Researcher's Role

I am a veteran teacher and have taught both fourth and fifth grade. I have served on the School Improvement Leadership Team for 5 years and have taken on many roles such as secretary, team leader, co-chair, and advisor to that leadership team. I have worked with some of the participants for 19 years and have provided several sessions of professional development. Due to pre-established relationships between the researcher, and the participating coaches and teachers, biases may occur. Before any data collection, permission was obtained in writing from the research and evaluation and building administrator.

Conclusion

In section 3 a design of the research study was discussed along with the setting and sample size. Quantitative data sources and their relationship to the study were explored. The sample size and the eligibility of participants, including characteristics of the selected sample were described. Plans for both data collection and data analysis were described and potential biases were discussed. Measures taken to protect the rights of participants were explained along with the role of the researcher. Section 4 of this quasi experimental design will present and report an interpretation of the data through a display of tables.

Section 4: Results

Introduction

The purpose of this study was to determine whether there was a significant difference between standardized test scores of students whose teachers participated in a mathematics coaching model and the scores of students whose teachers did not participate in the model. First, the Terra Nova, 2^{nd} Edition scores of fourth, fifth, and sixth grade students were examined. Next, the local standardized assessments scores of the McMillan/McGraw-Hill inventory test and the Scott Foresman/Addison-Wesley quarterly test for the same students were examined.

I used a quasi experimental, nonequivalent design to examine the students' pretest and posttest scores. *The Statistical Program for the Social Sciences (SPSS16.0)* was used to conduct repeated-measures *t*-test analysis to determine possible pretest and posttest differences between the same coached groups. In a repeated measures design there is no risk of the subjects in one treatment are different from the subjects in another treatment, thus, it decreases variance. SPSS was also employed to conduct independent sample *t*-test analysis to determine possible pretest and posttest differences between coached and uncoached groups. In this section, I first describe the sample and then address each of the three research questions.

Description of the Sample

A sample was drawn from a population of 198 fourth, fifth, and sixth grade students using the 2007 TerraNova data. In March, these students completed the Terra Nova, 2^{nd} Edition exam and earned an average score of 61.25 on the mathematics section.

Of those 198 students, 98 were enrolled in five different classrooms in which each teacher was coached. In March 2008, 223 students took the same exam and earned an average score of 64.86 on the mathematics section. Of those 223 students, 113 were in five classrooms of the same coached teachers from the previous year. Five teachers participated in the PCC model in mathematics in 2007 and the same five teachers participated again in 2008. I addressed the first research question and looked at the TerraNova assessment data by grade levels. For the 2007 TerraNova exam, the sample used was 98 and for 2008, a sample of 113 was used. The local assessments, which were the textbook inventory tests, used a sample of 98.

TerraNova Assessment 2007

Research Question #1: Coached and Uncoached Groups

Is there a significant difference between the mean scores on the TerraNova test of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model, was the first question addressed in this study. The means, standard deviations, and the null hypothesis were tested to answer Research Question 1. There was no significant difference between the mean scores on the TerraNova standardized test of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model are shown in Tables 1 through 6.

Fourth Grade

Table 1

Differences in Scores for 4th Grade Coached and Uncoached Groups

	TerraNova 2nd Ed. (March, 2007)	Difference	
Group (2007)	M	SD	M
Coached (n=18)	66.22	12.43	8.83
Uncoached (n=18	57.39	13.21	

Note. M = sample mean; *SD* = standard deviation; *n* = number of scores in a sample

Fourth grade consisted of four teachers. Two teachers were coached and two teachers were not coached. Eighty students took the TerraNova, 2nd Edition in 2007. Of those eighty students, 49% (39) were enrolled in two different classrooms in which each teacher was coached and 51% (41) were enrolled in two different classrooms in which each teacher was not coached. Table 1 shows that teachers who were part of the PCC model scored an *M* = 66.22 with a *SD* = 12.426. Teachers who were not part of the PCC model scored an *M* = 57.388 with a *SD* = 13.213. Statistical analysis indicates there is a significant difference between test scores of students whose teachers participated in the mathematics coaching model and the test scores of students whose teachers did not participate in the mathematics coaching model, $t(34) = 2.066$, $p = .047$, $r^2 = 0.11$ (Table 2).

