A Study of the Impact of Site-Based Mathematics Professional Development on Student Mathematics Achievement

Christine Attenhofer

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A Study of the Impact of Site-Based Mathematics Professional Development on Student Mathematics Achievement

Submitted in partial fulfillment
of the requirements of
Doctor of Education
National College of Education
National Louis University

Christine M. Attenhofer
Educational Leadership Doctoral Program

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11-18-19
Date Approved
Dedication

To my children, who I love more than my own life. I hope that the time I have devoted to my studies has motivated you to excel in your own. From the bottom of my heart, I appreciate your understanding and support as I found balance between being a single mom and a full-time doctoral student.

To John, your unconditional support has turned my dreams into reality. Thank you for understanding a messy house and a distracted fiancé. Thank you for asking for kisses while I worked diligently on my dissertation. Thank you for relieving me of responsibilities so I could work on my dissertation.

To my Daddy, who was always proud of me and looked forward to his daughter becoming a doctor. This will be my first graduation without you.

To my friends and family, who have supported and encouraged me through this journey – thank you.
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This journey has been long in the making, 50 years to be exact. I have attained a personal goal and a life-long dream. Through this process, I have taken the necessary steps to achieve other personal goals and other dreams. This would not have been possible without the encouragement, support, and guidance of many stakeholders.

Thank you, Dr. Carla Sparks and Dr. Rosita Riley for agreeing to be my dissertation committee. I know it was not always easy working in my accelerated timeline, but neither of you were phased by the sixteen-week due date. I respect both of you immensely and feel extremely blessed to have been able to share my journey with both of you.

My gratitude is extended to the faculty of the Ed.D. program at National Louis University. It was a pleasure to work with each faculty instructor. I gleaned insight and wisdom from all of them that shaped my mind and perspectives.

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I am appreciative to all my family members and friends who have encouraged and supported me through this journey. Thank you for understanding the many times I could not participate in events because I was working on my dissertation and knowing that my heart was always there.
Abstract

Student achievement at one suburban elementary school under study dropped notably in mathematics in one school year, as measured by the state standards assessment. The purpose of this inquiry was to determine what impact ongoing, on-demand, job-embedded, site-based professional development opportunities provided by a full-time, site-based math content area specialist had on teachers’ instructional practices and students’ mathematics achievement. I implemented a mixed methods approach to this inquiry. I analyzed the end of year state mathematics standards assessments for second through fifth grade students following the implementation of full-time, site-based professional development provided by a math content area specialist and weekly, mathematics focused, grade level collaboration facilitated by the math content area specialist. I compared assessment data from the previous school year to the same assessments at the end of the school year during which focused professional development was provided to teachers. I conducted surveys and interviews among teachers at the school to gain insight into their perspective on the impact of the professional development on their teaching and student learning. Results indicated an increase in test scores in all student subgroups and mixed results in the achievement levels of at-risk populations, though not statistically significant the results of this study show a substantive impact on student learning.
Preface

Minor et al. (2016) said “teacher learning [was] a central component of many school reform policies at the national, state, and local levels in the United States” (p. 2). Mezirow (1991) said “a disturbing fault line separate[d] theories of adult learning from the practice of those who try to help adults learn” (p. xi). My position as a math content area specialist was a vital part of the reform movement and faced the struggle of applying adult learning theories in real-world applications. I was new to my position, having recently received a lateral transfer from classroom teaching to professional development. I truly wanted to excel at my new job. Unfortunately, my job did not come with a concrete job description specific to mathematics coaching nor was a formal coaching model for mathematics provided by district personnel (Davis, 2015, p. 7).

Within the context of this study and as part of my leadership role at the study school, I was able to apply concepts gleaned from my research to support teachers through the coaching cycle and during grade level collaboration. The primary leadership lesson learned through this study was mathematics content area specialists were a linchpin to improving teacher instruction and student achievement. As an instructional leader, the mathematics content area specialist was responsible for instructional plan implementation as a follow up to grade level collaboration, faculty development in content and knowledge, and creation of a learning environment that promoted the learning of all teachers and students. As a leader within the study school district, I endeavored to develop instructional staff who were actively engaged in designing their own professional learning experiences while fully participating in the sharing of best teaching practices through grade level collaboration. The combination of on demand
professional learning and weekly mathematics focused grade level collaboration
facilitated by the mathematics content area specialist was an instructional model that the
leadership members of other schools could use to improve the content and knowledge of
instructors and students.
Table of Contents

ABSTRACT ........................................................................................................................ iv
PREFACE ........................................................................................................................... v

Section One: Introduction ................................................................................................. 1
  Purpose of the Program Evaluation .................................................................................. 2
  Rationale .......................................................................................................................... 4
  Goals ............................................................................................................................... 7
  Definition of Terms ......................................................................................................... 9
  Research Questions ........................................................................................................ 15
  Conclusion ...................................................................................................................... 15

Section Two: Literature Review ........................................................................................ 17
  Educational Reform .......................................................................................................... 19
  Traditional Professional Development ............................................................................. 21
  Standards for Professional Development ........................................................................ 23
    Collaboration .................................................................................................................. 23
    Peer Support .................................................................................................................. 24
  Professional Learning Communities ............................................................................... 25
  Team-based Learning Communities .............................................................................. 26
  Leadership ....................................................................................................................... 26
    Academic Coaches ........................................................................................................ 26
    Educational Governance .............................................................................................. 28
    School Administrators .................................................................................................. 28
  Resources ........................................................................................................................ 29
    Money .............................................................................................................................. 29
    Duration ........................................................................................................................ 30
  Data .................................................................................................................................. 32
    Student Data ................................................................................................................ 32
    Teacher Data ................................................................................................................ 34
  Learning Designs ............................................................................................................. 34
    Active Learning .............................................................................................................. 35
    Agency ............................................................................................................................ 36
    Coherence ....................................................................................................................... 36
    Content Knowledge ....................................................................................................... 37
    Differentiation ................................................................................................................ 39
    Job-Embedded ............................................................................................................... 39
    Observation ................................................................................................................... 40
    Pedagogy ......................................................................................................................... 41
    Reflection ....................................................................................................................... 42
    Self-Efficacy ................................................................................................................... 43
  Implementation ................................................................................................................ 44
    Feedback ........................................................................................................................ 44
    Follow-up ........................................................................................................................ 45
  Research on Change and Sustained Support ................................................................. 45
<table>
<thead>
<tr>
<th>Section Three: Methodology</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Design Overview</td>
<td>52</td>
</tr>
<tr>
<td>Participants</td>
<td>55</td>
</tr>
<tr>
<td>Data Gathering Techniques</td>
<td>56</td>
</tr>
<tr>
<td>Surveys</td>
<td>57</td>
</tr>
<tr>
<td>Interviews</td>
<td>57</td>
</tr>
<tr>
<td>Assessments</td>
<td>58</td>
</tr>
<tr>
<td>Data Analysis Techniques</td>
<td>59</td>
</tr>
<tr>
<td>Ethical Considerations</td>
<td>61</td>
</tr>
<tr>
<td>Limitations</td>
<td>62</td>
</tr>
<tr>
<td>Conclusion</td>
<td>63</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section Four: Results</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Findings</td>
<td>64</td>
</tr>
<tr>
<td>iReady</td>
<td>64</td>
</tr>
<tr>
<td>End of Year State Mathematics Standards Assessment</td>
<td>69</td>
</tr>
<tr>
<td>Surveys</td>
<td>106</td>
</tr>
<tr>
<td>Interviews</td>
<td>109</td>
</tr>
<tr>
<td>Context</td>
<td>115</td>
</tr>
<tr>
<td>Culture</td>
<td>118</td>
</tr>
<tr>
<td>Conditions</td>
<td>122</td>
</tr>
<tr>
<td>Competencies</td>
<td>123</td>
</tr>
<tr>
<td>Interpretation</td>
<td>128</td>
</tr>
<tr>
<td>Judgments</td>
<td>133</td>
</tr>
<tr>
<td>Recommendations</td>
<td>135</td>
</tr>
<tr>
<td>Conclusion</td>
<td>141</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section Five: To-Be Framework</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envisioning the Success To-Be</td>
<td>143</td>
</tr>
<tr>
<td>Context</td>
<td>144</td>
</tr>
<tr>
<td>Culture</td>
<td>145</td>
</tr>
<tr>
<td>Conditions</td>
<td>147</td>
</tr>
<tr>
<td>Competencies</td>
<td>150</td>
</tr>
<tr>
<td>Conclusion</td>
<td>152</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section Six: Strategies and Actions</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategies and Action</td>
<td>158</td>
</tr>
<tr>
<td>Conclusion</td>
<td>159</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section Seven: Implications and Policy Recommendations</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy Statement</td>
<td>167</td>
</tr>
<tr>
<td>Analysis of Needs</td>
<td>168</td>
</tr>
<tr>
<td>Conclusion</td>
<td>169</td>
</tr>
</tbody>
</table>
Section One: Introduction

The intended purpose of my program evaluation was to determine which types of site-based teacher professional development were the most impactful on teacher instructional practices in mathematics, and by extension student achievement in mathematics. I gathered data that examined the impact, positive or negative, on students’ achievement in mathematics after teachers at the study school participated in site-based professional development opportunities. My intended goal related directly to student learning and as such aligned with the strategic plan of the school district and the school improvement plan of the school under study. In evaluating both quantitative and qualitative data, I sought to determine the relationship ongoing, site-based, on-demand, job-embedded teacher professional development experiences had on student academic growth and scholarly achievement. Increased students’ scores on state and district assessments potentially indicated a positive relationship to teachers participating in professional development. If there was an improvement in the school grade earned by study school staff and students as assigned by representatives of the state department of education, then that might indicate that the ongoing, site-based, on-demand, job-embedded professional development opportunities provided by the full-time, site-based math content area specialist were valuable. I hypothesize that the site-based, job-embedded, on-demand, ongoing professional learning with feedback provided by a full-time, site-based math content area specialist would improve teachers’ instructional practices and ultimately student achievement.
Purpose of the Program Evaluation

The purpose of this evaluation was to determine what impact ongoing, on-demand, job-embedded, site-based professional development opportunities provided by a full-time, site-based math content area specialist have had on teachers’ instructional practices and students’ mathematics achievement in primary grades at an elementary school in a mid-size school district. After the 2017-2018 state standards assessment were administered to students at the study school, the state department of education representatives reported that the state assigned school grade of the elementary school under study had dropped from a B to a D, with students’ mathematics test scores decreasing in third through fifth grade classes. Students’ math achievement pass rates on the end of year state mathematics standards assessment decreased from 41% to 40%, as an average of third, fourth, and fifth grade students’ test scores. Students’ math learning gains fell from 50% to 41%, with less students improving one or more achievement levels in mathematics, less students maintaining levels identified as proficient, and less students improving within subcategories. Students’ learning gains can be achieved by improving from one or more achievement levels, maintaining a level 5 on a scale of 1 to 5 with 5 being the highest, remaining a level 3 or 4 and improving their score by at least one point, or level 1 or 2 who improve to a subcategory within that level (Citation withheld to preserve the anonymity of the study school). Finally, students’ learning gains in the bottom quartile of the student population of grades three through five plummeted from 48% to 27% in mathematics.

My evaluation examined whether the site-based, ongoing, on-demand, job-embedded professional learning opportunities provided by the full-time, site-based math
content area specialist met the objective of improving student achievement in mathematics through strategic research-based professional development opportunities for teachers. Shaha, Glassett, and Copas (2015b) said there has been a scarcity of valid, quantifiable research on teacher professional learning experiences impact on student academic performance (p. 163). Therefore, my evaluation has global implications in terms of addressing the professional development needs of teachers and determining the value of specific professional learning opportunities as they apply to student achievement. When full-time, site-based math content area specialists provided induction coaching, math content area specialists were able to eliminate teachers’ fears regarding their job performance while targeting improvements to attain success regarding their classroom instruction and improve student achievement (Thomas, Bell, Spelman, & Broidy, 2015).

I served, within the district under study, as a math content area specialist at the school under study. As such, I was responsible for providing site-based, ongoing, on-demand, job-embedded professional development to all teachers in grades pre-kindergarten through fifth grade in general education and exceptional education classrooms. In my role, I facilitated once a week, mathematics focused, 45-minute, grade level collaboration sessions, grade level lesson planning, grade level professional learning opportunities, and individual professional development experiences as requested by the teachers and the administrators of the school.

During the 2018-2019 academic year, I used a correlative mixed methods research approach to collect both quantitative and qualitative data. Quantitative data consisted of data from student mathematics achievement after the implementation of professional
development provided by a full-time, site-based professional development. I collected qualitative data from surveys and interviews that included teachers’ perceptions of professional development. With permission from the school district’s Director of School Counseling and Assessment Department, I monitored student achievement and analyzed data from the iReady AP3 diagnostic and the end of year state mathematics standards assessments as part of my program evaluation. Teachers completed Likert scale surveys and teachers’ survey answers provided quantitative data regarding their professional development experiences and implementation. I collected qualitative data when teachers completed survey questionnaires and during teacher interviews, after they completed professional development.

**Rationale**

When the school grades were released by representatives of the state department of education in the summer of 2018, student scores at the school under study had dropped two letter grades based on the results of the state standards assessments administered to students in third, fourth, and fifth grade. Though the school grade earned by students and staff at the study school dropped two letter grades to a D, the students and staff of the study school were not identified as being a bottom 300 school in the state, based on students’ performance on the state standards assessments in English Language Arts (ELA) nor was the school day extended an extra hour, as was typical for instructional staff and administrators of low performing students in the state. However, the students and staff of the school under study were targeted by representatives of the state department of education for remediation and scrutiny of achievement gains and achievement levels for the 2018-2019 school year. If student scores did not improve in
grades three through five classrooms at the study school, then representatives of the state department of education could mandate an extra hour of instruction per day during the 2019-2020 school year. Specifically, student learning gains were needed in the bottom quartile of students in grades three through five to improve the current grade earned by students and staff. Data driven professional development for teachers was designed by the math content area specialist and aligned with student academic needs. The math content area specialist designed teacher professional development targeted to student learning needs that had the potential to increase student achievement as measured by state mathematics standards assessments.

The students at the school under study had a Hispanic student population of 35.5%, which was almost equivalent to the White student population of 36.1% at the study school. Black students accounted for 23% of the remaining student population at the study school. It was important to note that 68.9% of the students lived in low-socioeconomic households. The student population of the study school had a high percentage of transient students historically.

Specifically, a percentage of Hispanic students enrolled at the school would withdraw and reenroll as they moved with their parents who were migrant farm workers. These students missed significant portions of core academic or Tier 1 instruction in ELA, math, and science. Teachers needed the tools to leverage maximum student achievement despite both language and duration barriers. Ongoing, on-demand, job-embedded professional development provided by a full-time, site-based math content area specialist may have provided teachers with the tools to forestall the achievement gap or close it entirely.
School district leaders wrote the district strategic plan to align with the goal of closing the achievement gap within its mission statement, vision statement, and six core values of professionalism, partnership, personal responsibility, equal opportunity, engaged citizenship, and honor. The mission statement written by district leaders said all district staff would strive “to empower every student to become a life-long learner who possesses the requisite skills and attitudes to be a responsible, productive, and engaged citizen” (District Strategic Plan, 2018, p. 26). District leaders wrote the vision statement with the goal of the school district becoming “the preferred provider for a free, quality, public education in the county” (District Strategic Plan, 2018, p. 26). School district leaders envisioned the school district becoming “the employer of first choice for highly-qualified, motivated, and highly-effective educators and support personnel” (District Strategic Plan, 2018, p. 26).

School district leaders wrote the district strategic plan with five main areas of focus. District leaders wrote the district strategic plan with goal one: to support safe, secure, and respectful schools. District representatives from all departments wrote the district strategic plan with goal two: to maximize federal, state, and local resources to ensure the most effective and efficient use of revenues. District staff wrote the district strategic plan with goal three: to hire, develop, retain, and support the most highly qualified teachers, administrators, and support personnel. The district improvement team members wrote the district strategic plan with goal four: to improve the quality, integrity and delivery of our communication to meet the needs of all stakeholders. District personnel wrote the district strategic plan with goal five: to improve academic achievement for all students and increase the percentage of students graduating, equipped
for post-secondary education and work through rigorous integrated curricula within a multi-tiered system of support.

Stakeholders from the study school developed and wrote the school improvement plan for the study school. The stakeholders from the study school wrote the school’s vision statement: creating lifelong learners that feel safe and inspired (School Improvement Plan, 2018, p. 6). Study school stakeholders wrote the vision statement to align with the school mission statement:

[The study school] seeks to create a challenging learning environment that encourages high expectations for all students, through developmentally appropriate and ambitious instruction, that allows for individual differences and learning style. Each student’s success is based upon the school, home, and community connection to ensure that each child will become a life-long learner. (p. 6)

**Goals**

My research contributed to the field of education in several ways. By implementing effective professional development strategies, through my position as the math content area specialist I strengthened the value of professional learning experiences for teachers at the study school. By applying the methods that research has identified as successful, I eliminated the negative stigma associated with traditional teacher professional development experiences and replaced the negative association with a desire to use reflective practices to drive professional learning experiences through self-efficacy. When the math content area specialist improved the professional development experiences of teachers, teacher instructional practices were enhanced, which ultimately
led to the academic growth of students and increased students’ scholarly achievements. Students’ improved academic performance diminished the achievement gap in mathematics between proficient and nonproficient students and began the process of eliminating the academic effects of the cycle of poverty for at-risk students. My research added new information to the existing body of research related to professional development and student achievement.

I evaluated the mathematics professional learning opportunities within the school under study. Though focused on the school under study, my research has global implications. There was no one-size-fits all answer to effective professional development. More research remained necessary to develop effective site-based professional development experiences that both improve teacher performance and student outcomes. Current research remained inconsistent and often uncertain. Within my research, I found that researchers agreed that traditional professional development were as ineffective as traditional teaching methods. The leaders of the school district and the study school expended a great deal of time and money on professional development with minimal positive output for teachers and students and no definitive return on investment for stakeholders. Kennedy (2016) said the goal of professional learning opportunities was to improve student learning but we have fallen short of the mark, as evidenced by the decreased pass rate of student scores on state mathematics standards assessments at the study school (p. 6).
Definition of Terms

The following content specific vocabulary terms were used throughout this dissertation. These terms were important to readers and provided specific content knowledge necessary to understand large portions of my dissertation.

Achievement or Performance Levels. Figure 1 shows the five categories of achievement that represented the success students demonstrated with the content assessed. The achievement levels were helpful in interpreting what a student’s score represented. Achievement levels ranged from 1 to 5, with Level 1 being the lowest and Level 5 being the highest. Achieving a score in Level 3 or higher was considered satisfactory. A minimum score of Level 3 was the passing score for each assessment (Citation withheld to preserve the anonymity of the school under study).

![Figure 1](image.png)

*Figure 1*. Achievement/performance levels with identified descriptive definitions associated with each level.

Active Learning. Activities that improved the knowledge of teachers while pushing them into cognitive dissonance before they incorporate the new concept into their own content and pedagogy (Brendefur, Thiede, Strother, Jesse, & Sutton, 2016, p. 100).

Andragogy. Learning schema specific to adults (Bishop, 2016, p. 21).

Coaching. A form of professional learning within classrooms that helped teachers develop strong plans, provided feedback, refined their practices, and examined results (Pemberton et al., 2016, p. 3).
Coherence. The strength of professional learning (Brendefur et al., 2016, p. 100).

Common content knowledge. Knowledge used in general settings (Garet et al., 2016, p. 3).

Continuous Professional Development. A life-long, continuous, and purposeful maintenance, improvement and broadening of knowledge, skills, and personal qualities in order to perform professional activities successfully throughout working life using systematic, ongoing, and self-directed learning with the goal of upgrading teaching abilities (Belay, 2016, p. 219).