Table 2

Independent-Measures t-test Analysis of Scores for 4th Grade Coached and Uncoached Groups

	t Score	*df*	Significance
Difference	2.066	34	.047

Note. T = statistic; *df* = degrees of freedom

Fifth Grade

Table 3

Difference in Scores for 5th Grade Coached and Uncoached Groups

	TerraNova 2nd Ed. (March, 2007)	Difference	
Group (2007)	*M*	*SD*	*M*
Coached (n=18)	66.00	12.00	.000
Uncoached (n=9)	66.00	11.30	

Fifth grade consisted of three teachers. Two teachers were coached and one teacher was not coached. Sixty students took the TerraNova, 2nd Edition in March, 2007. Of those sixty students, 70% (42) were enrolled in two different classrooms in which each teacher was coached and 30% (18) were enrolled in one classroom in which the teacher was not coached. Table 3 shows that teachers who were part of the PCC model scored an *M* = 69.000 with a *SD* = 12.000. Teachers who were not part of the PCC model scored an *M* = 69.000 with a *SD* = 11.302.

Statistical analysis indicated there was no significant difference between test scores of students whose teachers participated in the mathematics coaching model and the test scores of students whose teachers did not participate in the mathematics coaching model, $t(25) = .000$, $p = .000$, $r^2 = 0$ (Table 4).

Table 4

Independent-Measures t-test Analysis of Scores for 5th Grade Coached and Uncoached Groups

	t Score	*df*	Significance
Difference	.000	25	1.000

Sixth Grade

Table 5

Difference in Scores for 6th Grade Coached and Uncoached Groups

	TerraNova 2nd Ed. (March, 2007)	Difference	
Group (2007)	*M*	*SD*	*M*
Coached (n=8)	65.88	6.90	2.88
Uncoached (n=16)	63.00	9.19	

Sixth grade consisted of three teachers. One teacher was coached and two teachers were not coached. Fifty-eight students took the TerraNova, 2nd Edition in March, 2007. Of those fifty-eight students, 29% (17) were enrolled in one classroom in which the teacher was coached and 72% (42) were enrolled in two different classrooms in which each teacher was not coached. Table 5 shows that teachers who were part of the PCC model scored an $M = 65.875$ with a $SD = 6.895$. Teachers who were not part of the PCC model scored an $M = 63.000$ with a $SD = 9.186$. Statistical analysis indicated that there was no significant difference between test scores of students whose teachers participated in the mathematics coaching model and the test scores of students whose teachers did not participate in the mathematics coaching model, *t*(22) =.779, p = .444, $r^2 = 0.02$ (Table 6).

Table 6

Independent-Measures t-test Analysis of Scores for 6^{th} Grade Coached and Uncoached Groups

	t Score	*df*	Significance
Difference	.779	22	.444

TerraNova Assessment 2008

Teachers who participated in the PCC model in 2007 also participated in the mathematics PCC model in 2008. In March 2008, the TerraNova, 2^{nd} Edition was administered. Two hundred twenty-three students took the same exam as the previous year and earned an *M* = 64.86 on the mathematics section. Of those, 113 students were in classes of teachers who participated in the PCC model in mathematics. These teachers and students accounted for 50% of the population in 4^{th}, 5^{th}, and 6^{th} grade.

Research Question #1: Coached and Uncoached Participants

Is there a significant difference between the mean scores on the TerraNova test of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model, was the first question addressed in this study. The means, standard deviations, and the null hypothesis were tested to answer research question 1: There is no significant difference between the mean scores on the TerraNova standardized test of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model are shown in Tables 7 through 12.

Fourth Grade

Table 7

Difference in Scores for 4th Grade Coached and Uncoached Groups

	TerraNova 2nd Ed. (March, 2008)		Difference
Group (2008)	*M*	*SD*	*M*
Coached (n=18)	69.33	7.48	8.94
Uncoached (n=18)	60.39	9.71	

Fourth grade consisted of four teachers. Two teachers were coached and two teachers were not coached. Seventy-eight students took the TerraNova, 2nd Edition in 2008. Of those seventy-eight students, 50% (39) were enrolled two different classrooms in which each teacher was coached and 50% (39) were enrolled in two different classrooms in which each teacher was not coach. Table 7 shows that teachers who were part of the mathematics PCC model scored an *M* = 69.333 with a *SD* = 7.475. Teachers who were not part of the mathematics PCC model scored an *M* = 60.388 with a *SD* = 9.708. Statistical analysis indicated there was a significant difference between test scores of students whose teachers participated in the mathematics coaching model and the test scores of students whose teachers did not participate in the mathematics coaching model, $t(34) = 3.097$, $p = .004$, $r^2 = 0.22$ (Table 8).

Table 8

Independent-Measures t-test Analysis of Scores for 4th Grade Coached and Uncoached Groups

	t Score	*df*	Significance
Difference	3.097	34	.004

Fifth Grade

Table 9

Difference in Scores for 5th Grade Coached and Uncoached Groups

	TerraNova 2nd Ed. (March, 2008)	Difference	
Group (2008)	*M*	*SD*	*M*
Coached (n=18)	57.39	14.48	-7.61
Uncoached (n=9)	66.00	11.30	

Fifth grade consisted of three teachers. Two teachers were coached and one teacher was not coached. Seventy-six students took the TerraNova, 2nd Edition in March, 2008. Of those seventy-six students, 67% (51) were enrolled in two different classrooms in which each teacher was coached and 33% (25) were enrolled in one classroom in which the teacher was not coached. Table 9 shows that teachers who were part of the mathematics PCC model scored an *M* = 57.388 with a *SD* = 14.479. Teachers who were not part of the mathematics PCC model scored an *M* = 65.000 with a *SD* = 11.789. Statistical analysis indicated that there was no significant difference between test scores of students whose teachers participated in the mathematics coaching model and the test scores of students whose teachers did not participate in the mathematics coaching model, $t(25) = .-1.363$, $p = .185$, $r^2 = 0.06$ (Table 10).

Table 10

Independent-Measures t-test Analysis of Scores for 5th Grade Coached and Uncoached Groups

	t Score	*df*	Significance
Difference	-1.363	25	.185

Sixth Grade

Table 11

Difference in Scores for 6th Grade Coached and Uncoached Groups

	TerraNova 2nd Ed. (March, 2008)	Difference	
Group (2008)	*M*	*SD*	*M*
Coached (n=8)	66.13	8.72	-3.00
Uncoached (n=16)	69.13	9.97	

Sixth grade consisted of three teachers. One teacher was coached and two teachers were not coached. Fifty-eight students took the TerraNova, 2nd Edition in March, 2008. Of those fifty-eight students, 33% (23) were enrolled in one classroom in which the teacher was coached and 67% (46) were enrolled in two different classrooms in which each teacher was not coached. Table 11 shows teachers who were part of the mathematics PCC model scored an $M = 66.125$ with a $SD = 8.724$. Teachers who were not part of the mathematics PCC model scored an $M = 69.125$ with a $SD = 9.972$. Statistical analysis indicated that there was no significant difference between test scores of students whose teachers participated in the mathematics coaching model and the

test scores of students whose teachers did not participate in the mathematics coaching model, *t*(22) =.772, p = .478, $r^2 = 0.01$ (Table 12).

Table 12

Independent-Measures t-test Analysis of Scores for 6th Grade Coached and Uncoached Groups

	t Score	*df*	Significance
Difference	-7.22	22	.478

Local Assessments

For the local assessments, which were the textbook inventory tests, I first examined scores of students whose teachers participated in the mathematics PCC model. In order to establish a baseline, these students had to have taken both the pretest in the fall of 2007 and the posttest in the spring of 2008. In the fall of 2007, and before coaching occurred, ninety eight students took the McMillan/McGraw-Hill pretest and earned an average score of 49. In the spring of 2008, and after coaching, the same 98 students took the posttest and earned an average score of 64. Fourteen students who took the pretest had missing posttest scores and were excluded from the study. The total number of scores used for data analysis was 98 for all three grade levels. More specifically, 34 fourth grade scores, 43 fifth grade scores, and 21 sixth grade scores.

A repeated-measures *t* test was used because the same participants were measured twice using the same dependent variable. To answer research questions two and three, the coached and uncoached groups were well matched. The uncoached groups had the same demographics to include age, gender, grade, class size, curriculum, and textbook as the coached groups.

Research Question #2: Coached Groups (4th Grade)

Is there a significant difference between the mean scores on the McMillan/McGraw-Hill pretest and posttest of students whose teachers' participated in the mathematics coaching model was the second question addressed in this study. The means, standard deviations, and the null hypothesis were tested to help answer research question 2: There is no significant difference between the mean scores on the McMillan/McGraw-Hill pretest and posttest of students whose teachers participated in the mathematics coaching model, are shown in Tables 13 and 14.

Local Assessments

Fourth Grade

Table 13

Difference in Scores on Pretest and Posttest for 4th Grade Coached Groups

Coached Group (n=34	McMillan/McGraw-Hill (August 2007)	McMillan/McGraw-Hill (April 2008)	Difference
M	52.64	71.11	-1.84
SD	13.58	11.45	8.77

There were a total of 79 fourth grade students in this study. Of those seventy-nine students, 43% were in classrooms of coached teachers. The students who took the pretest before treatment scored an *M* = 52.64 with a *SD* = 13.58. The same students who were taught using the Mathematics Coaching Model scored an *M* = 71.11 with a *SD* = 11.45. Statistical analysis in Table 16 indicated there was a significant difference in scores on the McMillan/McGraw-Hill test of students whose teachers participated in the mathematics coaching model, $t(33) = -12.27$, $p < .05$, $r^2 = 0.82$.