Holding Environment. The four pillar practices that provide context and structure: teaming, providing leadership roles, collegial inquiry, and mentoring. The pillar practices “support adults with qualitatively different ways of understanding and interpreting [their own] experiences” (Drago-Severson, 2013, p. 34).

Horizon Knowledge. Knowledge of how topics build across grade levels (Garet et al., 2016, p. 3).

Horizontal Mathematization. Representing contextualized problems mathematically to find a solution strategy (Brendefur et al., 2016, p. 96).

Induction Coaching. An approach that focused on the improvement and success of teachers by providing ongoing professional development for teachers in areas such as implementing instructional strategies, classroom management, analyzing student work, and differentiated instruction (Thomas, Bell, Spelman, & Briody, 2015, p. 1).

iReady. iReady was a software program that provided reading and math lessons specific to the instructional level of each student. Students took a pretest (AP1) to place them at their “just right” instructional level. Students took a posttest (AP3) at the
conclusion of the academic year to determine proficiency and growth in both reading and math. This program was purchased using money from the district department of elementary education. Student participation was mandated by the both school and district administrators. Students were required to complete forty-five minutes of reading instruction each week and forty-five minutes of math instruction each week, for a total of one and a half hours of time devoted to students using the program during each instructional week.

**Item Specifications.** Specifications for test time writers to meet the test design limits written by representatives of the department of education. The state department of education published a list of item types that were used when state standards assessments were created. Teachers used item specs to match their instructional strategies to testing format. Teachers abbreviated the title and called these documents “item specs” (Citation withheld to preserve the anonymity of the school under study).

**Item Types.** Within the Item Specifications, test writers were given the item types that could appear on a state mathematics standard test. Representatives from the state department of education wrote the item specs to specify which item types could be used with each standard. State department of education representatives wrote the math item specs to allow any item type to be used with any math standard. Item types included equation editor, multi-select, selectable hot text, editing task, and multiple choice. Equation editor or grid response was a grid that students filled in with their solution to a given mathematics problem. Multi-select required students to choose more than one correct answer. Selectable hot text required students to select the best sentence or phrase to complete a mathematical statement. Editing task required students to select the correct
Knowledge. Focused on developing teachers’ understanding and instructional practices (Brendefur et al., 2016, p. 100).

Learning Gains. Figure 2 represented the gain levels. Representatives of the state department of education mandated learning gains methodology provided three ways in which a student could demonstrate that he or she made a learning gain (Citation withheld to preserve the anonymity of the school under study).

**Figure 2.** Learning gains methodology Level 1, 2, and 3.

1. Improve one or more achievement levels from one year to the next (e.g., move from Level 1 to Level 2; Level 2 to Level 4, etc.).

2. Maintain a Level 3, Level 4, or Level 5 from one year to the next and the student’s scores in Level 3 and Level 4 must have improved from one year to the next.

3. Split Levels 1 and 2 into multiple subcategories (Level 1 into thirds and Level 2 in half) and require the student to improve from one subcategory to a higher subcategory within the Level (e.g., move from the bottom third of Level 1 to the middle third of Level 1). Figure 3 provided an example of the cut scores for each level and subcategory.
Figure 3. Learning gains cut off scores sample numbers for levels.

**Math Collaboration.** Grade level teacher planning time devoted to pre-planning for standards-based math instruction using curriculum maps created by district personnel, state item specs, and state math standards.

**Mathematizing.** Activities such as generalizing, justifying, formalizing, and curtailing – included, but were not limited to, developing an abstract algorithm (Brendefur et al., 2016, p. 96).

**Mathematizing Process.** Built the knowledge of teachers and developed their learning path (Brendefur et al., 2016, p. 98).

**Multi-Tiered System of Support (MTSS).** Tier two and tier three instruction provided to students struggling with grade level standards mastery to close the achievement gap.

**Professional Development.** An approach to improve teacher effectiveness to raise student achievement (Hoge, 2016, p. 12). All learning experiences and those conscious and planned activities which were intended to be of direct or indirect benefit to the individual, group or school, which contributed through these, to the quality of education in the classroom (Belay, 2016, p. 219).

**Professional Learning Community.** “A group of committed educators working collaboratively in an ongoing process resulting in better student achievement” (Brown, Horn, & King, 2018, p. 54).
Reflection. “An active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends” (Dewey, 1910, p. 6).


Specialized Content Knowledge. Knowledge particular to teaching (Garet et al., 2016, p. 3).

Teacher agency. The capacity of teachers to act purposefully and constructively to direct their professional growth and contribute to the growth of their colleagues (Calvert, 2016, p. 4).

Tiered Instruction. Tier one (Tier 1) instruction was on-grade level instruction. Tier two (Tier 2) instruction was below grade level instruction. Tier two instruction would be less than a year behind or intervention instruction would have just begun through the staffing process to identify students with learning disabilities. Tier three (Tier 3) instruction was significantly below grade level instruction targeted to meet the needs of students performing over one year below grade level.

Transformative Learning. The process by which adults changed their frame of reference (Calvert, 2016, p. 8).

Vertical Mathematization. When students made representations and strategies objects of mathematical examination therefore taking their mathematics to a higher level (Brendefur et al., 2016, p. 96).

Walk-through. Short visits to classrooms during instruction delivery to maintain a “pulse check” on teachers and students. Observations from walk-throughs were used by
coaches to begin coaching cycle conversations with teachers and to identify best practices to share with others during collaboration. Walk-throughs were extremely informal in nature and there was generally no interaction between those being observed and those doing the observing.

**Research Questions**

The single overarching research question that drove this program evaluation was: Did site-based teacher professional development in mathematics influence positively student achievement?

My primary research questions included:

1. What type of site-based professional development improved teacher instructional practices and student achievement in mathematics?
2. What was the best way to develop effective job-embedded professional learning opportunities for teachers?

My secondary research question was:

a. What professional development elements were necessary for site-based mathematics professional development to be successful?

**Conclusion**

The research I conducted in this program evaluation directly supported the mission and vision statements created by the study school’s district leaders. In my research, I explored areas of teachers’ mathematics professional development that enhanced student performance in mathematics. The surveys and interviews I administered provided insight into the success of professional learning in developing highly-effective educators. The program evaluation I developed allowed me to potentially
identify areas of teacher professional development that needed attention to better support the mission of leaders from the school district’s professional development department and meet the goals of the district’s strategic plan and the study school’s improvement plan. The research I conducted in this program evaluation directly supported the mission and vision statements created by stakeholders of the study school.
Section Two: Review of the Literature

This literary review was my attempt to identify effective site-based mathematical professional development activities and strategies that would enhance teacher content knowledge and pedagogy, thus positively influencing student growth and achievement in elementary school. Accountability regarding the academic achievement of students put teachers in a “prominent position” within the public-school system (Bayar, 2014, p. 319). Successfully developing teachers was vital because they had the greatest impact on influencing student achievement (Bishop, 2016, p. 29). Bishop (2016) said there was a “direct link between teacher learning, improved classroom practices, and the relation of professional development opportunities to policies and professional experiences” (p. 39). Garet et al. (2016) said professional development made a positive impact on teacher knowledge and improved instructional practices (p. 1). Shaha, Glassett, and Ellsworth (2015) said teacher professional development continued to be key and logical within efforts to improve teacher instructional practices and student achievement (p. 29).

Minor, Desimone, Lee, and Hochberg (2016) said a positive relationship existed between teachers’ content knowledge and their depth of understanding (p. 17). Hill, Bicer, and Capraro (2017) said the time teachers actively engaged in professional development opportunities directly correlated to increased student achievement (p. 68). Shaha, Glassett, and Copas (2015b) said the primary purpose of professional learning was to positively impact student learning (p. 163). Brendefur et al. (2016) said students who completed kindergarten with below level mathematics skills would continue to struggle in mathematics throughout their elementary and secondary school years (p. 95). Teachers required professional learning activities to close the achievement gap in mathematics
between students identified as performing below level and students identified as performing at level.

The topics I addressed in this review of the current scholarly professional development literature included reforms to professional learning experiences, the history of professional development, standards for professional development, leadership, resources, data, learning designs, implementation, student curriculum standards, and suggestions for continued research. I accumulated articles for my review of literature primarily through reading other doctoral candidates’ dissertations, academic journal reports, and research articles. My first research strategy was to conduct internet searches of scholarly writings in the National Louis library online, the Elton B. Stephens company host educational database (EBSCO), the Educational Resource Information Center (ERIC), Journal Storage (JSTOR), and Google Scholar databases. To find appropriate scholarly articles, I used a combination of keywords specific to professional development: mathematics, professional learning, coaching, student achievement, student growth, pedagogy, teachers, content, knowledge, strategies, effective, successful, collaboration, standards, elementary schools, teacher in-service, and assessment.

My second research strategy was to read articles referenced in the scholarly articles I found in my initial web searches. Each article I read had twenty or more references and I winnowed through them to identify those specific to my area of focus: what makes mathematics professional development successful. I limited all my selections to research articles published between 2014 and 2019. I, also, referenced literature from my master’s degree and doctoral degree coursework. This literature review evolved
through the terms of my coursework as I refined my research and acquired expert-level knowledge of professional development.

Gersten, Taylor, Keys, Rolhhus, and Newman-Gonchar (2018) said professional development programs had a significant positive effect on teacher knowledge that was sustained through the school year with on-going supports (p. 35). The potential for huge improvement in student achievement was possible when teacher agency was improved in schools and school districts (Calvert, 2016, p. 13). Hoge (2016) said there was a correlation between heightened teacher performance and enhanced student performance; professional development improved teacher knowledge and skills thus improving teaching practices resulting in increased student achievement (p. 38). Minor et al. (2016) said professional development opportunities were most effective when calibrated to the prior knowledge of teachers and what they needed to learn to improve their teaching skills (p. 22). Student achievement cannot improve until we have improved the “skills and abilities of the teachers within” public schools as having high quality instructors was an essential component of a quality educational system (Bayar, 2014, p. 319). In an age when technology has become pervasive in society, teachers have increased their technology knowledge and improved student achievement by using technology in tandem with mathematics curriculum (Hill et al., 2017, p. 68).

**Educational Reform**

Teachers professional development remained an essential component of educational reform. Teachers and coaches needed to be critical purveyors of current educational practices to understand the characteristics of successful professional learning experiences (Bishop, 2016, p. 29). In 2002, federal department of education leaders
created the No Child Left Behind (NCLB) act and set the goal to enhance student learning through increased development of teacher knowledge and qualifications (Bishop, 2016, p. 13). Followed by the creation of the Elementary and Secondary Education Act (ESEA) of 2010, federal department of education leaders focused on creating an accountability system to measure student growth in public schools. Bishop (2016) said successful professional development opportunities correlated to increased teacher knowledge thus teaching practices were improved (p. 29). Federal department of education leaders reauthorized ESEA by creating the Every Student Succeeds Act in 2015 (U.S. Department of Education, 2018). Federal department of education leaders wrote ESSA to require “all students in America be taught to high academic standards that [would] prepare them to succeed in college and careers” (U.S. Department of Education, 2018).

Bishop (2016) said the shift in future professional development practices should include active learning opportunities for teachers (p. 20). The best models for professional learning experiences were “frequent and ongoing professional development… to support teachers in understanding, internalizing, and effectively using curriculum” (Olson, 2018, p. 4). McGatha (2017) said teacher certification should include a mathematics specialists’ endorsement as a collegiate reform measure that would improve the quality of mathematics instruction in elementary schools (p. 68). Brendefur et al. (2016) said “reform rather than the traditional approach” was one of the six characteristics of effective professional learning experiences (p. 100). Taton (2015) said teachers of mathematics needed a different type of professional learning that was content-oriented (p. 49). Teachers of mathematics have faced an extra set of obstacles that have required a unique approach to professional development design (Taton, 2015, p. 51).
Taton (2015) said teachers benefitted more from professional learning opportunities provided throughout the academic year rather than the one-off professional development experiences traditional delivered to instructors (p. 55).

**Traditional Professional Development**

Traditional professional development experiences have been passive activities with teachers required to absorb information provided to them while they sat and listened, with no opportunities provided for hands-on activities or social engagement (Bishop, 2016, p. 29). “The field of teacher education has been contentious since its inception” (Kennedy, 2016, p. 14). Teachers and administrators have perceived professional development opportunities negatively and regarded professional development as special occasions that happened a few times during the academic year and took time away from a teacher’s real job of classroom instruction (Guskey, 2000, p. 14). Calvert (2016) said most of the professional development offered to teachers had been an “empty exercise in compliance” and that those experiences had not met the high expectations for professional development nor achieved a positive impact on improving their subsequent professional practices (p. 2). Historically, professional development occurred in passive, lecture formats of short duration (Bishop, 2016, p. 47). The reality of traditional professional development opportunities was in direct contrast to what the ideal has been for current high-quality professional learning experiences.

The historic “top-down” professional development experiences have been “too isolated from school and classroom realities to have much impact on practice” (Guskey, 2000, p. 3). Traditional professional learning experiences were an opportunity for others to influence teachers with their agenda rather than allowing teachers to take ownership of
their learning goals (Calvert, 2016, p. 8). Professional development workshops have had minimal impact on improving student achievement (Hoge, 2016, p. 37). Taton (2015) said the most common form of professional development was one-time workshops that resulted in minimal improvement for teachers or their students (p. 49). Historically, teacher professional development experiences have lacked coherence, active learning, appropriate duration, and reflective practices (Shaha, Glassett, & Ellsworth, 2015, p. 29).

The traditional “one size fits all” professional development model fell short of meeting the needs of teachers participating in professional development experiences to enhance their classroom instructional skills (Minor et al., 2016, p. 21). Shaha, Glassett, and Ellsworth (2015) said school districts provided teachers with the minimum of 90 minutes of annual professional development (p. 30). Hoge (2016) said there has been minimal change in professional development in several areas: teacher evaluation, pre-service training content, and professional development offerings (p. 42). Guskey (2014) said facilitators have struggled with developing high-quality professional development experiences due to the discouraging findings from educational research (p. 12). Traditional professional development activities lacked “purpose, cohesiveness, and direction” opportunities as teachers planned for “processes, not results” (Guskey, 2014, p. 12). Taton (2015) said traditional professional development opportunities for teachers have not aligned with best practices for learning and teaching content specific knowledge (p. 51). Moreover, teachers became disengaged, passive participants in professional development activities that have not transferred to classroom instruction nor supported student learning (Taton, 2015, p. 51).
Standards for Professional Development

The department of education representatives in the state the study took place in developed a comprehensive list of professional development standards (citation withheld to preserve the anonymity of the school district under study). School level professional development provided to teachers included planning, learning, implementing, and evaluating (citation withheld to preserve the anonymity of the school district under study). Teachers’ school level planning included school needs assessment, reviewing professional development plans, reviewing annual performance appraisal data, generating a school-wide professional development plan, and individual leadership development plans. The school level learning of teachers consisted of learning communities, content focus, learning strategies, sustained professional learning, use of technology, time resources, and coordinated records. School level administrators implemented professional development that encompassed learning, coaching, mentoring, web-based resources, and assistance. School level evaluation by administrators and coaches incorporated implementing the plan, changes in educator practice, changes in students, evaluation measures, and use of results.

Collaboration. An important component of successful professional development has been ongoing teacher collaboration that introduced strategies that supported teacher and student achievement (Bishop, 2016, p. 20; Sutton, 2017, p. iii). Teacher collaboration through professional learning activities potentially improved teacher confidence in their instructional practices and their abilities to increase student achievement; furthermore, teachers’ willingness to try new things increased their influence as a change agent within their schools (Bishop, 2016, p. 34). Belay (2016) said teachers’ professional development
through collaborative learning had a greater probability to result in improved student achievement (p. 223). Within a constructivist exchange, the collaboration process of instructors empowered teachers to identify professional development topics using data to support the needs of teachers and students (Calvert, 2016, p. 5). Sutton (2017) said school administrators needed to prioritize the development of an effective system of teacher collaboration (p. 192).

The more teachers applied and refined their learning within “collective activities” the quicker the “culture of continuous improvement” grew (Crow, 2015, p. 16). Olson (2018) said collaboration had a determining factor in schools that displayed improvements in student learning (p. 3). Collaboration allowed teachers to generate questions that enhanced the rigor of classroom discussions while differentiating instruction (Olson, 2018, p. 11). Gersten et al. (2018) said strategically planning 35% of professional development time for collaboration, was a minimum for effective professional learning outcomes (p. 27). Belay (2016) said “creating a collaborative professional learning environment for teachers [was] the single most important factor for successful school improvement and the first order of business for those seeking to enhance the effectiveness of teaching and learning” (p. 223).

**Peer Support.** When teachers were a part of groups of their choosing there were positive peer effects, increased motivation, and teachers were encouraged to engage to a greater degree than without peer support (Calvert, 2016, p. 11). Teachers’ confidence matured and developed through peer support (Bishop, 2016, p. 31). Clarke and Clarke (2018) said teachers needed the chance to receive ongoing support from peers and critical friends (p. 2). Students and educators worked to reach high learning expectations through
sharing with and receiving support from others as part of the continuous improvement model and collective responsibility (Calvert, 2016, p. 8). Teachers shared professional practice through peer coaching opportunities as part their professional development (Brown et al., 2018, p. 54).

**Professional Learning Communities.** The historical structure of schools has been a barrier to the creation of professional learning communities (PLCs); a fundamental shift of infrastructure was needed to develop successful PLCs (Bishop, 2016, p. 35). “Professional learning communities were originally conceived as structured time for classroom teachers to work collaboratively to develop their practice and share their wisdom” (Buttram & Farley-Ripple, 2009, p. 192). Creating life-long learners remained the goal of PLCs regarding both student and teacher learning (Bishop, 2016, p. 35). “PLCs [were] a framework for school staff to work together in order to achieve continuous school improvement” through enhanced teaching practices that ultimately led to heightened student learning (Bishop, 2016, p. 36).

PLCs assisted teachers in the acquisition of new insights and teachers participated in engaging discussions regarding teaching practices, data, and student achievement (Kennedy, 2016, p. 19). PLCs were key to developing curriculum and meeting the needs of students by supporting teachers as they planned, executed, observed theirs and others, reflected upon, and revised effective lessons together with peers (Olson, 2018, p. 4). PLCs provided the opportunity for careful decisions that potentially enhanced classroom learning through coherence (Olson, 2018, p. 4). Brown et al. (2018) said PLCs emphasized learning rather than teaching by focusing on accountability and collaboration.
that led to school improvement, including how to respond when students do not learn (p. 54).

**Team-based Learning Communities.** Teacher professional development should “focus on team-based, collaborative learning” (Olson, 2018, p. 3). Olson (2018) said learning teams were exemplars of Every Student Succeeds Act (ESSA) definition of professional development being “sustained, intensive, job-embedded, classroom-focused, and data driven” (p. 4). Improved student achievement was a bi-product of team-based collaborative professional development experiences that focused on coherent instruction (Olson, 2018, p. 15). Crow (2017) said “professional learning that increases educator effectiveness and results for all students occurs within learning communities committed to continuous improvement, collective responsibility, and goal alignment” (p. 8).

**Leadership**

**Academic Coaches.** For over thirty-five years, “the mathematics educational community has recognized a need for” elementary level mathematics specialists (McGatha, 2017, p. 70). Bishop (2016) said an essential component of professional development was job-embedded coaching (p. 33). Academic coaches provided “ongoing, job-embedded professional learning for teachers focused on curriculum” (Olson, 2018, p. 10). Hoge (2016) said when teachers worked with specialists, the potential of their professional learning experiences was enhanced (p. 18). Coaching remained an effective means to gain teacher participation in productive discussions regarding teaching (Kennedy, 2016, p. 19). “Coaching can be perceived as a mysterious process, but in fact it requires intention, a plan, and a lot of practice; it requires a knowledge of adult learning theory and an understanding of systems and communication” (Aguilar, 2013, p. xii).
Coaches helped teachers acquire insight into their own teaching practices (Kennedy, 2016, p. 25). McGatha (2017) said there were “eight domains of mathematics coaching knowledge:” teacher practice, teacher development, teacher learning, communication, assessment, relationships, leadership, and student learning (p. 75).