Table 14

Repeated Measures t-Test Analysis of Scores for 4th Grade Coached Groups

	t Score	*df*	Significance
Difference	-12.27	33	.000

Research Question #2: Coached Groups (5th Grade)

Is there a significant difference between the mean scores on the McMillan/McGraw-Hill pretest and posttest of students whose teachers' participated in the mathematics coaching model was the second question addressed in this study. The means, standard deviations, and null hypothesis were tested to answer research question 2: There is no significant difference between the mean scores on the McMillan/McGraw-Hill pretest and posttest of students whose teachers participated in the mathematics coaching model, are shown in Tables 15 and 16.

Fifth Grade

Table 15

Difference in Scores on Pretest and Posttest for 5th Grade Coached Groups

Coached Group (n=34	McMillan/McGraw-Hill (August 2007)	McMillan/McGraw-Hill (April 2008)	Difference
M	50.00	61.40	-1.14
SD	14.94	14.23	9.86

The 5th Grade students at XYZ Elementary School also took the McMillan/McGraw-Hill pretest and posttest. In a total population of 68 fifth grade students, 43 of them were in classrooms of coached teachers. This accounted for 63 % of the 5th grade population. Forty-three fifth grade students took the McMillan/McGraw-Hill pretest and earned an average score of $M = 50$ and a standard deviation of 14.94. In the spring of 2008, the same 43 students took the posttest and earned an average score of $M = 61.40$ and a standard deviation of 14.23. Statistical analysis in Table 16 indicated there was a significant difference in scores on the McMillan/McGraw-Hill test of students whose teachers participated in the mathematics coaching model, $t(42) = -7.58$, $p < .05$, $r^2 = 0.59$.

Table 16

Repeated Measures t-Test Analysis of Scores for 5th Grade Coached Groups

	t Score	*df*	Significance
Difference	-7.58	42	.000

Research Question #3: Coached Students (6th Grade)

Is there a significant difference between the mean scores on the Scott Foresman/Addison-Wesley pretest and posttest of students whose teachers participated in the mathematics coaching model was the third question. The related null hypothesis states: There is no significant difference between the mean scores on the Scott Foresman/Addison-Wesley pretest and posttest of students whose teachers participated in the mathematics coaching model. Table 17 shows the coached group mean scores and standard deviations from the Scott Foresman/Addison-Wesley pretest and posttest.

Sixth Grade

Table 17

Difference in Scores on Pretest and Posttest for 6th Grade Coached Groups

Coached Group (n=34	Scott Foresman/ Addison-Wesley (August 2007)	Scott Foresman/ Addison-Wesley (April 2008)	Difference
M	41.30	57.36	-1.61
SD	14.15	13.50	12.04

Sixty-four sixth grade students were in this study. Of those sixty-four students, 21 students (33%), were in the classroom of a coached teacher and earned an average mean score of M = 41.29 on the pretest and had a standard deviation of 14.15. The mean on the posttest was M = 57.38 and the standard deviation was 13.50. The statistical analysis in Table 18 indicated there was a significant difference in scores on the Scott Foresman/ Addison-Wesley test of students whose teachers participated in the mathematics coaching model, $t(20) = -6.12$, p = .000, $r^2 = 0.70$.

Table 18

Repeated Measures t-Test Analysis of Scores for 6th Grade Coached Groups

	t Score	*df*	Significance
Difference	-6.12	20	.000

Summary

This section presented data to determine if the PCC model made an impact on test scores of students whose teachers were coached. Ten teachers participated in this study. Fifty percent of the teachers were coached and 50% of them were not coached. The students who were in the classes of the coached teachers accounted for almost half the population under study (48%). SPSS was used to conduct an *independent-measures t-test* on group scores described in the three hypotheses related to the three research questions. SPSS was also used to conduct a *repeated-measures t-test* on group scores that remained in the same group for both the pretest and posttest. Chapter 5 will present an interpretation of the findings, implications for social change, and recommendations for a plan of action.

Section 5: Overview

Introduction

PCC was used as a type of professional development to help increase students' test scores in mathematics. Fourth, fifth, and sixth grade teachers participated in this professional development. This study was conducted to determine if coaching teachers would increase student achievement. One hundred forty-two test scores were examined. This section contains an abbreviated summary of Sections 1 through 3, beginning with an overview of the study, an interpretation of the findings, implications for social change, recommendations for actions, and recommendations for further research.

Overview of the Study

According to the Department of Education (2007), American students fail to achieve basic levels of proficiency in mathematics on national tests. Sparks (2002), advocated that teachers who are experts in their fields is one of the leading variables that can influence student achievement. In order to meet the high demands of their jobs, high quality teachers must be capable and willing to continually learn and relearn their trade. One way this goal can be achieved is through coaching. There are many types of coaching models available including collaborative coaching, content coaching, and instructional coaching. Despite which model is implemented, it must be well planned and endorsed by the principal and the school district.

In this study, the number and selection of teachers who were coached was authorized by the principal. Five teachers were chosen and included two 4^{th} Grade teachers, two 5^{th} Grade teachers, and one 6^{th} Grade teacher. There were 10 teachers who taught 4th through 6th Grade, including five coached teachers and five who were not coached. A flexible schedule allocated one hour time slots for the coach to be in the classroom with teachers and an additional, separate, 30 minute increment of time to meet with teachers outside of regularly scheduled class time. During this time frame, the coach could meet with a teacher one-on-one or by grade level. There were other times that all five teachers met with the coach for professional development, such as for CCL.

A quasi nonequivalent experiment design was implemented to determine the effectiveness of the PCC model on student achievement. Exam test scores from the 2007 TerraNova for fourth, fifth, and sixth grade were used as pretest scores. Posttest scores were the 2008 TerraNova scores. I made a comparison between test scores of students of participating teachers and test scores of students of non participating teachers. The McMillan/McGraw-Hill inventory test (school's local assessment) was used as both the pretest and posttest for grades four and five The Scott Foresman/Addison-Wesley quarterly exam (school's local assessment) was used as both the pretest and posttest for Grade 6. I used SPSS to compare the mean scores of students whose teachers participated in the mathematics coaching model and the mean scores of students whose teachers did not participate in the mathematics coaching model.

Interpretation of Findings

Using the TerraNova scores for 2007 and 2008, the independent-measures *t*-test analysis was conducted to test the differences in the pretest and posttest scores of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model. It was also conducted to answer the following research question:

1. Is there a significant difference between the mean scores on the TerraNova test of students whose teachers participated in the mathematics coaching model and the scores of students whose teachers did not participate in the mathematics coaching model?

Using the local assessment scores, the repeated-measures *t*-test analysis was conducted to test the differences in the pretest and posttest scores of students whose teachers participated in the mathematics coaching model from fall to spring. These teachers had the same students all year. Therefore the same students were tested twice in fourth and fifth grade. This test was also conducted to answer the following research question:

2. Is there a significant difference between the mean scores on the McMillan/McGraw-Hill pretest and posttest of students whose teachers' participated in the mathematics coaching model?

Using the local assessment scores, the repeated-measures *t*-test analysis was also conducted to test the differences in the pretest and posttest scores of students whose teachers participated in the mathematics coaching model from fall to spring. These teachers had the same students all year. Therefore the same students were tested twice in 6^{th} Grade. This test was also conducted to answer the following research question:

3. Is there a significant difference between the mean scores on the Scott Foresman/Addison-Wesley pretest and posttest of students whose teachers participated in the mathematics coaching model?

Fourth Grade Findings

Fourth grade statistical analysis indicated a significant difference in scores between the TerraNova pretest and posttest. In 2007, the *t*-test result was 2.066 and in 2008 it was 3.097. The sample mean was different from the null hypothesis and the *t*-test values were in the extreme critical region. Thirty-six test scores were examined on the 2007 TerraNova and 36 test scores were examined in 2008. There was a significant difference in scores on the local assessment also. Students' average score before coaching occurred was 52.64 and after coaching their average was 71.11. The scores were statistically significant, $t(33) = -12.27$, $p < .05$, $r^2 = 0.82$.

Fifth Grade Findings

Fifth grade statistical analysis indicated no significant difference in scores on both the 2007 and 2008 TerraNova exam. In 2007, the *t*-test result was .000 and in 2008 it was -1.365. The sample mean is consistent with the null hypothesis. Twenty-seven test scores were examined on the 2007 TerraNova and 27 test scores were examined in 2008. However, there was a significant difference in scores on the local assessment. Students' average score before coaching occurred was 50 and after coaching their average was 61.40. The scores were statistically significant, $t(42) = -7.58$, $p < .05$, $r^2 = 0.78$.