Teachers learned best when coaches listened for understanding, asked relevant questions, and remained nonjudgmental during partner conversations (Thomas et al., 2015, p. 2). Instructional coaches remained “skilled communicators and act in ways that exemplify their professionalism” (Thomas et al., 2015, p. 6).

Using a co-teaching model, coaches supported the transfer of strategies between content areas (Olson, 2018, p. 5). Effective coaches provided collaborative professional development with teachers that included lesson planning and modeling strategic planning (Kennedy, 2016, p. 28). Pemberton et al. said coaching that was available regularly, within a job-embedded structure, was the most beneficial to teachers (2016, p. 3). Pemberton et al. (2016) said substantive coaching had a powerful impact on teacher practices and student achievement (p. 3). Bambrick-Santoyo (2016) said it was vital for teachers to be trained to ensure their success now and in the future (p. 25-26).

Coaching remained the “preferred professional development strategy to improve the teaching and learning of mathematics” in elementary schools (McGatha, 2017, p. 71). Hill et al. (2017) said coaching provided teachers with ongoing training targeted toward identified instructional areas thus teaching was improved, and gains were made in students’ mathematics achievement (p. 68). Coaching was used to identify and provide teacher professional development opportunities that improved deficiencies in instructional practices (Hill et al., 2017, p. 72). Thomas et al. (2015) said coaching
combined with follow-up to professional development was effective in improving teaching practices (p. 1). St. Clair (2019) said instructional coaches were the “missing link between the old way of teaching and the learning of new, desperately needed way” (p. 15).

**Educational Governance.** Representatives of the federal department of education identified the Theory of Education as an instrument to enhance the education system by developing connections between pedagogy, law, and theory (Smith, 2015, p. 14). Representatives of the federal department of education established policies and laws regarding education which required high quality, evidence-based professional development for teachers (Bishop, 2016, p. 12). Previously, the developers of NCLB created a national goal to extend teacher knowledge and qualifications in order to boost student learning (Bishop, 2016, p. 13). Currently, ESSA legislation created by federal department of education representatives mandated effective professional development opportunities for teachers to close the student achievement gap between the United States and other nations (Olson, 2018, p. 4).

**School Administrators.** Site-based administrators were responsible for ensuring that professional development provided at their schools was relevant and appropriate, of high quality, and ultimately increased student achievement (Bishop, 2016, p. 30). Crow (2017) said “professional learning that increases educator effectiveness and results for all students requires skillful leaders who develop capacity, advocate, and create support systems for professional learning” (p. 9). Clarke and Clarke (2018) said the support of school administration remained necessary for the long-term professional growth of teachers (p. 2). Teacher agency provided school leaders with strategies to improve both
teacher and student learning opportunities (Calvert, 2016, p. 6). Principals who understood teacher agency were able to correct the professional development issues of their school’s instructional staff (Calvert, 2016, p. 13).

Calvert (2016) said “a lot of principals have never had good professional learning, so they [do not] know how to help teachers to get it” (p. 13). School administrators must be required to be “reflective practitioners” while developing the professional development section of their school’s improvement plans (Smith, 2015, p. 107). Guskey (2014) said “many valuable improvement efforts fail miserably because of a lack of active participation and clear support from school leaders” (p. 15). Brown et al. (2018) said principals were critical in “communicating key reform initiatives because most teachers do not have direct access to such initiatives” (p. 57).

**Resources**

Crow (2017) said “professional learning that increases educator effectiveness and results for all students requires prioritizing, monitoring, and coordinating resources for educator learning” (p. 10). Guskey (2014) said “even the best professional learning experiences have been ineffective if teachers don’t have the time, funding, instructional materials, or necessary technology to use their new knowledge and skills” (p. 15). For teacher mathematics professional development to be successful, resources needed to be put in place by school and district leaders.

**Money.** Federal, state, and local educational department representatives provided funding for professional development in order to improve student achievement through improved teaching practices (Bishop, 2016, p. 12). In 2014, federal department of education representatives used the Eisenhower Program to budget approximately $2.3
billion for professional development in United States’ schools (Loveless, 2014, p. 1). Instructional coaches represented the greatest funding allocation in professional development in the last three decades (Pemberton et al., 2016, p. 5). Future professional development opportunities continued to be measured by student growth on standardized assessments to determine if time and monies devoted to improving teacher practices were influencing student achievement. (Smith, 2015, p. 9). Professional learning opportunities were not considered investments in teachers nor students until quantifiable positive proof of increased teacher and student efficacy were observed by educational leaders at all levels of public education (Shaha, Glassett, & Ellsworth, 2015, p. 32).

Shaha, Glassett, and Copas (2015b) said “decisions regarding PD expenditures and participation [remained] based primarily on marketing and reputation, and not on statistically rigorous, data-rich studies” (p. 164). Shaha, Glassett, and Copas (2015b) said professional development program designs needed to be strenuously evaluated and accountability increased so that a return on investment was ensured (p. 164). Taton (2015) said budgets for teachers’ professional development opportunities decreased limiting the potential for improving teacher practices and student performance (p. 52). “In the absence of proof, money used represents only an expenditure or an outlay without substantive evidence of impact” (Shaha, Glassett, & Ellsworth., 2015, p. 32). Blazer (2015) said “improving the quality of the teacher workforce [was] seen as an economic imperative” (p. 17).

**Duration.** Bishop (2016) said an inadequate number of professional development hours was a key reason for inadequate opportunities for teachers to engage in professional learning experiences (p. 13). Taton (2015) said teachers received less than
16 hours of content specific professional learning opportunities annually (p. 49). In-depth teacher discussions regarding content, teacher strategies, and student strengths and weaknesses were generated as a direct result of sustained professional development opportunities over time (Bishop, 2016, p. 14). Crow (2015) said “leaders in schools and districts have a responsibility not only to give sufficient time for learning but also to facilitate a plan for using that time well” (p. 27).

Teachers needed enough time and exposure to professional development to use curriculum effectively (Olson, 2018, p. 3). School administrators needed to allow time for planning and reflection to develop long-term professional growth of teachers (Clarke & Clarke, 2018, p. 2). Brendefur et al. (2016) said adequate duration was a vital component of effective professional development opportunities (p. 100). Successful sustained change in teacher practices required three to five years of contact hours, including professional development opportunities (Bishop, 2016, p. 37-38). Sutton (2017) said “the opportunity for classroom teachers to have time built into the school day to collaborate with a focus on teaching and learning [was] critically important to the transformation of mathematics instructional practices” (p. 191).

A correlation was shown to exist between the positive effect on student achievement and teachers’ active engagement in more than 14 hours of professional development experiences (Bishop, 2016, p. 39). Hoge (2016) said teachers who participated in professional development for an average of 49 hours boosted student achievement by 21% points (p. 39). Brendefur et al. (2016) said administrators and instructional staff needed to commit to 45 hours of intensive mathematics focused professional development annually (p. 100). Taton (2015) said teachers needed 50 or
more hours of content oriented professional learning experiences annually (p. 49).

Stakeholders needed to commit time and effort to fill all elementary classrooms with teachers who were skilled in mathematics practices to engage in successful mathematics instruction (Blazer, 2015, p. 27). Regularly scheduled meetings “build continuity and maintain momentum” within instructional staff (McGatha, 2017, p. 74). Taton (2015) said teaches’ available time for participating in professional learning experiences decreased at the expense of student achievement (p. 52).

Data

Student Data. The goal of teacher professional development remained to increase student achievement (Bishop, 2016, p. 30). Effective teacher professional development assisted teachers in furthering their understanding of how students learn content (Bishop, 2016, p. 31). Teacher professional development opportunities directly impacted student learning while scaffolding teachers in meeting the complex developmental needs of students (Smith, 2015, p. 8). Stakeholders used student data to develop effective teacher professional development opportunities focused on continuous student growth (Calvert, 2016, p. 5). Teachers needed to “foster students’ autonomy” while implementing Science, Technology, Engineering, and Mathematics (STEM) programs using higher-order thinking strategies (Cavedon, 2014, p. 1; Marquis, 2015, p. 1). Crow (2017) said “professional learning that increases educator effectiveness and results for all students aligns its outcomes with educator performance and student curriculum standards” (p. 14).

Teachers who participated in “rich, creative learning experiences that lead to mastery” were more likely to engage their students in similar learning opportunities
Teachers accessed data from formal assessments, but the “most useful knowledge for teachers is the knowledge they have in the moment, for this knowledge can guide their actions in the moment” (Kennedy, 2016, p. 10). Olson (2018) said using a data room to display school measures for analysis while cultivating strategic professional development supported student achievement (p. 6). Kennedy (2016) said a barrier to student learning was their teacher’s inability to transfer content in understandable ways to “naïve thinkers” (p. 20). Furthermore, teachers needed to develop the abilities to motivate students to participate in lessons, minimize off-task student behaviors to maximize instruction, and gain an understanding of individual students’ ways of thinking to adjust lessons (Kennedy, 2016, p. 10).

When teachers informed students of their progress toward a specific goal, teachers increased students’ achievement by scaffolding student learning (Bishop, 2016, p. 15). Guided by Vygotsky’s social development theory and the subsequent theory of constructivism, Smith (2015) said academic stakeholders needed to design instruction that was student-centered with educational activities that engaged students in the learning of new concepts (p. 11). Teacher’s role shifted from instructor to facilitator as students took ownership of and responsibility for their own learning (Smith, 2015, p. 13). As stakeholders created rigorous educational policy to develop college and career ready students, teachers needed instruction in new skills to meet the needs of 21st century students (Cavedon, 2014, p. 1). Teachers had a profound impact on the academic and lifelong learning of students (Blazer, 2015, p. 16). Crow (2017) said “professional learning that increases educator effectiveness and results for all students uses a variety of sources and types of student, educator, and system data to plan, assess, and evaluate professional
Teacher Data. Stakeholders knowledge of andragogy, the way that adults learn, was essential when developing professional learning opportunities for teachers (Bishop, 2016, p. 21; Calvert, 2016, p. 5). Knowles’s adult learning theory identified five principals to use when planning professional development: self-concept, adult learner experience, readiness to learn, orientation to learning, and motivation to learn (Bishop, 2016, p. 21). Bishop (2016) said Knowle’s theoretical framework was a primary component to develop concrete experiences that included support and feedback (p. 22). For teachers to engage in transformative learning it remained essential for their professional development experiences to be different in form and function from the educational developmental norms of children (Calvert, 2016, p. 8).

Teachers’ professional development experiences were developed to support learners’ needs and produced positive learner outcomes (Bishop, 2016, p. 47). Bishop (2016) said long-term study groups changed the teaching practices of 70% of teachers surveyed; 48% of those same teachers changed their assessment methods because of collaboration (p. 34-35). Of teachers who participated in workshops with a length of more than two days, 61.1% reported they changed their planning strategies, while 52.8% reported they changed their teaching style (Bishop, 2016, p. 38). Student achievement went up almost 21% when instructed by teachers who actively engaged in 49 hours of professional development (Bishop, 2016, p. 39).

Learning Designs

Crow (2017) said “professional learning that increases educator effectiveness and results for all students integrates theories, research, and models of human learning to
achieve its intended outcomes” (p. 11). In addition, “professional development has been shown to be less effective when it [was] removed from teachers’ classrooms and not directly related to the issues they face every day” (Mudzimiri, Burroughs, Luebeck, Sutton, & Yopp, 2014, p. 30). Teacher mathematics professional development opportunities needed to be designed to meet the learning styles and learning needs of all instructional personnel, para-professionals, and administrators at the study school.

**Active Learning.** For teachers to be able to analyze and share how professional development opportunities affect their classroom practices, it was essential for teachers to be actively involved in the construction of professional development experiences that met their professional needs (Bishop, 2016, p. 31). Active learning that allowed teachers to observe others, provided feedback to and received feedback from peers, and analyzed the work of students promoted successful professional development; as opposed to the passive professional development sessions traditionally offered to teachers (Bishop, 2016, p. 20). Hands-on activities had a greater potential to enrich teachers’ knowledge and skills when included in professional development opportunities (Bishop, 2016, p. 32; Clarke & Clarke, 2018, p. 2).

Hoge (2016) said active engagement in relevant discussions, practice, and planning was a key component of effective professional development (p. 36). Reform-oriented professional development opportunities allowed teachers to be active participants in developing their own schema to improve their instructional practices (Smith, 2015, p. 94). Bayar (2014) said teachers needed opportunities to be active participants in their professional learning (p. 319). Brendefur et al. (2016) said active learning by participants was a necessary characteristic of effective professional
development (p. 100).

**Agency.** Teachers with agency were active participants in their own professional learning experiences, they made choices to drive their own professional growth; they resisted traditional passive professional development opportunities (Calvert, 2016, p. 4). Belay (2016) said teachers’ lack of motivation inhibited professional development opportunities for teachers (p. 224). Calvert (2016) said teachers with agency had “internal motivation to master one’s craft, to be accomplished, to prepare students for the future”; they were “planners, designers, advisors, presenters, implementers, evaluators, and decision makers” in the professional development process (p. 5). If teachers did not think that a professional development opportunity was beneficial to them or the presentation format was not engaging, then teachers felt that their time was wasted and that they were not respected as professionals.

If professional learning activities did not enhance teachers’ knowledge or skills, then professional development experiences were not effective in producing highly-effective teachers (Calvert, 2016, p. 7). Bayar (2014) said effective professional development activities provided an opportunity for teachers to be involved in planning and designing learning experiences that met their professional growth needs (p. 319). Thomas et al. (2015) said when teachers were included in their professional development as partners they were more actively engaged, retained more, and implemented what they learned (p. 1). “Agency [was] not a panacea, but one of the many important elements in creating professional learning that works” (Calvert, 2016, p. 20).

**Coherence.** Teachers professional development that included coherent programs built upon teachers’ prior knowledge paved the way for future opportunities that
enhanced teachers’ knowledge and skills (Bishop, 2016, p. 21). Blazer (2015) said professional development experiences engaged “teachers substantively around their own teaching practices” and improved teach instruction (p. 27). Teachers found coherent programs were more valuable and were more likely to have a positive impact adding strategies to teachers’ current practices (Bishop, 2016, p. 20). A focus on knowledge and skills in isolation did not produce as impactful an experience to teaching practice as coherence (Bishop, 2016, p. 40). Crow (2017) said “professional learning that increases educator effectiveness and results for all students applies research on change and sustains support for implementation of professional learning for long-term changes” (p. 13).

Teachers reported improvement in their knowledge and skills as a direct result of professional development which integrated coherence with other learning activities (Hoge, 2016, p. 36). Teachers coherent evolution of mathematical ideas promoted teachers’ learning of mathematics concepts (Garet et al., 2016, p. 3). Teachers professional development experiences needed to match the existing needs of students, administrators, teachers, and school communities (Bayar, 2014, p. 319). Brendefur et al. (2016) said coherence was a vital component of successful professional learning experiences (p. 100).

Content Knowledge. A vital part of effective teachers’ professional development was enhancing teachers’ content knowledge (Bishop, 2016, p. 30; Kennedy, 2016, p. 27). Teachers needed the required knowledge and skills in order to improve their teaching strategies (Bishop, 2016, p. 14). Opportunities to learn new strategies were essential to teachers in order to maintain the accountability of higher expectations (Bishop, 2016, p. 18). Garet et al. (2016) said there were three necessary areas of content knowledge for
improving mathematics knowledge: horizontal knowledge, common content knowledge, and specialized content knowledge (p. 3). Teachers with heightened knowledge levels transferred their knowledge into practice more aptly, than teachers with lowered levels of content knowledge (Gersten et al., 2016, p. 40).

Teachers reported improvement in their knowledge and skills as a direct result of professional development focused on content knowledge (Hoge, 2016, p. 36). Minor et al. (2016) said within professional development there was the potential to build teacher confidence while filling teachers’ gaps in content knowledge (p. 15). Teacher professional development increased teacher-efficacy and content knowledge and potentially started to close the achievement gap through increased student performance (Smith, 2015, p. 27). Blazer (2015) said a teacher’s ability to teach mathematics correlated to their knowledge of content in mathematics (p. 22). Belay (2016) said when teachers improved their subject-matter knowledge students were more engaged and developed higher-order thinking skills (p. 219).

Brendefur et al. (2016) said it was imperative that teachers questioned their knowledge of mathematics to improve their instructional practices (p. 98). More effective teacher instructional practices were evidenced by teachers with increased content knowledge (Brendefur et al., 2016, p. 101). Guskey (2014) said coherence, collaboration, inquiry-based learning approach, and a focus on content were required components of effective professional learning designs (p. 12). Dixon et al. (2014) said teachers were not comfortable with their own content area knowledge and as a result were unable to make necessary adjustments during the delivery of their lessons that would have met the needs of their students (p. 115). Taton (2015) said teachers of mathematics needed to know far
more mathematics than they would teach, but often their content knowledge was superficial or incomplete (p. 51).

**Differentiation.** Teachers participated in professional development activities based on their personal experiences, interests, preferences, and history (Bishop, 2016, p. 12). An essential component of teacher professional development remained the assessment of the needs of each teacher in order to tailor teachers’ professional learning experiences that were relevant; teacher professional development that has been proven successful does not guarantee it was necessary (Bishop, 2016, p. 20). New teachers and experienced teachers had different professional development needs and their professional development opportunities needed to reflect the changes that happened as teachers evolved (Bishop, 2016, p. 48; Calvert, 2016, p. 5). Bishop (2016) said “teachers must participate in professional development that specifically addresses their needs and deficit areas” (p. 43).

Teacher professional development experiences required differentiation based on the needs of school and district leaders (Bishop, 2016, p. 45). Minor et al.’s (2016) said teachers needed differentiated professional development to internalize learning experiences based on teachers’ prior knowledge and motivation to hone teachers’ instructional skills (p. 21-22). Differentiated teacher instruction was a direct result of professional development PLCs (Olson, 2018, p. 11). Teachers professional development needed to be differentiated to meet the needs of teachers and school leaders (Bayar, 2014, p. 319). Dixon et al. (2014) said when teachers received professional development in differentiation, teachers better differentiated their own instruction (p. 123).

**Job-embedded.** Teacher professional development was a vital part of the daily
lives of teachers (Bishop, 2016, p. 29). Representatives from both the U.S. Department of Education and the National Staff Development Council extolled job-embedded teacher professional development activities as a prerequisite component of effective teaching (Bishop, 2016, p. 33). Research-based teaching strategies were successfully integrated into classroom instruction as a result of job-embedded teacher professional development experiences (Bishop, 2016, p. 33). Calvert (2016) said there was a need to provide professional development experiences that promoted a growth mind set during school hours (p. 11).

Job-embedded teacher professional development needed to support the curriculum used in teachers’ classrooms (Olson, 2018, p. 3). Olson (2018) said using learning walks needed to be a part of job-embedded professional development that assessed the effectiveness of PLCs in a non-evaluative format (p. 5). Rather than teachers believing that teacher professional learning experiences were a “one and done style of implementation,” teacher professional development should be ongoing and job-embedded with opportunities for teachers to practice new skills and strategies (Smith, 2017, p. 94). Brendefur et al. (2016) said explicit, embedded teacher professional learning opportunities helped teachers develop their instructional practices (p. 98).

**Observation.** Being observed and observing others was a vital part of active learning for teachers (Bishop, 2016, p. 31). Blazer (2015) said there was a positive effect on teacher behaviors and student outcomes after initiating observation measures within a coaching program (p. 27). Teachers’ confidence was increased through the observation process (Bishop, 2016, p. 31). Teacher observation was a form of data used to increase teacher agency and focused teacher professional development on the strengths and
weaknesses of teachers as change agents (Calvert, 2016, p. 5). Shaha, Glasset, and Copas (2015a) said observations were a form of professional development that school administrators invested in that has shown to positively affect student achievement (p. 55). Teachers who were observed more often, in conjunction with continued teacher professional development activities, had greater gains in student performance than teachers who were not observed (Shaha, Glassett, & Copas, 2015a, p. 60).