Forty-three scores were examined on both the pretest and posttest of the McMillan/McGraw-Hill inventory test. Erchick, Brosnan, Forrest, Douglass, Grant, and

Hughes (2007), reported findings from the first year of a three-year mathematics coaching project. The purpose of this study was to understand the effectiveness of the mathematics coaching project as a professional development intervention in schools and its effect on student achievement in those schools. Similar to the school under study, students took a pretest in January when the mathematics coaches began their work in schools and a posttest in May. Even within that short time span, there were modest gains in student mathematics content knowledge for both grade 3 and 4.

Sixth Grade Findings

Sixth grade statistical analysis indicated no significant difference in scores on both the 2007 and 2008 TerraNova exam. In 2007, the *t*-test result was .779 and in 2008 it was -.722. Twenty-seven test scores were examined on the 2007 TerraNova and 27 test scores were examined in 2008. However, there was a significant difference in scores on the Scott Foresman/Addison-Wesley local assessment. Students' average score before coaching occurred was 41.29 and after coaching their average was 57.38. The scores were statistically significant, $t(20) = -6.12$, $p < .05$, $r^2 = 0.70$. Twenty-one scores were examined on both the pretest and posttest of the Scott Foresman/ Addison-Wesley quarterly inventory test.

During the 2007/2008 school year, one teacher who was part of the mathematics coaching model, looped (same students moved with teacher to the next grade) from fourth to fifth grade, and thus taught the same students two consecutive years. One fifth grade teacher moved to sixth grade, but did not keep the same students. This could have played a role in test results in that this was each teacher's first year of teaching those grade levels. Another finding is that the results of this study do support the research that showed significant differences in scores of students whose teachers participated in the mathematics coaching model and scores of students whose teachers did not participate.

Implications for Social Change

PCC in mathematics is a type of professional development intended to help guide teachers in their content and instruction of mathematics. PCC lends itself to in depth learning and best practices that can become embedded in school climate in any academic subject. The results of this study may inspire and inform staff developers into influencing school districts, counties, states, and schools into implementing professional learning communities that can deepen teachers' pedagogical content knowledge and increase student achievement. As teachers begin to construct new knowledge in their mathematical thinking, and learn new standard-based problem solving skills, they can share this information with students, at grade level meetings, with coworkers, and with parents.

Beyer (2008) believed that the research showing the effectiveness of teaching thinking skills and the benefits derived from it indicates that such teaching is worth doing. It improves students' academic achievement and their quality of thinking. Further more, developing thinking skills addresses many complex issues in teaching and learning. Swartz, Costa, Beyer, Reagan, and Kallic (2008) claim that teaching skillful thinking not only enhances students' thinking abilities and learning in the content areas but also greatly improves the quality of their lives and their professional work after they leave school.

Recommendations for Actions

This study focused on the effectiveness of the mathematics coaching model and its impact on students' test scores. TerraNova and local assessment data showed significant gains in scores of students whose teachers participated in the PCC model. Specifically, fourth, fifth, and sixth grade scores were all significant on the local assessments. Fourth grade scores were also significant on the TerraNova exam for 2007 and for 2008. However, fifth and sixth Grade scores on the TerraNova exam were not statistically significant for either year. The following suggestions were recommended for further actions:

1. Schools should offer teachers continuous professional development in mathematics. Erskine (2010) found that many elementary teachers lack the necessary knowledge to support student learning in mathematics. Without professional development, educators, who teach the same traditional way, will yield the same traditional results year after year.
2. Before implementation of a coaching model, districts and schools should have a well planned and well organized coaching model. Coaches who have deep content knowledge for the learning and teaching of mathematics should also seek continuous training on how to be an effective coach and constantly learn more math.
3. It would be an advantage to survey teachers on mathematics coursework they may have completed in the past few years, level of degrees and certification, if co planning and co teaching were implemented, how high-level thinking

problem solving activities are being incorporated, and their basic interest in teaching mathematics. This survey could serve as a foundation to help the principal in the identification of who may need coaching services to help students gain deeper mathematical knowledge and raise test scores. A survey for teachers after coaching has occurred for the school year could also be helpful to the coach for further planning.

4. The collection of qualitative data such as interviewing teachers to talk about instructional practices and students to talk about problem solving skills could assist in building collaboration and mathematical understanding. Qualitative research may provide greater insight about the effectiveness of PCC mathematics model versus traditional textbook teaching of mathematics.
5. Principals should allocate and plan for substitute coverage so that coaches can meet with assigned teachers to conduct professional development. Therefore, a well, planned budget needs to be in place.
6. When implementing a coaching model; start with coaching one grade level. Sometimes districts design coaching positions differently and do not get to the heart of what the data is driving them to do. Therefore, do not assume that coaching is a quick fix to raising student achievement. It takes a period of time to see consistent results.
7. Demographics should be a consideration in this study. For that reason, gender, ethnicity, and cultural background should be examined to determine if it had a

direct impact on instructional practices of the PCC model and achievement scores.

8. The scores for fifth and sixth grade on the TerraNova exam were not statistically significant. Perhaps a revised schedule that allows the coach to spend more one-on-one time with each teacher to improve pedagogy, pre plan lessons, work through lessons, and model lessons may help support student achievement. This may require coaching a smaller number of teachers in order to gain valuable coaching time, or working with one teacher for several weeks.
9. Based on class scores on the TerraNova exam, it is recommended that student's individual scores are examined to determine which group of students did not meet the standard for achievement in mathematics. There may be a need to explore the instructional practices that teachers draw on to achieve results.
10. Since half the population of teachers in 4 through 6 Grade were coached, and there was only one coach in the school under study, it is highly recommended that allocations for additional coaches is considered when reviewing staffing vouchers.

Though peer coaching is only one type of coaching, it is recommended that other types of coaching be carefully explored before deciding on a model for the district or school. Exploring other types of coaching may add to the existing body of knowledge about optional ways to teach and learn mathematics. Hence, increasing teachers' mathematical content knowledge and pedagogy, may allow teachers to better understand other avenues to reach and meet individual learning needs of their students and increase student achievement.

Recommendations for Further Study

There were statistically significant gains in this research study as well as conclusions that suggest implications for further studies. Will students who are exposed to coaching in early elementary classes such as first and second grade, perform better on standardized tests in 3rd Grade and higher? It was recommended that coaching begins in lower grades such as first and second so that teachers and students can gain conceptual knowledge and begin developing the big mathematical ideas. The understanding of manipulating numbers at an early age may assist students in mathematics content as they become more challenged while moving to the next grade level.

What effect does a teacher's subject content knowledge, certifications, years of teaching experience, and previous test results have on student achievement? Before teachers are placed in grade levels they have never taught, perhaps principals could check certifications, levels of subject content, and test results from previous years. Because a teacher is certified to teach a certain subject, does not necessarily mean the teacher is qualified to teach the subject.

What effect, if any, does coaching have on students who have been in coached classes for three or more years? Perhaps backgrounds of students could be studied to see if they have remained at the same school for a number of years. The scores of students who have remained in a coached class for three years may differ from the scores of students who have not been in any coached classes for three years.

It was recommended that additional research about PCC and its effect on student achievement in mathematics be studied. Because one size does not fit all, it was also recommended that other types of coaching be examined to see what the best fit for the district or school is. For example content coaching could be accompanied by a specific skill in mathematics such as problem solving and could pose the following question: What effect, if any, does content coaching have on student achievement in mathematics problem solving?

Did teachers' instructional practices change as a result of being coached? A qualitative study may be the best way to gather data on what teachers are doing in their classrooms. This could mean studying the interactions of students and teachers, observing the types of questions that are being asked, observing to see if students are given efficient time to respond, observing to see how problem solving is addressed, and looking at the type and amount of pre planning and post planning that goes into a lesson.

Over three-fourths of the students in fifth grade were in two classrooms of a coached teacher. Why was there no difference in mean scores after a year of coaching? Did teachers use modeled lessons that had been presented by the coach or do these teachers need more one-on-one coaching time? Will teachers continue using the instructional practices that were implemented during the coaching phase, or will they go back to traditional teaching page-by-page book methods? Statistical analysis revealed that the two 6th Grade uncoached teachers' mean scores were comparable with the coached teacher scores. Could these uncoached teachers have had a greater or equal grasp on mathematics content knowledge as their counterpart?

It should be noted that a delimitation of this study was that it was limited to fourth, fifth, and sixth grade teachers only. Although third grade is a testing grade in the district under study, the coaching model was set up to include only Grades 4 through 6, and sixth grade could only be included in the coaching model if they were part of the school. This study was limited to one pre kindergarten through sixth grade elementary school in the district. Therefore, it was further recommended that this study be replicated using a larger sample size and a larger population. For example, a study might be conducted to compare the mathematics coaching model effect on student achievement in private schools versus public schools or one district's schools versus another district's schools.

The 4th Grade findings indicated there was a significant difference between the coached group and the uncoached group on the TerraNova exam for years 2007 and 2008. The findings in this study also suggested that fifth and sixth grade test scores were not significant on the TerraNova exam. Therefore, it was recommended that each subskill on the mathematics section of the TerraNova be revisited to help inform teachers of weaknesses and gains. Furthermore, an examination of all mathematics individual subskills, for all students who take the TerraNova test, can help instruct and inform learning.