Systematic teacher observations by administrators and coaches synced with purposeful teacher professional learning experiences resulted in increased achievement for students taking standardized assessments in mathematics (Shaha, Glassett, & Copas, 2015a, p. 55). Gersten et al. (2018) said teacher observations that lasted for 10 minutes and provided the teachers under observation with qualitative data focused on one area of strength and two areas of improvement were beneficial to teachers (p. 25). An analytical framework found a relationship between observed teacher classroom practices and student achievement gains (Hoge, 2016, p. 48). Brown et al. (2018) said teacher classroom observations prioritized professional advancement of teachers and provided positive student learning experiences and outcomes (p. 54). Shaha, Glassett, and Copas (2015a) said teacher observations were goal oriented and were used to identify the strengths and weaknesses of instructional staff so teacher professional development could focus on improving teachers’ performance and skills (p. 56).

Pedagogy. Improvement in teachers’ content knowledge and pedagogical skills were often associated with successful teacher professional development opportunities (Bishop, 2016, p. 30). Teacher pedagogy was enhanced when teachers were empowered through agency to learn how students understand (Calvert, 2016, p. 9). Garet et al. (2016)
said there were three areas of pedagogy that contributed to improved student achievement: knowledge of typical student misconceptions and errors, knowledge of examples and concrete materials to support students’ learning, and knowledge of materials specific to instruction (p. 3). The quality education of students was dependent upon improved content knowledge and pedagogy of teachers (Belay, 2016, p. 218). “Effective teaching [required] understanding of what to do, how to do it, when to do it, and why to do it” (Hoge, 2016, p. 30).

Smith (2015) said there was a need for revised teacher professional development specific to classroom pedagogy (p. 5). Student-centered activities that supported standards-based pedagogy specific to mathematics problem solving and depth of understanding were a key component of reform-oriented teacher professional development (Smith, 2015, p. 24). Enhanced student learning was an outcome of teacher professional development focused on pedagogy (Smith, 2015, p. 33). Hill et al. (2017) said developing teachers’ “pedagogical skills of a specific content” had a positive impact on their teaching practices (p. 68). Brendefur et al. (2016) said there were five components to develop mathematical thinking that should be incorporated into mathematics planning and instruction: “take students’ ideas seriously, press students conceptually, encourage multiple strategies or models, focus on the structure of the mathematics, and address misconceptions” (p. 97). Dixon et al. (2014) said teachers transformed their content specific knowledge into “pedagogically powerful” instructional practices that met the needs of their students’ abilities and background knowledge (p. 123).

Reflection. To optimize adult learning associated with professional development,
teachers needed to become critically reflective through discourse without coercion (Calvert, 2016, p. 8). Teachers’ reflective self-assessment needed to drive their professional development experiences (Hoge, 2016, p. 36). Teachers’ reflection was a critical component of school leaders’ analysis of teacher professional development needs and the successful implementation of teacher professional learning experiences (Smith, 2015, p. 104). Teachers developed reflective practices through less-directive teacher professional development experiences (McGatha, 2017, p. 74). Belay (2016) said teachers introduced to reflective practices improved their instructional skills as they studied themselves (p. 220). Mezirow (1991) said “reflection is the central dynamic in intentional learning” (p. 99).

**Self-efficacy.** Piaget’s constructivist theory established a framework for designing teacher professional development built upon teachers’ experiences and beliefs to increase their knowledge and skills (Calvert, 2016, p. 8). It remained vital for teachers to direct their own learning (Bishop, 2016, p. 21). Clarke and Clarke (2018) said teachers needed a degree of choice in their professional development options (p. 2). Teachers desired to be treated like professionals, and as such wanted to drive their own professional development opportunities as an extension of the reflective practices that provided invaluable insight into their professional growth (Calvert, 2016, p. 3). Thomas, Jong, Fisher, and Schack (2017) said adult learners desired to be involved in their learning process (p. 2). Belay (2016) said when teachers participated in effective professional learning activities, teachers developed a greater responsibility for the learning of their students (p. 223).

Effective teachers were motivated to scaffold students to be academically
successful (Hoge, 2016, p. 29). Kennedy (2016) said motivation was a vital component of teachers acquiring new knowledge and developing new skills (p. 29). Minor et al. (2016) said developing teacher professional learning opportunities aligned to specific knowledge and needs of teachers was beneficial (p. 21). Teacher self-efficacy enhanced teachers’ abilities to effectively and successfully transfer their content knowledge to their students, thus enhancing teachers’ instructional strategies and culminating in greater student engagement (Smith, 2015, p. 27). Dixon et al. (2014) said “a greater number of professional development hours in differentiation of instruction was positively associated with both teacher efficacy and the teacher’s sense of efficacy beliefs” (p. 111).

**Implementation**

Teacher professional development that expanded educators’ abilities to be effective and improved student results “applies research on change and sustains support for implementation of professional learning for long-term change” (Crow, 2017, p. 2). France (2019) said “educators deserve professional learning tailored to their needs” (1). Teacher mathematics professional development should be “meaningful and relevant” to instructional personnel and meet the individual needs of teachers as they develop “a collective consciousness of professional learning” (France, 2019, p. 2).

**Feedback.** Teaching continued to be an isolated profession; when teachers worked in isolation, they missed the vital feedback process (Bishop, 2016, p. 34). Teachers who received feedback had an essential component to improve upon regarding their teaching skills and strategies of instruction (Bishop, 2016, p. 36; Garet et al., 2016, p. 4). Bishop (2016) said feedback was the “most powerful modification that increases achievement” (p. 15). Teachers’ confidence increased when they were provided with
feedback through established feedback loops (Bishop, 2016, p. 31; Calvert, 2016, p. 5). Shaha, Glassett, and Copas (2015a) said feedback to teachers identified areas for professional improvement and resulted in positive student impact (p. 56).

Teachers’ understanding of content increased when they received feedback on teaching strategies (Bishop, 2016, p. 32). During teacher observations, effective feedback was specific to the focus of the lesson to avoid misconceptions and the perception of wasting of teachers’ valuable time (Smith, 2015, p. 86). Thomas et al. (2015) said constructive feedback supported actively engaged teachers in improving their instructional practices (p. 1). Guskey (2014) said feedback provided to teachers on their efforts after professional development was vital but was often lacking (p. 15). Bambrick-Santoyo (2016) said feedback made all the difference and changed outcomes in teacher instruction and by extension student achievement (p. 142).

**Follow-up.** Kennedy (2016) said effective teacher professional development needed to continue throughout the entire school year to maintain the cohesiveness of the professional development and student learning (p. 7). Teachers’ instructional practices evolved through day-to-day support from school-based staff during the academic year (Smith, 2015, p. 1). Ongoing teacher professional development implemented at the classroom level was an essential component of teacher professional development (Smith, 2015, p. 5). Bayar (2014) said effective teacher professional development provided “long-term engagement” for teachers (p. 319). Brendefur et al. (2016) said successful teacher professional development included “ongoing or embedded follow-up” (p. 100).

**Research on Change and Sustained Support.** Teacher effectiveness had the greatest effect on student learning (Hoge, 2016, p. 25). Blazer’s (2015) said “inquiry-
oriented instruction [was] positively related to student outcomes on a low-stakes math test,” and supported reform to “refocus mathematics instruction toward inquiry and concept-based teaching” (p. 27). Less-directive teacher professional development was “more powerful in supporting teachers in changing their instructional practice” (McGatha, 2017, p. 74).

**Student Curriculum Standards**

Blazer (2015) said a correlation existed between the mathematics achievement of students’ and the instructional dimensions of teachers’ classroom instruction (p. 27). Clarke and Clarke (2018) said when teachers focused on children’s mathematical thinking, teachers improved their mathematical knowledge (p. 3). “More rigorous standards and a shift in educational expectations” have required teachers to develop “a deeper understanding of the subject matter as well as the ways in which students learn the information” (Bishop, 2016, p. 19). Bishop also said, “Job-embedded [teacher] professional learning experiences [facilitated] the instruction of educational standards, as required by both local and state agencies” (p. 33). If math content area specialists aligned teacher professional development activities with the objectives of state and district leaders a coherence would be created making the teacher professional learning experiences more valuable to teachers and would create coherence between state and district leaders’ expectations and students’ output (Bishop, 2016, p. 39).

Brendefur et al. (2016) said students learned best when teachers used both horizontal and vertical mathematization that addressed misconceptions and developed higher-order thinking skills (p. 96). Hoge (2016) said teacher professional development enhanced teacher practices and developed curriculum that was anticipatory to creating
standards-based instruction, a vital component to improved student performance (p. 37). National Council of Teachers of Mathematics (NCTM) representatives said teacher professional development targeted on standards-based strategies and focused on developing a conceptual understanding in mathematics was the most beneficial to teachers and students (Smith, 2015, p. 24). Teachers’ instruction focused on content standards had the potential to close the achievement gap between proficient and nonproficient as related to student performance in mathematics (Smith, 2015, p. 27).

**Recommendations for Future Research**

Bishop (2016) said further research to guide the development of evidence-based, high quality, effective professional development was necessary to meet the needs of all stakeholders (p. 49). Student achievement remained “virtually unstudied” and there has been an “unfortunate and unjustifiable lack of scientifically-based research” to quantifiably demonstrate student achievement resulted from teachers’ professional development experiences (Shaha, Glassett, & Ellsworth, 2015, p. 29). Gersten et al. (2018) said future researchers needed to find the knowledge and teacher practices that correlated to gains in student achievement (p. 45). Cavedon (2014) said continued research to isolate the characteristics of reflective teacher professional development that enhanced the instructional practices of teachers and created high-quality classroom instruction (p. 120). Though teachers reported gains in student achievement in mathematics, McGatha (2017) said more research was needed, especially regarding mathematics specialists (p. 74). Shaha, Glassett, and Copas (2015b) said additional research was necessary to prove quantitatively that there was a correlation between student achievement and teachers’ participation in professional learning opportunities (p.
Guskey (2014) said “the research community has failed to offer useful guidelines for best practices that would help improve the quality and effectiveness of professional learning activities” (p. 12).

Kennedy (2016) said future researchers needed to find a connection between teacher professional development models and research designs to theories of motivation and teacher learning (p. 30). Minor et al. (2016) said exploring the relationship between what instructional staff learned in teacher professional development and their content knowledge was vital to the development of teacher professional development and increased student achievement through improved teacher instruction (p. 10). Shaha, Glassett, and Copas (2015a) said “little quantitative evidence” existed to link teacher professional development experiences and observation-based feedback with an improvement in teachers’ abilities and student achievement (p. 56). Shaha, Glassett, and Copas (2015a) said online teacher professional learning opportunities needed to be aligned with observed needs in teacher instructional practices because student gains were verified as a result of online, on-demand teacher professional development (p. 60). Olson (2018) said school leaders needed to create teacher professional development opportunities that supported curriculum implementation for teachers (p. 19). Bayar (2014) said effective teacher professional development needed to consist of six components: 1) high-quality instructors, 2) long-term engagement, 3) match to existing teacher needs, 4) match to existing school needs, 5) provide active participation opportunities, and 6) allow teacher involvement in the planning and designing of professional learning activities (p. 324-325).
Conclusion

In conclusion, my synthesis of this literature review identified trends in academic literature pertaining to teacher professional development in education: reform, traditional approaches, standards for professional development, outcomes, and suggestions for future research. Brendefur et al. (2016) said teacher professional development was the instrument that provided elementary schools with the desperately needed changes in mathematics instruction (p. 95). Smith (2015) said reform in teacher professional development gave teachers ownership of their learning through teacher-selected professional development which benefitted teachers and students (p. 98). Belay (2016) said Continuous Professional Development (CPD) provided teachers with the resources to improve students’ academic achievement (p. 221). Shaha, Glassett, and Ellsworth (2015) said the students, of teachers who participated in long-term on-demand professional development, increased students’ proficiency levels from proficient to advanced after two to three years (p. 31).

Within the literature I reviewed, there was a consensus that the traditional “sit and get” model of teacher professional development was ineffective for all stakeholders. As teachers were required to meet the needs of 21st century students, so too teacher professional development facilitators needed to adjust their techniques to meet the needs of a new generation of teachers even as teachers took ownership of their own professional growth and learning. Hill et al. (2017) said the mathematics scores of students increased in correspondence to the number of hours teachers participated in professional development (p. 72). Saylor and Johnson (2014) said “content focus, active learning, coherence, duration, and collective participation” were the essential components needed
for successful teacher professional learning experiences (p. 30). Shaha, Glassett, and Ellsworth (2015) said student gains were significantly increased when teachers committed to long-term professional learning, with longer duration correlated to greater sustained growth in student learning (p. 31).

Though there was no consensus regarding the data, all the authors agreed teacher professional learning experiences impacted teachers and students. Using the standards for professional development, teacher learning experiences promoted learning communities with support from school leadership and developed learning activities strategically designed using relevant data and resources promoting a growth mindset within instructional personnel. Effective teacher professional learning experiences included active learning, agency, coherence, context knowledge, differentiation, observation, pedagogy, reflection, self-efficacy, and were job-embedded. Feedback and follow-up were essential aspects of the implementation of successful teacher professional learning experiences. Teacher professional development was essential to support and maintain high-quality instructors of mathematics because the positive relationship between student achievement and teacher quality relied on the quality of teachers in schools (Bayar, 2014, p. 320). Brendefur et al. (2016) said student achievement increased thorough teacher professional development that improved teacher instructional practices (p. 104). Guskey (2014) said “you must clarify the goals you want to achieve in terms of better educator practice and improved student learning before you can judge the value, worth, and appropriateness of any professional learning activity” (p. 13).

A vital component of teacher professional learning was the creation of learning communities with their form meeting the needs of stakeholders: collaboration, peer
support, PLCs, and team-based learning communities. Educational governing bodies, school personnel, and academic coaches provided leadership for the implementation of teacher professional development experiences that aligned with the needs of school districts, schools, teachers, and students. Coaching was identified as having the potential to “positively impact student learning, and education leaders need to ensure that coaching was designed and implemented to achieve that potential” (Pemberton et al., 2016, p. 5).

Though similar, adult learning remained significantly different from the learning of children. When designing teacher professional development, school leaders needed to consider not just what but how adults learn to maximize the effectiveness of professional learning opportunities.

Most cited authors supported the belief that teachers have had the single greatest influence on the academic growth of students. Brendefur et al. (2016) said teacher professional development’s goal was to improve teachers’ understanding of pedagogy and how children think through the mathematizing process (p. 98). The benefits of teacher professional development depended upon teachers’ attention (Hill et al., 2017, p. 73). “Meaningful and effective training and professional development programs for teachers [were] key to the improvement of teaching practices in our schools” (Saylor & Johnson, 2014, p. 30). Belay (2016) said professional development was the foremost professional responsibility of all teachers (p. 219).
Section Three: Methodology

The intended purpose of my correlative, mixed methods, program evaluation was to determine what types of teacher professional development were the most impactful on teacher instructional practices in mathematics. I wanted to gather data that examined the impact, positive or negative, on students’ achievement in mathematics. My intended goal related directly to student learning. In evaluating quantitative and qualitative data, I determined the relationship teacher professional development experiences had on student academic growth and scholarly achievement at the study school.

Research Design Overview

This utilization-focused evaluative study accessed if there were specific characteristics of teacher professional development in mathematics that positively affected student achievement (Patton, 2008, p. 305). This theory of change approach, program evaluation focused on the teacher mathematics professional development delivered to elementary school mathematics teachers at one of the thirty-one elementary schools located in a school district of less than 43,000 students (citation withheld to preserve the anonymity of the school district under study). I determined the quality of mathematical instruction at the study school using a model of quality instruction in mathematics that facilitated interactions between the math content area specialist, teachers, students, and state standards mathematics content to enhance student learning. The math content area specialist acted as the flywheel by supporting the continuous improvement of teachers and students through interaction with mathematics content to increase student achievement.

Figure 4 displays the interactions that occurred through the implementation of the
model of quality instruction in mathematics I developed. As a mathematics content area specialist, I facilitated a deeper understanding of the mathematics content for both teachers and students. While working with teachers, we dissected the state mathematics standards to better understand what should be taught and what mastery of each standard would look like in their classrooms. While modeling mathematics instruction to teachers, I provided instruction to students specific to math content knowledge. Teachers and students interacted in mathematics instruction that was both teacher-driven and student-driven as a direct result of professional development provided by the mathematics content area specialist.

Figure 4. Model of quality instruction in mathematics.

Within a goals-based focus, I used a correlative, mixed-methods approach when I evaluated the effectiveness of teachers’ school-based mathematics professional development as determined by state and local assessment tools. I collected qualitative
data came from teacher interviews (See Appendix F) and teacher surveys (See Appendix C, D, & E). I generated quantitative data from survey scales used during teacher interviews (See Appendix F), local assessment data, and state assessment data. Patton (2008) said the evaluation design needed to match the evaluation situation “taking into account the priority questions and intended uses of primary intended users, the costs and benefits of alternative designs, the decisions that are to be made, the level of evidence necessary to support those decisions, ethical considerations, and utility” (p. 460).

I created an As-Is Diagram to analyze the context, conditions, competencies, and culture of the study school at the onset of the study (See Appendix G). My As-Is Diagram identified the instructional staff of the study school as having poor content knowledge, alignment to standards, and instructional practices in grades 2-5. The identified deficits of the instructional staff perpetuated the achievement gap in mathematics between students mastering mathematics content and those students performing a year or more below grade level in mathematics. The identified deficits of the instructional staff also demonstrated a continued need for focused mathematics professional development among teachers in grades 2-5.

I also created a To-Be Diagram to illustrate what I envisioned the instructional staff of the study school would look like after the successful implementation of site-based, on-demand professional development provided by a full-time mathematics content area specialist (See Appendix H). My To-Be Diagram identified the context, conditions, competencies, and culture that could be achieved at the study school with the support of a mathematics content area specialist. The teachers at the study school would develop strong content knowledge and pedagogy in mathematics, potentially closing the
achievement gap in mathematics between students who had mastered mathematics concepts and those students performing a year or more behind in mathematics.

Participants

Potential participants included all teachers in grades pre-k through fifth grade who provide mathematics instruction at a suburban elementary school, including teachers of exceptional education and English learner students. The study school’s instructional staff consisted of 74 teachers during the 2018-2019 academic school year. Of the 74 teachers at the study school, I was able to use the quantitative data from twelve teachers in second through fifth grade who taught math in the same grade-levels during both years of the correlatives study. Of the 74 teachers at the study school, four teachers volunteered to participate in the qualitative surveys and interviews I created and administered. The four teachers who volunteered to participate in the study provided me with one representative each for grades two, three, four, and five.

The study school’s student population consistently had the highest proportion of any elementary school within school district. The study school’s student population had a transient population that ranged from 875 to 925 students throughout the school year. Students’ demographics of the study school did not mirror the district student population information (citation withheld to preserve the anonymity of the school district under study). With that in mind, I used an ethnographic focus that represented the diverse population percentages represented within the student population of the study school. Figure 5 displayed the student population information of the study school and the district under study during the 2018-2019 academic year.

<table>
<thead>
<tr>
<th>Elementary Students</th>
<th>District</th>
<th>Study School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Students</td>
<td>21,304</td>
<td>879</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>Hispanic</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td>51.8%</td>
<td>20.9%</td>
</tr>
<tr>
<td></td>
<td>36.1%</td>
<td>35.5%</td>
</tr>
</tbody>
</table>

*Figure 5.* Elementary school student population information.

As the math content area specialist at the study school, I developed a PEP study to improve the student achievement in mathematics at my assigned location for the 2018-2019 school year. The scope of the study covered pre-kindergarten through fifth grade teachers. The instructional staff of the study school historically had a high teacher turnover, including the academic year the program evaluation occurred, with many teachers new to the grade levels they were instructing.