Because scores of students whose teachers participated in the mathematics coaching model may be significantly different than the scores of students whose teachers did not participate in the mathematics coaching model, does not mean it was due only to coaching. There were factors in this quasi experimental design that may have systematically influenced the outcome of this study. For example, some participants may have automatically fallen into the same demographic make up; some may have tested low on the pretest and test low on the posttest; yet others may have had attitudes and behaviors that could have affected their test scores. Teacher quality and achievement gap could also have affected test scores. A teacher's years of experience could also have been a factor. Differences between test scores may also have been due to sampling error or chance. Lastly, it was highly recommended that local assessments such as pretests and posttests be treated equally as important as state assessments. This type of data can serve as baseline tools to help inform and guide instruction.

Conclusion

This section presented an abbreviated overview of the study, which included interpretations of the findings, implications for social change, recommendations for action, and recommendations for further study. There are many types of coaching and each can be implemented differently. How, and at which grade level, a coaching program is needed depends on the individual school or district. A PCC model was launched to determine if it could make an impact on test scores of students whose teachers were coached.

PCC did make an impact on teachers who were coached on both the local assessments and state assessment. It also created a community of learning where teachers, students, and administrators were all involved. By participating in a coaching model, it can allow one to construct new knowledge in their mathematical thinking by learning new standards-based problem solving skills. Gellert (2008) found that, when elementary teachers participated in a community of practice where teachers could talk about mathematics and mathematics teaching, teachers' confidence and competence increased.

A plan of action has been set forth and recommendations have been made to include that schools should offer teachers continuous professional development in mathematics. Surveying teachers to find out what are their specific strengths and what is their basic interest in teaching mathematics can add to the administrator's body of knowledge of what type of professional development needs to be offered and what grade level or subject matter teachers could teach.

In order to carry out any plan of action, further study may be necessary. It was recommended that coaching begin in lower grades such as first and second so that teachers and students can gain conceptual knowledge and develop the big mathematical ideas at an early stage. In addition, local assessments such as pretests and posttests should be treated equally important as state assessments. Whatever coaching model a school or district adopts, should be kept in place long enough and evaluated often enough to measure if it is impacting student achievement and teacher instructional practices.

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Curriculum Vitae

Merita Trimuel Stewart

Work Experience

2010-2011 Read 180 Teacher (Grades 3, 4, & 6))
2006-2011 Mathematics Coach (Grades 4, 5, & 6)
2005-2006 Mathematics Instructional Support (Grades 4, 5, & 6)
1998-2005 4th Grade Teacher
1991-1998 5th Grade Teacher

Education

2013 Doctorate of Education, Teacher Leadership, Walden University
2000 Master of Public Administration Savannah State University
1990 Bachelor of Arts, Business Management, Saint Leo College
1990 Associate of Science, Marketing & Management, South College
1988 Associate of Arts, Liberal Arts, Saint Leo College

Certification

Georgia Teaching Certificate (Grades 4-8)
Georgia Leadership, Instructional Supervision
DoDEA Teaching Certificate (Grades 4-8)
DoDEA Instructional Systems Specialist
DoDEA Teacher of Business

Additional Learning Experiences

Scoring and Using Results of Balanced Assessment in Math (BAM Scoring), May 2004
Scoring Mathematic Problems with Rubrics (BAM Scoring), May 2005
DVLP Math: Making Meaning of Operations, June 2005
DVLP Math: Building a System of Ten, June 2005
Solving Math Word Problems, April 2006
Hands on Learning with Math Manipulatives, April 2006
Math Pre-Implementation, October 2006
Lenses on Learning, July 2006
Measuring Space in One, Two, and Three Dimensions, December 2006
Content-Focused Mathematics Coaching and Facilitating, December 2006
Content-Focused Math Coach- Explore Rational Numbers, June 2007
Content-Focused Mathematics Facilitating, February 2008
Content-Focused Mathematics Facilitating Part 2, April 2008

Water Quality Spring II, April 2008
Administering the School Improvement Process, March 2005
Guided Reading: Making It Work In Your Classroom, February 2006
Elementary Science Pre-Implementation 2005
Technology: The Basic, Spring 2005
Integrating Technology in Student Centered Classrooms, May 2002

JOB-RELATED HONORS & AWARDS

Certificate of Recognition for the 2001 Mineral Chemistry Workshop presented by Armstrong Atlantic State University (AASU) & Kerr-McGee

Certificate of Recognition for the 2001 Teachers' Environment & Free Enterprise Institute presented by AASU & International Paper

Certificate of Recognition for the 2001 Project Wild presented by AASU

State finalist for the 2004 Presidential Awards for Excellence in Mathematics and Science Teaching Program