In the 2018-2019 school year, some teachers opted to team-teach, reducing the number of teachers potentially working with the math content area specialist. Second grade students struggled with cognitive stall and the development of Piaget’s concrete operational stage (McLeod, 2018). Third grade students’ scores were critical at the study school, as third grade was the first year students were required to take standardized state tests and retention was mandatory if academic expectations were deficit. Fifth grade students experienced the transition year between elementary school and middle with students needing a firm foundation in mathematics to be successful in secondary mathematics coursework. Therefore, I focused much of my study on second, third, fourth, and fifth grade teachers’ instructional practices and students’ scores.

**Data Gathering Techniques**

I gathered correlative quantitative data from students’ end of year, state mathematics standards assessments in 2017-2018 and 2018-2019 looking only at data
from teachers who taught math both years. I gathered qualitative data from teachers’ responses to survey and interview questions. Teachers provided quantitative data during their self-reflective assessment of their teaching abilities pre- and post-professional development during the final interview session administered by me.

**Surveys.** All teachers who participated in the study completed monthly pre and post-surveys regarding their professional development experiences and mathematics content knowledge provided me with data and maintained an accountability focus throughout the study (See Appendix C). Moreover, teachers’ answers to the survey questions provided an attribute focus that determined “the relationship between the program and the resulting outcomes” (Patton, 2008, p. 300). Context focused teacher survey questions provided environmental data (See Appendix D). Teacher survey questions included data on teacher demographics, background information, and content knowledge before and after professional learning experiences. Additionally, teachers completed surveys about their instructional practices, classroom organization, and training pre- and post-professional development (See Appendix E).

**Interviews.** I conducted interviews with mathematics teachers who participated in professional development and weekly collaboration opportunities I facilitated as the math content area specialist. Teacher interviews included a capacity-building focus that enhanced the long-term capacity of reflective evaluation. I gathered qualitative data from the teachers after they reflected upon their thoughts and feelings regarding student achievement and their site-based professional development experiences and weekly mathematics collaboration (See Appendix F).
My interviews with math teachers were semi-structured and specific to teachers’ experiences with professional development I facilitated as the math content area specialist. The semi-structured format allowed me to ask questions and probe further in a conversational style, though I used guiding questions developed prior to the interviews (See Appendix F). I focused on gathering information regarding teacher perceptions of the programs within the coaching cycle of professional development. Also, I used the interviews to investigate the reflective practices of mathematics teachers as a result of ongoing site-based professional development experiences and weekly mathematics collaboration.

Assessments. I collected quantitative data from the state department of education and the school district’s assessment department. The state department of education representatives mandated third through fifth grade teachers administer the state mathematics standards assessment to students during the first sixteen days of May 2019. In the 2017-2018 school year, students at the study school took the state mathematics standards assessments with questions in four domains of mathematics: number operations, algebra and algebraic thinking, measurement and data, and geometry. The 2017-2018 item specs created by representatives from the state department of education listed the state mathematics standards assessment would have 48% of questions specific to number operations, algebraic thinking, and numbers in base ten. State department of education representatives stated fractions, a subset of number operations, composed 17% of questions on the state mathematics standards assessment. State department of education representatives said measurement, data, and geometry constituted the remaining 35% of the state mathematics standards assessment. I found the mean and
standard deviation scores at the teacher level to provide me with relative data between students’ state mathematics standards assessment data from 2017-2018 and 2018-2019 for teachers who instructed the same grade level both years.

Second grade students did not participate in the state’s mathematics standards testing. I obtained quantitative data from the second-grade content student mastery assessment in mathematics developed by iReady designers and given at the end of the school year. At the teacher level, I compared data from 2017-2018 to 2018-2019 providing mean and standard deviation quantitative data for teachers who remained teaching in the same grade level. Standardized test results of core subjects, such as mathematics, “were identified as reliable parameters to reflect student achievement” (Hoge, 2016, p. 62).

Students used iReady software weekly as mandated by district leaders. Students were required to complete a minimum of 45 minutes of mathematics instruction per week. iReady software included a plethora of reports to glean supplementary quantitative data regarding mathematics standards mastery in kindergarten through fifth grade classrooms. I paired student data based on iReady with the data for teachers who taught the same grade level both years 2017-2018 and 2018-2019. Students’ iReady data was statistically comparable to the state mathematics standards assessment. I used the data from students’ iReady usage to find the means and standard deviations at the teacher level.

**Data Analysis Techniques**

In this study I used a correlative mixed-methods model to collect and analyze the data. I examined the independent variables of teacher practices in instruction and teacher
professional development as they relate to the dependent variable of student achievement on state mathematics standards assessments and iReady assessments. An effectiveness focus of the data allowed me to determine “to what extent [was] the program effective in attaining its goal” of improving students’ mastery of mathematical content (Patton, 2008, p. 301). In conjunction with the effectiveness focus, I used an efficiency focus to develop teachers’ self-reflection and self-efficacy.

The student results on the 2017-2018 state assessments demonstrated a decrease in student achievement in both reading and mathematics for the study school, thus lowering the school grade earned by students and staff from a B to a D. Teachers increasing students’ abilities to demonstrate their content knowledge on state and local assessments was vital for the 2018-2019 school year. A critical issues focus identified areas of concern using the data available from the district and state assessments. At the conclusion of this school year, an evaluability focus assessed the program’s effectiveness using state and local end-of-course exams.

Students’ data from the study specific to mathematics achievement was “retrospective, archival, and routinely collected school information” (Hoge, 2016, p. 54). Teachers’ quantitative data collected from state and local end-of-course assessments, focused on evaluating the teachers rather than the students. I compared students’ 2017-2018 assessment data with the 2018-2019 assessment data to identify areas of improvement in mathematics instruction for teachers working in the same grade levels within the same school for both years by comparing means and standard deviation scores. Bishop (2016) said utilizing a data comparison of standard deviations allows researchers “to determine if the ongoing professional development program had any impact on

I obtained qualitative data from semi-structured interviews and surveys with math teachers in the elementary school participating in the study. The rich human experience of the professional development process emerged within the qualitative data I collected from mathematics teachers’ interviews and surveys. I gained insight regarding the thoughts and feelings of mathematics instructors particular to site-based professional development activities.

**Ethical Considerations**

The paramount ethical consideration for this program evaluation was to protect the anonymity of each participant. An equity focus ensured all participants were “treated fairly and justly” (Patton, 2008, p. 302). The appropriate school and district personnel provided the permission necessary to conduct this research. All participants were unidentifiable in study documents to protect student and teacher identities. A potential ethical conflict could have developed from my position as a math content area specialist and the positive monetary and professional incentives of improving mathematics at the study school from a D grade to an A grade assigned by the state. School personnel that contributed to improving school grades were rewarded with monetary incentives by representatives from the state department of education. One component of my professional evaluation rubric was tied to the school grade, an increase in the school grade equated to a higher proficiency rating for me.
Limitations

While conducting my study I was limited to teachers at one elementary school in a small Southeastern school district, therefore findings could not be generalized to all school populations. My findings when I conducted my study would only be applicable to schools with similar student demographic information. When I conducted my study, I was limited by time management as it was completed in one academic year, providing minimal data to determine if the teacher professional development implementations were truly effective. Teachers spent most of their workday instructing students and their time to engage in meaningful teacher professional development experiences without violating their instructional contract were limited.

I was acutely interested in improving student achievement in mathematics because increased mathematics scores on state mathematics standards assessments had the potential to change the school grade from a C to a B and improve the culture of the school population to that of a high achieving academic identity. If the study school students and staff earned a B grade from representatives of the state department of education, then all school personnel would benefit financially. Furthermore, if students’ scores increased on state mathematics standards assessments it would reflect positively on me as the math content area specialist assigned to the study school. Finally, Aguilar (2013) said, “we run the risk of rogue beliefs taking over our internal operation systems” if we are not aware of our own belief systems and biases (p. 35). I was mindful of avoiding any preconceived notions or making inferences and remained neutral. I analyzed the data not the participants.
Conclusion

My study analyzed data from the 2017-2018 and 2018-2019 school years from the end-of-term assessments. iReady mathematics scores were used as a predictor of state assessments scores. State assessments and iReady data were utilized to identify statistically significant impacts on student achievement subsequent to the onset of the ongoing professional development program provided by the Math Content Area Specialist. Student data was collected from one elementary school in a school district.

The 2017-2018 test scores represented the data prior to the implementation of the professional development program at the school under study. The 2018-2019 test scores represented the data following the implementation of the professional development program at the school under study. I used test data disaggregated at the teacher level to determine means and standard deviation scores and compared them with the pre- and post-assessments data. Correlated data was collected specific to teachers from the 2017-2018 and 2018-2019 academic years.
Section Four: Results

This results section represented my interpretation of emerging trends and themes within the data collected. Professional development in mathematics has been identified as a key component necessary for improving math instruction and student achievement in math (Aguilar, 2013; Belay, 2016; Bishop, 2016; Blazer, 2015; Brendefur et al., 2016; Clarke & Clarke, 2018; Garet et al., 2016; Gersten et al., 2018; Hill et al., 2017; Hoge, 2016; Holm, Kajander, & Avoseh, 2016; Kennedy, 2016; McGatha, 2017; Saylor & Johnson, 2014; Shaha, Glassett, & Ellsworth, 2015; Smith, 2015; Sutton, 2017; Taton, 2015; & Thomas et al., 2017). Throughout my Program Evaluation Project, I maintained an open mind that allowed the data I collected to drive my conclusions rather than any preordained bias on my part. I was surprised at my findings and used them to drive further professional learning opportunities at the study school.

Findings

After students’ scores were determined for the 2017-2018 state standards assessment, state department of education representatives reported the state assigned school grade of the elementary school under study had dropped from a B in 2016-2017 to a D, with students’ mathematics test scores decreasing in grades three through five. Students’ math achievement level on the state mathematics standards assessment decreased from a 41% to 40%, as an average of third, fourth, and fifth grade test scores. Students’ math learning gains fell from 50% to 41%. Students were able to earn learning gains in several ways, including the following: by improving from one or more achievement levels, maintaining a level five on a scale of one to five with five being the highest, remaining a level three or four and improving their score by at least one point, or
level one or two who improve to a subcategory within that level. Finally, students’ learning gains in the bottom quartile of math plummeted from 48% to 27%.

I was extremely excited when I began this evaluation. I did not see participation in this study as any more than the site-based teachers were already doing. Prior to the onset of this evaluation, teachers were participating in the coaching cycle, participating in mandated collaboration, and attending professional development sessions. The lack of participation in surveys and interviews by teachers was unexpected, as was the rationale that they were already overburdened and could not take on another responsibility. The four teachers who participated in the study displayed the type of agency, self-efficacy, and reflective practices that the research in my literature review demonstrated benefits instructional practices and student achievement (Calvert, 2016; Belay, 2016; Bayar, 2014; Thomas et al., 2015; Hoge, 2016; Smith, 2015; McGatha, 2017; Bishop, 2016; Clark & Clark, 2018; Kennedy, 2016; Minor et al., 2016; & Dixon et al., 2014). Teachers C2, B3, D4, and D5 shared a goal to improve their instruction through professional development, one of the Seven Disciplines of Strengthening Instruction (Wagner et al., 2006, p. 27). Among the mathematics teachers at the study school, 13% participated in the surveys and interviews to collect qualitative data for this mixed-methods study.

Teacher turnover also hindered my acquisition of correlated data. With such a small sample size, I was unable to prove statistical significance (Carroll & Carroll, 2002, p. 88). Though the teaching unit allocations at the study school had the potential for seven sets of data in grades two through five, I could only use the data from three teachers in each grade level due to internal grade level transfers and teachers not returning to the school.
57% of fifth grade teachers were new to the grade level in the 2018-2019 school year and 14% of fifth grade teachers left the grade mid-year. 17% of fourth grade teachers were new to the grade level in the 2018-2019 school year and 17% of fourth grade teachers left the grade mid-year. 14% of third grade teachers were new to the grade level in the 2018-2019 school year. 43% of second grade teachers were new to the grade level in the 2018-2019 school year and 43% of the second-grade teachers left the grade level mid-year. The consistency of grade-level mathematics standards instruction of 86% experienced third grade teachers was clear in the test scores of third grade students.

Murphy (2016) said that capacity building and retention of effective teachers was a necessary undertaking for school improvement (p. 52).

Such inconsistencies of instruction impacted negatively student achievement as teachers strove to acquire new content knowledge and pedagogy specific to the new grade level. The mid-year teacher turnovers documented previously in second, fourth, and fifth grade further eroded the base of teachers and weakened those grade levels as classes swelled in proportion to the allocated teaching units. Within the grade levels students and staff needed “nested communities of practice related to the continuous improvement of instruction” (Wagner et al., 2006, p. 114). Teachers new to grade levels routinely lacked the depth of mathematics content knowledge necessary to correct student misconceptions and answer questions regarding mathematics skills application. When given a student assessment prior to collaborative planning, some teachers were unable to correctly compute to achieve the desired answer and others cried in frustration because they did not know what to do. Hallowell (2011) said administrators need to “put the right people in the right jobs, and give them responsibilities that light up their brains” and the
correct selection of teachers was more important than any strategy that could be initiated (p. 6). Murphy (2016) said it was vital for administrators to place teachers in subjects and grade levels “for which they [were] formally prepared” (p. 52).

Beyond the limitations of teacher mathematics content knowledge, teachers had one-hundred eighty instructional days to teach students all grade level mathematics state standards to mastery level. State mathematics standards testing of students in third through fifth grade were mandated to occur within the first sixteen days of May, meaning that grade-level mathematics instruction ends three weeks before the end of the school year. In addition to the end of year assessments, there are quarterly, unit, and standards assessments throughout the year that further deplete the time available to provide quality mathematics instruction. In totality, teachers provided less than one-hundred sixty days of instruction on average in an elementary classroom. Instead of teaching for deeper understanding, teachers were planning instruction and review of mathematics skills and knowledge based on testing dates not student development (Wagner, 2008, p. 3). Wagner (2008) said “schools need to let kids be much more curious instead of learning to pass test” (p. 17).

Students lacked mastery of foundational mathematics skills as they progressed through the grade levels, delaying the acquisition of grade-level mathematics skills as teachers remediated to minimize the achievement gap in mathematics. Students struggled to acquire standards-based mathematical skills that were not aligned with typical brain development (Mishra & Singh, 2019, p. 102). Elementary students have typically fallen into three of Piaget’s stages of cognitive development: preoperational stage, concrete stage, or formal stage. Students in pre-kindergarten through second grade, ages four to
seven, were usually in the preoperational stage and were restricted by irreversibility, centration, and egocentrism which limited their abilities to perform tasks involving conservation. Students in second through fifth grade, ages seven to eleven, were usually in the concrete operations stage and developed the ability to use conservation in conjunction with the development of mathematical operations though they had difficulty with hypothetical problems. Students in fifth grade, age 11 and above, were in the formal operations stage and developed the logical and systematic thinking necessary for hypothetical mathematics problems. Site-based professional development and grade-level collaboration supported teachers who were inexperienced with the pedagogy of student brain-mapped development.

Teacher resistance to content area specialist facilitated collaboration and site-based professional learning opportunities further impacted student achievement and produced low test scores. Third grade teachers actively engaged in standards-based collaboration and generated out-of-the-box ideas to promote student learning. One third grade teacher participated in the study surveys and interviews, all third-grade math teachers regularly met with me in my capacity as the math content area specialist for one-on-one collaboration and coaching. Conversely, second grade math teachers participated minimally in math collaboration and only teacher C2 participated in the coaching cycle or sought out any additional support to enhance classroom mathematics instruction.

End of year student achievement scores reflected the divergent attitudes towards site-based professional development provided by a math content area specialist and grade-level standards-based collaboration facilitated by the math content area specialist. Teachers at the study school were in various phases of transformational learning.
Mezirow (1991) said:

> Perspective transformation is a social process: others precipitate the disorientating dilemma, provide us with alternative perspective, provide support for change, participate in validating changes perspectives through rational discourse, and require new relationships to be worked out within the context of a new perspective. (p. 194)

Teachers who participated in collaboration as a compliance measure rather than experiencing the positive benefits of deliberate practice perpetuated their own form of suffering while missing out on the transformative potential of collaboration with peers (Duckworth, 2016, p. 135).

**iReady.** The iReady software program was used as a tier one support in grades second through fifth in the 2017-2018 and 2018-2019 school years. iReady was a software program purchased by district leaders that allowed students to complete assigned tasks in reading and math. Students took AP1, beginning of year assessment, at the onset of both school years to place them at their “just right” instructional level. iReady instructional lessons were aligned with the state mathematics standards. iReady representatives suggested 45 minutes of online instruction in math and reading each week to maximize the effectiveness of the intervention with fidelity. The iReady AP3 diagnostic was used as the end of year assessment for kindergarten through second grades in place of the state assessments taken by grades three through five.

Figure 6 displayed the AP3 end of year results for the three second grade teachers who taught math in 2017-2018 and 2018-2019. Teachers A2 and C2 were actively involved in collaboration sessions twice per week as mandated by the school’s
administrative team and facilitated by the math content area specialist. Teacher B2 was resistant to collaboration and did not participate in the coaching cycle. Teacher C2 was actively participated in the coaching cycle with the math content area specialist throughout the school year. Teacher C2 actively sought out assistance and implemented math activities that were collaboratively developed with the math content area specialist to enhance math instruction and support students’ mastery of state standards. Though no second-grade teacher’s class reached proficiency level of 441, two of the three teachers’ data showed improved scores in mathematics. Teacher A2’s class showed an 18-point increase and teacher C2’s class showed a 16-point increase in AP3 scores.

Neither increase in class scores was statistically significant. The small sample size of teachers and comparison of two years’ data inhibited the potential to achieve statistical relevance. High teacher turnover rates and grade-level transitions impacted negatively my ability to collect data from a larger sample size. In the 2017-2018 school year, six teaching units were allocated to the study school in second grade. In the 2018-2019 school year, seven second grade teaching units were assigned to the study school. Of the seven teacher units assigned to second grade in the 2018-2019 school year, three taught second grade at the study school during the 2017-2018 school year.

The second-grade team and their students had several transitions throughout the course of the year, potentially impacting negatively student performance. Teacher B2 was a departmentalized teacher whose partner left mid-year and was eventually replaced by a long-term substitute teacher. Teacher A2 was a departmentalized teacher whose partner left mid-year and was not replaced requiring teacher A2 to teach all subjects for the remainder of the year. Teacher C2 taught all subjects in a general education self-
contained classroom. Additionally, a teacher new to second grade went on maternity leave mid-term and did not return for the remainder of the school year. Though second grade was allocated seven units, on average students were divided between four or five classrooms for a significant portion of the year when substitute teachers were unavailable to fill the vacated positions. The growth of teachers A2 and C2 may not be statistically relevant but are noteworthy given the dynamic of the second-grade team and students for the 2018-2019 school year.

![Figure 6. Second grade end of year class averages by teacher for iReady AP3.](image)

Figure 7 displayed the AP3 end of year results for the three third grade teachers who taught math in 2017-2018 and 2018-2019. Teachers B3 and C3 were actively involved in the collaboration sessions twice per week as mandated by the school’s administration team and facilitated by the math content area specialist as both teachers were departmentalized and did not work with the reading content area specialist. Additionally, both teachers actively participated in the coaching cycle with the math content area specialist. Teacher B3 participated in mathematics professional development
offered by the content area specialist and in co-teaching experiences with the math content area specialist. Teacher A3 taught all subjects and participated minimally in math collaboration, though all resources were shared with Teacher A3.

No third-grade teacher’s class average reached proficiency. Though all three teachers’ average students’ scores were close to the 464-proficiency score, teacher A3’s class showed a 58-point increase, but the scores were not statistically significant. The small sample size of three teachers and comparison of two years’ data inhibited the potential to achieve statistical relevance. High teacher turnover rates and grade-level transitions negatively impacted the researcher’s ability to collect data from a larger sample size, with only three teachers remaining in third grade and teaching math.

The math content area specialist provided third grade bottom quartile students with extra opportunities to participate in iReady instruction to close the achievement gap in mathematics between proficient and nonproficient students. The math content area specialist assigned extra lessons in math to students in third, fourth, and fifth grade to support grade level standards. Students worked on the extra lessons twice a week for 20 minutes before the official start of the school day. The math content area specialist monitored the students’ progress and provided incentives for students based on their passing rates. Students AP3 data did not support this being an effective intervention for third-grade students as no class reached proficiency.
Figure 7. Third grade end of year class averages by teacher for iReady AP3.

Figure 8 displayed the AP3 end of year results for the three fourth grade teachers who taught math in 2017-2018 and 2018-2019. Teachers B4 and C4 were actively involved in the collaboration sessions twice per week as mandated by the school’s administration team and facilitated by the math content area specialist as both teachers were departmentalized and did not work with the reading content area specialist. Neither teacher participated in any other professional development offered by the math content area specialist. Teacher A4 taught all subjects and participated minimally in math collaboration, though all resources were shared with Teacher A4. Teacher A4 retired at the end of the 2018-2019 school year.

The growth of students of teacher B4 may not be statistically relevant but was noteworthy with a mean increase of 33 points and given the dynamic of the fourth-grade team and students for the 2018-2019 school year. No fourth-grade teacher’s class average reached the proficiency level of 482. The small sample size of three teachers and
comparison of two years’ data inhibited the potential to achieve statistical relevance. High teacher turnover rates and grade-level transitions impacted negatively my ability to collect data from a larger sample size. In the 2017-2018 school year, seven fourth grade teacher units were assigned to the study school. In the 2018-2019 school year, seven fourth grade teacher units were assigned to the study school. Of the seven teacher units assigned to fourth grade in the 2018-2019 school year, only three had taught fourth grade at the study school during the 2017-2018 school year.

Like the dynamics in second grade, the fourth-grade team and students had several transitions throughout the course of the year, potentially impacting negatively student performance. The study school staff was allocated seven fourth grade units but was unable to maintain seven classes through the course of the academic year. Teacher A4 began the year as a departmentalized math teacher but transitioned to teaching all subjects when a seventh fourth grade teacher was hired. The new teacher became the new departmentalized math teacher, until the partnered fourth grade reading teacher resigned, and the departmentalized math teacher was required to teach all subjects. The fourth-grade team and students had six teachers for the remainder of the year with class sizes averaging 25 students. If a teacher was absent the class was split, and fourth grade class sizes swelled to 30 students. Though fourth grade was allocated seven units, students were divided between five or six classrooms for a significant portion of the year when substitute teachers were unavailable to fill the vacant positions.

The math content area specialist provided fourth grade bottom quartile students with extra opportunities to participate in iReady instruction to close the achievement gap in mathematics between proficient and nonproficient students. Students were assigned
extra lessons in math to support grade level standards. Students worked on the extra lessons twice a week for 20 minutes before the official start of the school day. The math content area specialist monitored the students’ progress and provided incentives for students based on their passing rates. The AP3 student data do not support this as an effective intervention for fourth grade students as no class reached and average proficiency level of 482.

![Student Mean Scale Scores by Teacher](image)

*Figure 8* Fourth grade end of year class averages by teacher for iReady AP3.

Figure 9 displayed the AP3 end of year results for the three fifth grade teachers who taught math in 2017-2018 and 2018-2019. Since fifth grade students were required to take end of year state standards assessments in ELA, math, and science, the fifth-grade team was divided into three teams for the mandatory collaboration sessions twice per week with content area specialists. Teacher A5 always planned for math. Teacher B5 always planned for ELA, though teacher B5 actively participated in the math coaching cycle and participated in mathematics professional development delivered by the math
content area specialist. Teacher C5 always planned for science. The teachers were divided thus to work with the four teachers who were new to the grade level. No fifth-grade teachers were departmentalized for the 2018-2019 school year, so all resources were shared with all teachers.

No fifth-grade teacher’s class reached an average proficiency level of 498. Teacher C5’s data showed a dramatic decline. In 2017-2018, teacher C5’s class consisted of students who had reached level four or level five on the fourth-grade end of year state reading standards assessment. The same teacher had a normal class distribution in 2018-2019, with students from all five scale score areas of the state assessment rather than from only the highest two areas. The small sample size of three teachers and comparison of two years’ data inhibited the potential to achieve statistical relevance.

High teacher turnover rates and grade-level transitions impacted negatively my ability to collect data from a larger sample size. In the 2017-2018 school year, seven fifth grade teaching units were assigned to the study school. In the 2018-2019 school year, seven fifth grade teaching units were assigned to the study school. Of the seven teacher units assigned to fifth grade in the 2018-2019 school year, three had taught fifth grade math at the study school during the 2017-2018 school year.

Like the second and fourth grade teacher dynamics, the fifth-grade team and students had a significant transition during the year, potentially impacting negatively student performance. The study school staff was allocated seven fifth grade units and teachers were hired for all units, three returning and four new to the grade level and school. Upon reviewing the first quarter data, the administrative team of the study school decided to consolidate down to six units and the fifth-grade class size increased to 25
students. As with fourth grade, if a teacher was absent the class was divided, and the remaining class sizes swelled to 30 students.

The math content area specialist provided fifth grade students in the bottom quartile with extra opportunities to participate in iReady instruction to close the achievement gap in mathematics between proficient and nonproficient students. Students were assigned lessons in math to support grade level standards. Students worked on the extra lessons twice a week for 20 minutes before the official start of the school day. The math content area specialist monitored the students’ progress and provided incentives for students based on their passing rates. Students’ AP3 data did not support this as an effective intervention for fifth grade students as no class reached an average proficiency of 498.

**Figure 9.** Fifth grade end of year class averages by teacher for iReady AP3.

I stated through the directional null hypothesis that there would be no difference in mathematics scores between teachers supported by a full-time, site-based mathematics content area specialist and those that did not have a full-time, site-based mathematics
content area specialist (Carroll & Carroll, 2002, p.87). Based on the data from iReady AP3, I accepted the null hypothesis because there was no statistical difference. A full-time, site-based mathematics content area specialist did not significantly improve teachers’ abilities nor students’ tier one achievement based on students’ iReady AP3 scores from school years 2017-2018 and 2018-2019.

Figure 10 displayed the data for the four grade levels of iReady data for the years 2017-2018 and 2018-2019. Mean scores improved in all grades with the exception of grade five. As previously noted, one fifth grade class declined significant in their iReady mean score. Standard deviations decreased in all grade levels. Less deviation in scores could have been attributed to the math content area specialist facilitated collaborative lesson planning sessions teachers were required to attend twice a week. Improved alignment of instructional strategies, as supported by the math content area specialist, led to a more consistent level of standards-based instruction. Though there was growth in the majority of classroom averages, the growth was insufficient to be considered statistically relevant within the context of this study.

Second grade teachers improved their standard deviation from 11.68 to 3.79, a decrease of 7.89 in variance. Third grade teachers improved their standard deviation variance from 36.09 to 2.31, a decrease of 33.78 in variance. Fourth grade teachers improved their standard deviation variance from 21.39 to 6.59, a decrease of 14.80 in variance. Fifth grade teachers improved their 19.97 to 3.51, a decrease of 16.46 in variance. Third grade teacher scores displayed the greatest decrease in standard deviation and the greatest increase in students’ mean proficiency; the reduction in variance was related to improved student achievement. The decrease in teachers standard deviations
may have indicated improved teacher instruction better aligned to state mathematics standards as a result of site-based mathematics professional development and weekly mathematics grade level collaboration supported by the math content area specialist.

<table>
<thead>
<tr>
<th>Teachers’ Groups</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd grade math teachers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017-2018</td>
<td>420.33</td>
<td>11.68</td>
</tr>
<tr>
<td>2018-2019</td>
<td>429.67</td>
<td>3.79</td>
</tr>
<tr>
<td>3rd grade math teachers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017-2018</td>
<td>440.67</td>
<td>36.09</td>
</tr>
<tr>
<td>2018-2019</td>
<td>459.67</td>
<td>2.31</td>
</tr>
<tr>
<td>4th grade math teachers</td>
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<td></td>
</tr>
<tr>
<td>2017-2018</td>
<td>467.67</td>
<td>21.39</td>
</tr>
<tr>
<td>2018-2019</td>
<td>469.00</td>
<td>6.56</td>
</tr>
<tr>
<td>5th grade math teachers</td>
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<tr>
<td>2017-2018</td>
<td>489.00</td>
<td>19.97</td>
</tr>
<tr>
<td>2018-2019</td>
<td>487.33</td>
<td>3.51</td>
</tr>
</tbody>
</table>

*Figure 10.* iReady Math correlated data analysis.

**End of Year State Mathematics Standards Assessment.** Figure 11 displayed the end of year state mathematics standards assessment results for the three third grade teachers who taught math in 2017-2018 and 2018-2019. Though all mean scores improved, none of the third grade teachers’ mean scores were statistically significant enough to prove a positive impact on student achievement (Carroll & Carroll, 2002, p. 88). All three teachers’ mean scores were above the state assessment proficiency level of 297. Though all mean scores improved, none of the third grade mean scores were statistically significant enough to prove a positive impact on student achievement (Carroll & Carroll, 2002, p. 88). Third grade teachers’ instructional practices were aligned to the lesson plans jointly created during collaborative sessions with the math content area specialist and they were willing to allow teachers with perceived weaknesses to observe
more experienced teachers during instruction.

Teacher A3 improved the class mean by 14 points. Teacher B3 improved the class mean by 4 points. Teacher C3 improved the class mean by 3 points. All third-grade teachers in the study were able to achieve mean scores that exceeded the third-grade proficiency level of 297. The increases in teachers mean scores may have indicated improved teacher instruction better aligned to state mathematics standards as a result of site-based mathematics professional development and weekly mathematics grade level collaboration supported by the math content area specialist.

![Student Mean Scale Scores by Teacher](image)

*Figure 11.* Third grade mean scores by teacher on state math assessment.

Figure 12 displayed teacher A3’s student achievement scale scores for the 2017-2018 and 2018-2019 academic years. Teacher A3 taught mathematics to 17 students during each year. During the 2017-2018 academic year, 24% of students in teacher A3’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. During the 2018-2019 academic year, 59% of students in teacher A3’s class
were proficient in mathematics as assessed by the state end of year exam in mathematics. Though not statistically significant because of the small sample size, teacher A3’s data showed a trend of positively moving students from non-proficient to proficient. The 35% increase in student proficiency could be attributed to full-time, ongoing, job-embedded mathematics professional development received from the math content area specialist.

![Bar chart showing student achievement by scale score for Teacher A3](image)

*Figure 12.* Teacher A3’s student achievement by scale score.

Figure 13 displayed teacher B3’s student achievement scale scores for the 2017-2018 and 2018-2019 academic years. Teacher B3 taught mathematics to 17 students in the 2017-2018 academic year. During the 2018-2019, teacher B3 team taught and was responsible for the math instruction of 31 students. During the 2017-2018 academic year, 47% of students in teacher B3’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. During the 2018-2019 academic year, 74% of students in teacher B3’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. Though not statistically significant because of the small
sample size, teacher B3’s data showed a trend of positively moving students from non-proficient to proficient. The 27% increase in student proficiency could be attributed to full-time, ongoing, job-embedded mathematics professional development received from the math content area specialist.

Figure 13. Teacher B3’s student achievement by scale score.

Figure 14 displayed teacher C3’s student achievement scale scores for the 2017-2018 and 2018-2019 academic years. Teacher C3 taught mathematics to 18 students in the 2017-2018 academic year. During the 2018-2019, teacher C3 team taught and was responsible for the math instruction of 34 students. During the 2017-2018 academic year, 72% of students in teacher C3’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. During the 2018-2019 academic year, 71% of students in teacher C3’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. Teacher C3’s data showed a trend of more students scoring below grade-level proficiency in the 2018-2019 school year. The 1% decrease in student
proficiency is not statistically significant.

Figure 14. Teacher C3’s student achievement by scale score.

Figure 15 displayed the students’ scale scores for the end of year assessment in mathematics for the 2017-2018 and the 2018-2019 academic year in third grade. Sixty-seven students took the end of year math assessment in 2017-2019 and ninety-seven students took the end of year math assessment in 2018-2019. The number of students scoring a Level One decreased from 25% to 16%, decreasing the percentage of students identified as non-proficient 9%. The number of students scoring a Level Three increased from 22% to 29%. The number of students scoring a Level Four increased from 18% to 29%.

Though three more students scored a Level Five in 2018-2019, the percentage based on student count was 1% lower than the previous year. However, the third grade teachers in this study were able to move a substantive number of students within Levels Four and Five. During the 2017-2018 school year, 33% of students in third grade scored a
Level Four or Five while 42% of students scored a Level Four or Five during the 2018-2019 academic year. The trend I noticed in third grade students’ end of year assessment scores for the 2018-2019 end of year mathematics assessment was an increase in students scoring proficient. Students mathematics proficiency increased from 55% to 70%, while students’ scores decreased in nonproficient levels from 45% to 30%. Students scoring Level Four or Five increased by 9%, which was a noteworthy and unintended consequence of the professional development opportunities afforded the third-grade teachers.

Figure 15. Third grade scale scores of students.

Figure 16 displayed the end of year state mathematics standardized assessment results for the three fourth grade teachers who taught math in 2017-2018 and 2018-2019. All three teachers’ mean scores were above the state assessment proficiency level of 310. Teacher C4 increased the class mean score by 22 points but this was insufficient to identify students’ growth as statistically relevant. The fourth-grade math teachers were
actively engaged in collaborative planning sessions with the math content area specialist throughout the school year.

Teacher A4’s mean score decreased by 1 point in mathematics. Teacher B4’s mean score increased by 4 points in mathematics. Teacher C4’s mean score increased by 22 points in mathematics. All fourth-grade teachers’ mean mathematics scores exceeded the fourth grade proficiency level of 310. The increases in teachers mean scores may have indicated improved teacher instruction better aligned to state mathematics standards as a result of site-based mathematics professional development and weekly mathematics grade level collaboration supported by the math content area specialist.

Figure 16. Fourth grade mean scores by teacher on state math assessment.

Figure 17 displayed teacher A4’s student achievement scale scores for the 2017-2018 and 2018-2019 academic years. Teacher A4 taught mathematics to 21 students in the 2017-2018 academic year. During the 2018-2019, teacher A4 team taught mathematics to 24 students. During the 2017-2018 academic year, 48% of students in
teacher A4’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. During the 2018-2019 academic year, 54% of students in teacher A4’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. Though not statistically significant because of the small sample size, teacher A4’s data showed trends of maintaining percentages of non-proficient in Level 1 and increasing proficiency in Level 3. The 6% increase in student proficiency could be attributed to full-time, ongoing, job-embedded mathematics professional development received from the math content area specialist.

Figure 17. Teacher A4’s student achievement by scale score.

Figure 18 displayed teacher B4’s student achievement scale scores for the 2017-2018 and 2018-2019 academic years. Teacher B4 taught mathematics to 23 students in the 2017-2018 academic year. During the 2018-2019, teacher B4 team taught and was responsible for the math instruction of 44 students. During the 2017-2018 academic year, 35% of students in teacher B4’s class were proficient in mathematics as assessed by the
state end of year exam in mathematics. During the 2018-2019 academic year, 61% of students in teacher B4’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. Though not statistically significant because of the small sample size, teacher B4’s data showed a trend of positively moving students from non-proficient to proficient. The 26% increase in student proficiency could be attributed to full-time, ongoing, job-embedded mathematics professional development received from the math content area specialist.

**Figure 18.** Teacher B4’s student achievement by scale score.

Figure 19 displayed teacher C4’s student achievement scale scores for the 2017-2018 and 2018-2019 academic years. Teacher C4 taught mathematics to 20 students in the 2017-2018 academic year. During the 2018-2019, teacher C4 team taught and was responsible for the math instruction of 48 students. During the 2017-2018 academic year, 35% of students in teacher C4’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. During the 2018-2019 academic year, 56% of
students in teacher C4’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. Though not statistically significant because of the small sample size, teacher C4’s data showed a trend of positively moving students from non-proficient to proficient. The 21% increase in student proficiency could be attributed to full-time, ongoing, job-embedded mathematics professional development received from the math content area specialist.

Figure 19. Teacher C3’s student achievement by scale score.

Figure 20 displayed the students’ scale scores for the end of year assessment in mathematics for the 2017-2018 and the 2018-2019 academic year. Though a similar number of students maintained a Level One, the percentage varies based on the student count. In the 2017-2018 academic year, seventeen students scored a Level One or 25% of the students in fourth grade. In the 2018-2019 academic year, fifteen students scored a Level One or 15% of the students in fourth grade.

Though the graph looks like the percentage of Level One students increased, it
decreased 10%. Likewise, the percentage of students who scored a Level Two decreased from 20% to 19%. The fourth grade teachers in this study were able to move a substantive number of students within Level Four and Five. During the 2017-2018 school year, 27% of students in third grade scored a Level Four or Five while 35% of students scored a Level Four or Five during the 2018-2019 academic year. The trend I noticed in fourth grade students’ end of year assessment scores for the 2018-2019 end of year mathematics assessment was an increase in students scoring proficient. Students mathematics proficiency increased from 47% to 60%, while students’ scores decreased in non-proficient from 53% to 40%. Students scoring Level Four or Five increased 8%, which was a noteworthy and unintended consequence of the professional development opportunities afforded the third-grade teachers.

![Bar chart](chart.png)

**Figure 20.** Fourth grade scale scores of students.

Figure 21 displayed the end of year state mathematics standardized assessment results for the three fifth grade teachers who taught math in 2017-2018 and 2018-2019.
Teacher C5 was the only fifth grade teacher to achieve a mean score over the state proficiency level of 320. As previously stated, the dramatic decrease in teacher C5’s scores may have been due to the changing demographics of the classroom, with the 2017-2018 class consisting of only high achieving students.

Teacher A5’s mean score increased by 12 point in mathematics. Teacher B5’s mean score increased by 6 points in mathematics. Teacher C4’s mean score decreased by 16 point in mathematics. As previously noted, teacher C4’s decrease may have been attributed to moving from all high achieving students in the 2017-2018 school year to a randomly selected normal distribution population within a standard bell curve class during the 2018-2019 school year. Despite the decrease in mean score, teacher C4 was the sole fifth grade teacher to exceed the fifth-grade proficiency level of 320. The increases in teacher A5’s and B5’s mean scores may have indicated improved teacher instruction better aligned to state mathematics standards as a result of site-based mathematics professional development and weekly mathematics grade level collaboration supported by the math content area specialist.
Figure 21. Fifth grade average scores by teacher on state math assessment.

Figure 22 displayed teacher A5’s student achievement scale scores for the 2017-2018 and 2018-2019 academic years. Teacher A5 taught mathematics to 24 students in the 2017-2018 academic year. During the 2018-2019, teacher A5 taught 25 students in mathematics. During the 2017-2018 academic year, 33% of students in teacher A5’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. During the 2018-2019 academic year, 40% of students in teacher A5’s class were proficient in mathematics as assessed by the state end of year exam in mathematics.

Though not statistically significant because of the small sample size, teacher A5’s data showed trends of decreasing the percent of non-proficient students and positively moving students from non-proficient to proficient. The 7% increase in student proficiency could be attributed to full-time, ongoing, job-embedded mathematics professional development received from the math content area specialist.
Figure 22. Teacher A5’s student achievement by scale score.

Figure 23 displayed teacher B5’s student achievement scale scores for the 2017-2018 and 2018-2019 academic years. Teacher B5 taught mathematics to 21 students in the 2017-2018 academic year. During the 2018-2019, teacher B5 taught 22 students’ mathematics. During the 2017-2018 academic year, 29% of students in teacher B5’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. During the 2018-2019 academic year, 50% of students in teacher B5’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. Though not statistically significant because of the small sample size, teacher B5’s data showed a trend of positively moving students from non-proficient to proficient. The 21% increase in student proficiency could be attributed to full-time, ongoing, job-embedded mathematics professional development received from the math content area specialist.
Figure 23. Teacher B5’s student achievement by scale score.

Figure 24 displayed teacher C5’s student achievement scale scores for the 2017-2018 and 2018-2019 academic years. Teacher C5 taught mathematics to 24 students in the 2017-2018 academic year. During the 2018-2019, teacher C5 taught 25 students’ mathematics. During the 2017-2018 academic year, 92% of students in teacher C5’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. During the 2018-2019 academic year, 48% of students in teacher C5’s class were proficient in mathematics as assessed by the state end of year exam in mathematics. Though not statistically significant because of the small sample size, teacher C5’s data showed a trend of increased non-proficiency student scores. The 44% decrease in student proficiency was expected with the change in demographics within the classroom, moving from all high achieving students in the 2017-2018 school year to a randomly selected normal distribution population within a standard bell curve class during the 2018-2019 school year.
Figure 24. Teacher C5’s student achievement by scale score.

Figure 25 displayed the students’ scale scores for the end of year assessment in mathematics for the 2017-2018 and the 2018-2019 academic year. On the end of year mathematics assessments, an increased percentage of students scored Tier One in 2018-2019 but a decreased percentage of students who scored Tier Two. The percentage of students who scored a Level Four on the end of year mathematics assessment increased by 4%. The trend I noticed in fifth grade students’ end of year assessment scores for the 2018-2019 end of year mathematics assessment was a decrease in students scoring proficient. However, the fifth grade teachers in this study were able to move a substantive number of students within Levels Four and Five. During the 2017-2018 school year, 14% of students in third grade scored a Level Four or Five while 29% of students scored a Level Four or Five during the 2018-2019 academic year. Students’ proficiency in mathematics decreased from 54% to 51%, while student scores increased in non-proficient levels from 46% to 49%. The dynamics of the fifth-grade teachers, with four
having no prior experience teaching fifth grade mathematics, could have impacted negatively the students’ scores on the end of year mathematics assessment. Yet, students scoring Level Four or Five increased 15%, which was a noteworthy and unintended consequence of the professional development opportunities afforded the third-grade teachers.

![Bar chart showing number of students at different achievement levels for the years 2017-2018 and 2018-2019.]

**Figure 25.** Fifth grade scale scores of students.

I stated the directional null hypothesis would be that there was no difference in the mathematics scores between teachers supported by a full-time, site-based mathematics content area specialist and those that did not have a full-time, site-based mathematics content area specialist (Carroll & Carroll, 2002, p.87). Based on the data from the end of year state mathematics assessment, I accepted the null hypothesis because there was no statistical difference in teachers’ score. A full-time, site-based mathematics content area specialist did not significantly improve teachers’ abilities nor students’ Tier One achievement based on students’ state end of year mathematics assessment scores from school years 2017-2018 and 2018-2019.
Figure 26 displayed the data for the three grade levels’ end of year state standards assessment data for the years 2017-2018 and 2018-2019. Mean scores improved in third and fourth grades, but grade five mean scores remained the same. As previously noted, one grade five class had a significant change in academic demographics. Standard deviations decreased in all grade levels. The decrease in state mathematics standards assessment standard deviation scores mirrored those in AP3 standard deviation during the year of the study (See Figure 10). The decrease in standard deviations in all grade level scores could have been attributed to the math content area specialist facilitating weekly, grade level collaboration.

Third grade teachers improved their standard deviation variance from 9.81 to 3.79, a decrease of 6.02 in variance. Fourth grade teachers improved their standard deviation variance from 9.45 to 2.65, a decrease of 6.80 in variance. Fifth grade teachers improved their standard deviation variance 17.79 to 3.21, a decrease of 14.58 in variance. The decrease in teachers’ standard deviations may have indicated improved teacher instruction better aligned to state mathematics standards as a result of site-based mathematics professional development and weekly mathematics grade level collaboration supported by the math content area specialist.

<table>
<thead>
<tr>
<th>Teachers’ Groups</th>
<th>Mean</th>
<th>Standard Deviation</th>
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</thead>
<tbody>
<tr>
<td>3rd grade math teachers (297 Proficient)</td>
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<td></td>
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<tr>
<td>2017-2018</td>
<td>296</td>
<td>9.81</td>
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<tr>
<td>2018-2019</td>
<td>303</td>
<td>3.79</td>
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<tr>
<td>4th grade math teachers (310 Proficient)</td>
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<td></td>
</tr>
<tr>
<td>2017-2018</td>
<td>305</td>
<td>9.45</td>
</tr>
<tr>
<td>2018-2019</td>
<td>313</td>
<td>2.65</td>
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<tr>
<td>5th grade math teachers (320 Proficient)</td>
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<td></td>
</tr>
<tr>
<td>2017-2018</td>
<td>317</td>
<td>17.79</td>
</tr>
<tr>
<td>2018-2019</td>
<td>317</td>
<td>3.21</td>
</tr>
</tbody>
</table>

*Figure 26.* State Math Assessment correlated data analysis.
Figure 27 displayed the students’ mean scores for the state’s standardized end of year mathematics assessment pass rate percentages. The table showed the state means for all school districts, the district means for all schools, the district means for all elementary schools, and the means for the study school for school years 2017-2018 and 2018-2019. State and district means were stagnant, while district elementary schools showed a slight improvement. The study school’s mean score increased from 40% to 50%, which was double the average 5% growth in all elementary schools in the district. The study school’s improved mean score of 50% was equal to that of the district’s mean of all schools for both years of the study. While state and district pass rates remained stagnant, the mean pass rate of the study school increased by 10% indicting that the study school was successfully closing the achievement gap between proficient and nonproficient students in mathematics.

Figure 27. State Standardized Math Assessment pass rate percentage.

Figure 28 displayed the mean percentages for student learning gains in 2017-2018
and 2018-2019. Student learning gains means displayed included the state, all schools in the district, all elementary schools in the district, and the study school. Student learning gains increased in all sections with the study school showing the greatest increase in student learning gains. The state mean improved 1%, the district mean improved 2%, and the district elementary schools mean increased 11%. The study school’s student learning gains increase of 18% was not statistically significant. Student learning gains were earned when students increased their nonproficient scores based on a state rubric (See Figure 2 & Figure 3).

Figure 28. State Standardized Math Assessment learning gains.

Figure 29 displayed the mean percentages for student learning gains for the bottom quartile of students in 2017-2018 and 2018-2019. Bottom quartile learning gains means were shown for the state, all schools in the district, all elementary schools in the district, and the study school. The state’s bottom quartile learning gains remained stagnant. The bottom quartile learning gains of students improved for all schools in the
district, all elementary schools in the district, and the study school. The study school’s bottom quartile students’ scores increased from 22% to 49%. The study school’s lowest quartile students’ scores increased by 27%, which more than doubled the original mean score. The learning gains achieved by students of the study school surpassed the average learning gains in the state. Student learning gains for the bottom quartile were not statistically significant, though the decrease was relevant to this study. The study school’s student learning gains of the bottom quartile surpassed the state average by 3%. The learning gains of bottom quartile students represented the beginning of closing the achievement gap between proficient and nonproficient students at the study school.

![Figure 29. State Standardized Assessment learning gains for lowest quartile (25%).](image)

One responsibility given to the math coach in 2018-2019 was to oversee Tier Two and Tier Three math interventions in kindergarten through fifth grade classrooms. The math content area specialist was responsible for dispersing materials and providing professional development to teachers that supported students who struggled in math.
Additionally, the math content area specialist provided professional development on appropriate documentation and scheduling of Tier Two and Tier Three interventions within the instructional block.

The content area specialist supervised a morning intervention group of bottom quartile students in grades three through five. These students met in a computer lab and completed extra iReady lessons assigned by the math content area specialist. Students were assigned on-level standards lessons with the goal of closing the achievement gap between the targeted struggling students and students on level in mathematics. Students worked on math twice a week for 20 minutes before the official start of the instructional day. Student participation was voluntary, and invitations were given to students based on their math scores on the previous year’s state and district end of year assessments.

When the 2017-2018 student test results were received and the study school’s staff and students earned a D grade from leaders at the department of education, the leadership team of the school analyzed the data to plan for the following school year. One area of improvement identified was the bottom quartile learning gains of students. If the study school was able to increase the bottom quartile of student learning gains, then there was a possibility that the school grade would increase to a C.

Figure 30 displays the mean percentage scores for the achievement levels that were used to determine school grades within the state in which the school under study was located. The state department of education leaders used a formula consisting of achievement levels, learning gains, and bottom quartile learning gains in ELA, math, and 5th grade science to determine the school grade earned by the study school. Though none of the mean scores were statistically relevant, the improved bottom quartile student
learning gains could be a result of full-time, site-based mathematics professional development provided by the math content area specialist.

<table>
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<tr>
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<th>Standard Deviation</th>
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<td></td>
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<tr>
<td>2017-2018</td>
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<td>2018-2019</td>
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<td>Learning Gains</td>
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<tr>
<td>2016-2017</td>
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<tr>
<td>2017-2018</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>2018-2019</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>Learning Gains Lowest (25%)*</td>
<td>13.4</td>
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</tr>
<tr>
<td>2015-2016</td>
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<td></td>
</tr>
<tr>
<td>2018-2019</td>
<td>49</td>
<td></td>
</tr>
</tbody>
</table>

Figure 30. Study school correlated pair data for state standards assessment. *Learning gains in the bottom quartile.

Figure 31 displayed the percentage of points earned by the study school’s students out of 100 possible points on state mathematics standards assessments for the last four years. Student math achievement remained near 40% in 2016-2018 and rose to 50% in 2019. Student math gains fluctuated between 40% and 50% but increased to 59% in the 2018-2019 school year. Student math bottom quartile gains fluctuated from 30% in 2016 to 49% in 2019.

While students performing on level mathematics achievement was relatively stagnant over the last three years, during the 2018-2019 school year student proficiency scores increased by 10%. Student learning gains of the bottom quartile increased and showed 27% of the lowest performing students mastered grade level mathematics skills.
in tested grades. The increases in students’ grade level proficiency and students’ bottom quartile learning gains reduced the achievement gap in mathematics at the study school between students performing on level and below level. There may be a relationship between full-time, site-based professional development in mathematics and increased student mathematics mastery in third through fifth grade.

\[\text{Figure 31. State Standards Math Assessment school grade points earned 2016-2019.}\]

Figure 32 displayed the subgroups represented within the study school during the 2017-2018 and 2018-2019 academic years. The pass rates of students with disabilities improved in all categories with a substantial leaning gains increase of 31% in the bottom quartile student learning gains. The scores of students learning English improved in all categories with a 23% increase in grade level math achievement and a substantial 29% increase in the bottom quartile student learning gains. The scores of Black students improved in all categories with a 25% increase student learning gains and a 23% increase in the bottom quartile student learning gains. The scores of Hispanic students increased in
all categories with a substantial student learning gains increase of 27% in the bottom quartile student learning gains. The scores of White students improved in all categories with a 21% increase in learning gains and a substantial 32% increase in the bottom quartile learning gains. The scores of students who received free or reduced priced lunches improved in all categories with a notable 25% increase in the bottom quartile student learning gains.

Student math achievement pass rates increased in all subgroups at the study school. Students with disabilities math achievement pass rate increased from 18% to 30%, an increase of 12%. English language learning students’ math achievement pass rate increased from 26% to 49%, an increase of 23%. Black student math achievement pass rates increased from 32% to 45%, an increase of 13%. Hispanic student math achievement pass rates increased from 37% to 52%, an increase of 15%. White student math achievement pass rates increased from 45% to 58%, an increase of 13%. Students who receive free or reduced lunch math achievement pass rate increased from 39% to 51%, an increase of 12%.

Student math achievement learning gains pass rates increased in all subgroups at the study school. Students with disabilities learning gains pass rates increased from 32% to 55%, an increase of 23%. English language learning student learning gains pass rate increased from 41% to 60%, an increase of 19%. Black student learning gains pass rate increased from 33% to 58%, an increase of 25%. Hispanic student learning gains pass rate increased from 42% to 58%, an increase of 16%. White student learning gains pass rate increased from 43% to 64%, an increase of 21%. Students who received free or reduced lunch math achievement pass rates increased 41% to 57%, an increase of 16%.
Student math achievement learning gains in the bottom quartile pass rates increased in all subgroups at the study school. Students with disabilities learning gains in the bottom quartile pass rate increased from 19% to 50%, an increase of 31%. English language learning students learning gains in the bottom quartile pass rate increased from 29% to 58%, an increase of 29%. Black students learning gains in the bottom quartile pass rates increased from 15% to 38%, an increase of 23%. Hispanic students learning gains in the bottom quartile pass rate increased from 27% to 54%, an increase of 27%. White students learning gains in the bottom quartile pass rate increased from 23% to 55%, an increase of 32%. Students who received free or reduced lunch learning gains in the bottom quartile pass rates increased from 20% to 45%, an increase of 25%.

Students with disabilities averaged a 22% increase in mathematics scores from 2017-2018 to 2018-2019. English language learning students averaged a 24% increase in mathematics scores from 2017-2018 to 2018-2019. Black students averaged a 20% increase in mathematics scores from 2017-2018 to 2018-2019. Hispanic students averaged a 19% increase in mathematics scores from 2017-2018 to 2018-2019. White students averaged a 22% increase in mathematics scores from 2017-2018 to 2018-2019. Students who received free or reduced lunch averaged a 17% increase in mathematics scores from 2017-2018 to 2018-2019. The consistent improvement in students’ math pass rates in all subgroups could be a direct result of having a full-time, site-based math content area specialist at the study school who facilitated weekly, grade level mathematics collaboration and provided mathematics professional development.

On average, student math achievement pass rates increased 15% at the study school. On average, student learning gains pass rates increased 20% at the study school.
On average, student learning gains in the bottom quartile pass rates increased 28% at the study school. There may be a relationship between full-time, site-based professional development in mathematics and increased student mathematics mastery in third through fifth grade as evidenced by the improvement of students’ mathematics pass rates after the implementation of site-based mathematics professional development and weekly, grade level mathematics collaboration.

Figure 32. School grades in component subgroups in mathematics.
Figure 33 displayed the pass rate comparison data in third, fourth, and fifth grade for the 2017-2018 and 2018-2019 academic years. Third grade students made a notable increase of 20% improvement in mathematics in comparison to district and state scores that remained relatively stagnant. Fourth grade students made a notable increase of 21% improvement in mathematics in comparison to district improvement of 7% and state scores that remained stagnant. The scores of fifth grade students decreased 5% as did the average scores of fifth graders across the district on the state standards math assessment. The fifth-grade math assessment scores of students within the study state remained stagnant.

Figure 33. Math state assessment comparisons in grade three through five 2018-2019.

Surveys. As part of my research, I developed four types of surveys to collect qualitative data regarding site-based mathematics professional development at the study school in second through fifth grade. Teachers who participated in the study agreed to complete a Pre-Professional Development Survey, a Post-Professional Development
Survey, a Content Knowledge and Demographics Survey, and an Instructional Practices Survey. Given the pressure of moving the study school from a D rating to a C rating, many teachers were unwilling to take on what they felt was the added responsibility of participating in the research study. Four teachers volunteered to participate in the study, one teacher from each grade level in second through fifth grade. Two of the teachers who participated in the study were new to the study school and two of the teachers who participated in the study were teaching math for the second consecutive year in the same grade level. All four teachers identified positive relationships between their improved instructional practices, their student scores, and site-based mathematics professional development. A trend that emerged as I reviewed the data from the surveys was that site-based professional development and coaching provided by the math content area specialist along with weekly grade-level math collaboration facilitated by the math content area specialist benefitted teachers’ instructional practices and students’ achievement.

Teacher C2 had taught second grade for a total of 13 years, the last three of which were at the study school. When answering the Instructional Practices Survey question, “How has professional development enhanced your mathematics instruction?” teacher C2 wrote mathematics professional development experiences given by the math content area specialist provided “more awareness of a variety of strategies to use in reaching students at all levels.” When answering the Content Knowledge and Demographics Survey question, “To what degree do you effectively use mathematics manipulatives in elementary mathematics instruction?” teacher C2 wrote mathematics professional development provided by the math content area specialist supported teaching using the
“C-R-A method, concrete to representational to abstract, and moved students along that continuum as they were ready and took them back to concrete with manipulatives when they struggled.” Teacher C2 wrote, “I have grown in this area this year as we worked collaboratively to develop tests and analyze the questions that were in the tests provided to us in the curriculum to see if they matched up to the test item specifications,” when answering the Instructional Practice Survey question “How comfortable are you using test item specifications to design instructional activities?” Teacher C2 wrote, “Using test item specifications to design both the instructional activities and the tests” as a strength that I brought to collaboration as the content area specialist in mathematics when answering the Post-Professional Development Survey question, “Is there anything else you want me to know about your professional development experiences?”

Teacher B3 taught third grade at the study school for the last seven years. Teacher B3 taught math and science during the 2018-2019 school year. As a departmentalized teacher, teacher B3 participated exclusively in math grade-level collaboration facilitated by the math content area specialist and professional development provided by the math content area specialist. In the Instructional Practices Survey, teacher B3 said professional development enhanced instruction because the math content area specialist facilitated collaboration allowed for the sharing of other’s ideas “on how to teach tricky standards and incorporate them” into lesson plans and classroom instruction. In the Post Survey, Teacher B3 identified “using data to drive instruction and focusing on multiple ways to teach the standards to help students understand the content and the why” was the strength of standards-based mathematics instruction resulting from the year’s professional development.
Teacher D4 was new to the study school and new to fourth grade; therefore, there was no correlative data associated with this teacher. However, as a new teacher, teacher D4 volunteered to participate in the coaching cycle. During the Post-Professional Development Survey, teacher D4 wrote the professional development program at the study school was “well planned out and comprehensive.” Teacher D4 wrote as a result of site-based professional learning opportunities, “I have a better understanding of how to offer my students better remediation and enrichment activities to support individualized instruction.”

Teacher D5 was new to the study school and new to fifth grade; therefore, there was no correlative data associated with this teacher. However, as a new teacher, teacher D5 volunteered to participate in the coaching cycle. Teacher D5 wrote “more engaging strategies and sharing of ideas that work and have been proven” in response to the Post-Professional Development Survey question “What are your strengths in standards-based mathematical instruction after professional development?” provided by the math content area specialist. Teacher D5 wrote site-based professional development provided by the math coach was the reason instructional practices improved when asked “Is there anything else you want me to know about your professional development experience?” in the Post-Professional Development Survey.

**Interviews.** As part of my research, I developed quarterly interviews to collect qualitative and quantitative data regarding site-based mathematics professional development at the study school in second through fifth grade. Given the pressure teachers felt from school administrators, district personnel, and state department of education leaders to move the study school from a D rating to a C rating, many teachers
were unwilling to take on what they felt was the added responsibility of participating in the research study. Four teachers volunteered to participate in the interviews, one teacher from each grade level in second through fifth grade. Two of the teachers who participated in the study were new to the study school and two of the teachers who participated in the study were teaching math for the second consecutive year in the same grade level. A trend that emerged as I reviewed the data from the interviews was that student test scores were impacted positively as a direct result of mathematics professional development and coaching provided by the math content area specialist along with weekly grade-level mathematics collaboration facilitated by the math content area specialist.

Teacher C2 had taught second grade for a total of 13 years, the last three of which were at the study school. During the End of Year Interview, teacher C2 stated the math center we co-created at the beginning of the school year was very engaging to the students and was often selected when students had a choice of math centers. We co-created an independent math center designed for students to practice adding and subtracting by ones and tens from any number between one and one-hundred. During the End of Year Interview, teacher C2 stated, “Professional development helped my test scores.” Teacher C2 stated, during the End of Year Interview, “Your work with me helped me to get organized and excited about what I was doing in math centers, and teacher enthusiasm always helps students to have a better attitude about their learning and be more engaged.”

During the End of Year Interview, teacher C2 stated, “The strategies [on which] we collaborated in lesson planning helped me to anticipate some misunderstandings or try approaches that I might not have thought of on my own.” During the Quarter Four
Interview, teacher C2 said, “I have become more reflective regarding instructional practices as a result of the mathematics professional learning in which I participated this year.” During the Quarter Four Interview, teacher C2 stated, “Because we worked together, every time I saw you in collaboration or we discussed math, I was continually evaluating how things were working; even just seeing you in the hallway made me think about my math practices and what I was doing to continue what we had discussed.”

Teacher B3 had taught third grade at the study school for the last seven years. Teacher B3 taught math and science during the 2018-2019 school year. Being departmentalized allowed teacher B3 to focus on math content during collaboration and coaching. During the Quarter One Interview, teacher B3 agreed the mathematics professional development program at the study school made a positive difference in the academic achievement of students because third grade scores “were amazing last year.” During the Final Interview, teacher B3 said that professional development impacted positively math test scores. Teacher B3 went on to say during math collaboration, third grade teachers were “really focused on item specs and finding resources that practiced those test item specs.”

Teacher D4 was new to the study school and new to fourth grade; therefore, there were no correlative data associated with this teacher. However, as a new teacher, teacher D4 agreed to participate in interviews throughout the 2018-2019 school year. During the End of Year Interview, teacher D4 stated, “I believe my students greatly benefitted from the various strategies you introduced during our professional development.” During the End of Year Interview, teacher D4 said, “I believe the professional development positively affected my students’ test scores based on quarterly assessments and
benchmark exams leading up to the state standards assessment at the end of the year.”

During the Quarter One Interview, teacher D4 stated, “I believe the school’s math professional development was very beneficial to students because it provided a variety of resources focusing on all modalities and it offered various learning techniques for whole group activities, small groups, independent study, testing strategies, and center based learning; it’s very comprehensive.” During the Quarter Four Interview, teacher D4 said, “I am definitely more reflective, and it helped me provide meaningful instruction as well as benefitting my lesson planning; I feel more empowered with techniques and resources.”

Teacher D5 was new to the study school and new to fifth grade; therefore, there were no correlative data associated with this teacher. However, as a new teacher, teacher D5 agreed to participate in interviews throughout the 2018-2019 school year. During the End of Year Interview, teacher D5 was asked to rate personal mathematics instruction pre-professional development and post-ongoing, job-embedded, professional development. Teacher D5 self-rated at an instructional level of six on a Likert Scale from zero to ten, reflecting on beginning of the year instruction before the onset of mathematics professional development. At the conclusion of the year, teacher D5 self-rated at an instruction level of eight and identified site-based mathematics professional development was a vital support in that improved score. During the End of Year Interview, teacher D5 said ongoing, job-embedded professional development in mathematics “Helped improve my teaching strategies and I gained more knowledge and ideas from the other teachers.”

During the End of Year Interview teacher D5 said “If all grade level teachers
connected the skills that students should master, then it would help close the learning gaps.” In response to the Quarter One Interview question, “Do you believe that the mathematics professional development program at our school is making a positive difference in the academic achievement of students?” teacher D5 said, “When scores are better after [mathematics] professional development it is possible that the new learning strategies and knowledge were applied in the teaching-learning classroom environment.” In response to the Quarter Three Interview question, “How can I improve the way I design and implement mathematics professional learning to enable teachers to develop a clear vision of the program’s effectiveness and areas for improvement?” teacher D5 said site-based professional development could be improved by “providing hands-on experiences for the teachers similar to those students benefit from.” In response to the Quarter Four Interview question, “Have you become more reflective regarding your instructional practices as a result of the mathematics professional learning in which you participated this year?,” teacher D5 said there was an improvement in reflective practices and said, “I thought a lot of what could work best for my students and tried different strategies and attended [mathematics] professional development trainings that enhanced my knowledge in teaching math.”

Figure 34 displayed participants’ reflective self-ratings of their mathematics instructional practices based on my End of Year Interview questions. The quantitative interview question was to self-rate the level of mathematics instruction at the onset of the year and to reevaluate the level at the end of the year. All teachers who participated in the study cited an improvement in their perceived instructional abilities as a result of the site-based mathematics professional learning experiences delivered by the math content area
specialist.

![Teacher Qualitative Instruction Self-Rating](image)

**Figure 34** Teacher self-ratings of math mathematics instructional practices.

My As-Is Diagram 4Cs Analysis focused on the existing context, culture, conditions, and competencies of the stakeholders of the study school (See Appendix G). For the purposes of this study, context was defined as the overarching overt and subversive influences that impacted the study schools’ stakeholders socially, historically, and economically (Wagner et al., 2006, p. 104) Wagner et al. (2006) defined culture as the “shared values, beliefs, assumptions, expectations, and behaviors related to students and learning, teachers and teaching, instructional leadership, and the quality of relationships within and beyond the school” (p. 102). Conditions referred to the extrinsic necessities that were essential to develop student learning: time, space, and resources (Wagner et al, 2006, p. 101). Competencies were the knowledge and skills that impacted students’ learning (Wagner, 2006, p. 99).
**Context.** In elementary schools there was a strong focus on students and teachers in grades three through five. The school grades earned by students and staff at public schools within the study state were based on state standards assessments in grades three through five. School staff incentives or oversite were determined by school grades earned by staff and students. However understandable, the historic focus on third through fifth grade students was short-sighted by school and district administrators. If students in kindergarten, first, and second grade were not held to the same high-expectations nor receiving the same instructional supports such as after-school tutoring, extra iReady lessons designed to close the achievement gap between students proficient in mathematics and those students not yet proficient in mathematics, and more mathematics collaboration because of departmentalization, then the scores of third, fourth, and fifth grade students will suffer.

The focus on kindergarten, first, and second grade math content knowledge and pedagogy needed to be equally important as in third, fourth, and fifth grades. Equal focus would help close the achievement gap between students performing at grade level in mathematics and those students not yet performing at grade level in mathematics. It is long past time to stop seeing primary and intermediate grades as “competing commitments” of elementary schools (Wagner et al., 2006, p. 87-89). “Focusing the combined time, energy, and creativity of a group of committed professionals on a single pedagogical issue will inevitably lead to program improvements, as well as the school becoming a center of excellence” (Sagor, 2000, p. 9).

Students, staff, and leaders of the school under study were under oversight during the 2018-2019 academic year by the school district’s leaders and representatives of the
state’s department of education. Though not one of the lowest 300 schools as identified by state leaders, the school under study was targeted by representatives of the state department of education as needing improvement in state test scores or the state representatives would mandate additional measures to improve student achievement. Teachers and administrators were under a great deal of pressure to improve the school grade, with representatives of the state department of education threatening to sanction penalties upon the school if students underperformed again. Sanctions to the staff of the school could include change of all administrators, change of all instructional staff, extending the school day, and hiring an external operator to manage the school. The school’s administrators focused resources on the tested grades, 3rd grade through 5th grade, to reach the desired school grade of C and close the achievement gap identified in grades two through five between students proficient in mathematics and those not yet proficient in mathematics.

The school was built in a neighborhood that had been avoided historically by middle- and upper-socioeconomic families because of negative connotations associated with the surrounding neighborhood. This neighborhood had a high percentage of low-socioeconomic and minority families. The school’s population was almost evenly split with 1/3 White students, 1/3 Hispanic students, and about 1/3 Black students. The school’s zoning area stretched more than fifteen miles across and bordered the zoning boundaries of four other schools. Some students attended the study school though they lived closer to another elementary school.

In the 2017-2018 academic year, stakeholders at the study school had the resources of a part-time math content area specialist who worked with all teachers. Of the
two and a half days the math content area specialist was on the campus, one day was used for collaboration with 3rd through 5th grade teachers in grade level meetings focused on mathematics. In the 2018-2019 school year, the school under study had access to a full-time, site-based math content area specialist who worked with all teachers. Of the five days the coach was on the campus, two days were used for collaboration with kindergarten through 5th grade teachers in grade level meetings.

Kindergarten and first grade teachers met with the math content area specialist once a week to plan for mathematics instruction. Second, third, and fourth grade teachers were departmentalized allowing the math content area specialist to work with the teachers who taught math twice a week. Fifth grade teachers were split into three groups for collaboration: those who taught ELA, math, and science. The math content area specialist took on the role of math and science coach with fifth grade, devoting one collaborative session to math and one to science planning. The structure of the collaboration and instructional priorities limited the equity access to mathematics professional development opportunities through collaborative experiences.

The single overarching research question that drove this program evaluation was: Does site-based professional development in mathematics influence positively student achievement? The data did not support the hypothesis that site-based professional development opportunities influenced positively the Tier One achievement of students. There was compelling evidence that site-based professional development experiences impacted positively Tier Two and Tier Three instruction thus reducing the achievement gap among students performing below grade-level in mathematics, specifically students performing in the bottom quartile. Additionally, there was substantial growth in
mathematics assessments scores in all categories and subgroups. Furthermore, teachers at the study school identified mathematics professional development was a primary reason that students’ scores improved between the 2017-2018 and the 2018-2019 school years. Hoge (2016) said the most important thing schools and school districts can do to improve the achievement of students was to improve the quality of instruction received by the students (p. 89).

**Culture.** Within a social context, the study school’s student population was primarily from low-socioeconomic households. Most staff at the study school were middle-class females with multiple educational degrees. Administrators at the school had a high turnover rate, with five principals since the school opened nine years ago. The academic identity of the instructional staff, student population, and community were closely aligned with the state grades given the school as a result of the end of year state assessments. In nine years, the instructional staff and students of the study school earned one B, five C’s, and three D’s as assigned by the representatives from the state department of education.

The study school’s leaders wrote the school improvement plan with the objective to teach all students in grades pre-kindergarten through fifth. The study school’s leaders wrote the 2018-2019 mission statement to read “[the study school] seeks to create a challenging learning environment that encourages high expectations for all students, through developmentally appropriate and ambitious instruction, that allows for individual differences and learning style” (Citation withheld to preserve the anonymity of the school under study). However, there was an emphasis and prioritization of students and teachers in grades three through five because those student scores influenced the grade leaders
from the state department of education would assign the school for the 2018-2019 year. Competing priorities from state department of education representatives, district personnel, and school administrators impacted negatively teachers’ abilities to focus on one priority. Teachers often made fear-based decisions about instruction to protect their jobs. These same teachers were experiencing initiative fatigue with the school district leaders’ adoption of a new ELA curriculum for the second consecutive year.

The teachers of the study school possessed a low-expectation academic identity. Brendefur et al. (2016) said professional development was unable to increase student achievement because teachers did not have the characteristics needed to change their teaching practices: “coherence, active learning, sufficient duration, collective participation, a focus on content knowledge, and a reform rather than traditional approach” (p. 100). A growth mindset was initiated by the principal to encourage teachers and students to change the school’s academic identity to academically high achieving. Continuing to find and place blame on teachers and students only perpetuated the cycle rather than identify the problems and continued the cycle of perceived “failure” (Wagner et al., 2006, p. 8). Learning deficits in students were perpetuated across grade levels when students who complete kindergarten “with an inadequate knowledge of basic mathematics concepts and skills will continue to experience difficulties with mathematics throughout their elementary and secondary years” (Brendefur et al., 2016, p. 95).

Among the student population, 68.9% were labeled as living in low socio-economic households. The school’s zoned boundaries included several neighborhoods with high minority and low socio-economic populations. Though these neighborhoods were not all near the school site, thus limiting some parents’ abilities to participate in
school functions. The school had students enrolled and withdrawn throughout the year, in addition to students coming in tardy and leaving early, thus impacting negatively students’ academic instructional opportunities.

My first primary research question was: What type of site-based professional development improved teacher instructional practices and student achievement in mathematics? During mathematics collaboration, the math content area specialist observed several teachers did not fully understand the mathematics standards they were teaching nor were they able to perform the math that they were expected to teach; based on the knowledge of the math content area specialist regarding the study school’s teachers, this was competencies issue rather than a cultural issue. Grade-level teachers, facilitated by the math content area specialist, devoted a considerable amount of mathematics collaboration time to building understanding of the state mathematics standards and developmentally appropriate practices to teach those mathematics standards to students. Fifth grade teachers planned specifically with the end in mind, they started their math collaboration sessions by completing the assessment for the next math unit. If the teachers struggled to answer the questions, then they would struggle to teach the skills to their students, at which point the math content area specialist provided job-embedded on-demand mathematics professional development specific to the needs of the teachers.

During the weekly mathematics collaborative sessions, the math content area specialist identified teachers who were challenging students with standards reserved for the next grade level without ensuring that their class had mastered the required grade level skills. The math content area specialist provided mathematics professional
development experiences with pedagogical and content knowledge that developed a deeper understanding of the mathematics standards. Hoge (2016) said teachers involved in the coaching cycle with a math coach “had student achievement scores nearly twelve points higher than the average of all teachers’ students” (p. 90).

Through the course of the year, the math content area specialist worked with teachers on areas of weaknesses they self-identified and asked for assistance with. Subsequent to these teacher self-reflections, the math content area specialist provided model lessons, professional development experiences, co-teaching lessons, small group planning, and coaching cycle interactions. My goal was to develop teachers’ agency through self-reflection on their teaching practices. Teachers self-reflection enabled teachers to be purposeful and constructive in directing their own mathematics professional growth.

In addition to mathematics, the math content area specialist provided professional development and training for teachers using computer software and programs. The math content area specialist was the iReady Champion on-site and trained teachers on how to access the program and analyze the reports to maximize students’ instructional engagement. The math content area specialist also taught teachers how to use Performance Matters, FasttMath, Think Central, and StemScopes software to plan lessons and review student data.

Teachers benefitted from differentiated, on-demand, job-embedded professional learning experiences with feedback that was driven by their own agency. Teacher self-reflection was an essential component of mathematics professional development opportunities. Self-efficacy was critical to teachers improving their craft. Though there
was no statistical correlation found within the student test scores, many teachers’ scores improved with the addition of a full-time, site-based math content area specialist to support math instruction at the study school.

**Conditions.** The school under study maintained a negative social stigma with parents reluctant to enroll their children in a school that repeatedly produced proficiency averages of 40% in mathematics, well below the state averages of 57% (Citation withheld to preserve the anonymity of the school under study). Full-time, site-based mathematics professional development opportunities were inconsistent with a high turnover rate in mathematics site-based coaches and part-time coaches instead of full-time coaches, when site-based coaches were available to teachers at the school under study. Teacher equity of access was a limitation to some teachers receiving the full benefit of full-time, site-based mathematics coaching opportunities. Teachers who were not compartmentalized focused on ELA planning and professional learning more than mathematics.

Mandatory collaborative planning sessions were scheduled twice a week and incorporated professional learning activities, but teachers who taught multiple subjects had to prioritize with which content area specialist they would work. The school grade earned by the staff and students in 2017-2018 was impacted highly by a limited amount of student learning gains in the bottom quartile of the schools’ students. The grade earned by students and staff at the study school dropped from a B to a D because of the lack of student learning gains in the 2017-2018 school year. As a result of this decrease in the school grade, teachers and school administrators focused on closing the achievement gap by increasing learning gains in students scoring in the bottom quartile.

My second primary research question was: What was the best way to develop
effective job-embedded professional learning opportunities for teachers? Full-time, site-based mathematics content area specialists were the best way to provide effective job-embedded professional development to teachers. Math content area specialist used surveys, walk-throughs, and reflective activities to drive teacher agency in developing differentiated job-embedded professional learning opportunities.

**Competencies.** Historically, most professional development targeted ELA teachers. In order to improve the mathematics skills of our teachers, professional development specific to mathematics content knowledge and pedagogy was essential. Teachers were unable to teach that which they did not know. Teachers were able to tell students if they had an incorrect answer because teacher edition of the curriculum had the answers in it, but teachers without the necessary content knowledge in mathematics were unable to help students find the error in their calculations nor correct their misconceptions regarding mathematics. Teachers who lacked mathematics content knowledge struggled with meeting the needs of struggling students and challenging advanced students to maintain their engagement. It was not a requirement of perspective teachers to have passed the math sub-section in order to have passed the teaching licensing exam for elementary grade levels (Blazer, 2014, p. 27). High quality mathematics professional development was vital and when implemented well positively impacted student achievement (Brendefur, 2016, p. 105, Brown et al., 2018, p. 53).

More than just a lack of mathematics content knowledge and skills, site-based teachers were unfamiliar with the depth of content of the grade-level state standards in mathematics. Some teachers conducted surface level mathematics instruction without the pre-requisite knowledge of all the skills some standards covered nor the understanding of
what the skill would look like when translated into action by a student. Figure 35 displayed a fifth-grade fraction standard which required students to apply and extend upon their prior knowledge and understanding of multiplication and division to multiply and divide fractions.

Without content knowledge, teachers did not know what perquisite skills were needed for students to build upon. Collaboration sessions with the math content area specialist often involved decomposing the standards to ensure that all skills embedded within them were planned for with fidelity. Using Figure 35 fifth-grade teachers should have planned activities that compared, explained, recognized, and related fractions without performing multiplication. During a test preparation session, I taught this standard to every fifth-grade class in April of 2019 per the request of fifth grade teachers who were not comfortable teaching this standard. It was obvious that most of the fifth-grade students had not engaged in any discussion to explain their thinking and students struggled with not performing the multiplication to determine the relationship between fractions. This standard was not taught correctly by most fifth-grade teachers.

![Figure 35. Fifth-grade fraction standard: interpret multiplication as scaling (resizing).](image)

The administrators of the study school lacked knowledge of mathematics content knowledge and skills. Both assistance principals had previously been reading coaches.
One assistant principal was heard by the math content area specialist at a faculty meeting to say, “Math was not my thing.” During classroom walkthroughs, the site-based administrators contacted the math content area specialist to verify the appropriateness of mathematics instruction in classrooms. The study school administrators sat in and contributed during reading collaboration but not during math collaboration. Administrators were responsible for the evaluation of all instructional staff but lacked content knowledge in mathematics potentially limiting their ability to evaluate effectively. Wagner et al. (2006) said “there is no school for leaders that will teach them exactly how to make their [school] into one that will leave no child behind” in both math and reading (p. 11). St. Clair (2019) said coaching principals and other school leaders was just as important to continuous improvement within schools as coaching teachers (p. 8).

The biggest obstacle to overcome, in my experience during this study, was teachers’ resistance to mathematics professional development through collaborative planning and the coaching cycle. Few teachers were reflective enough to identify areas of weakness and ask for help to improve their teaching skills. Teachers were vocal in their displeasure with having to plan with their colleagues. Instead of appreciating the value in collaboration, teachers felt disrespected as professionals. Teachers wanted to plan “their way” using their template, resources, and experiences.

Moreover, teachers did not want their sacred planning time as defined in their contract to be taken away from them for forced math collaboration. Teachers capitulated to participate in math collaboration because it was mandated by site-based administrators. If teachers were as engaged as they strove for their students to be, then math collaboration would have been more impactful for those who participated. Teachers
mathematics professional development had the potential to increase the capacity of teachers to act purposefully and constructively to direct their own professional learning and contribute to the growth of their colleagues (Calvert, 2016, p. 2).

Levine (2019) said teachers’ isolation has caused a culture that makes it difficult to see options and invite peers to offer support (p. 65). The isolative nature of educators lent itself to a lack of appreciation for the benefits inherent through coaching and collaboration. When in the classroom, teachers had only themselves to depend upon in order to deliver meaningful instruction and maintain student engagement. Moreover, even if teachers participated in math collaboration there was not a system in place that ensured the best practices shared in math collaboration were translated to improved classroom practices. Belay (2016) said “teachers’ lack of motivation was found to be a significant inhibitor” of improved practices (p. 224). Wagner et al. (2006) said “virtually every other profession in modern life has transitioned to various forms of teamwork, yet most educators still work alone” (p. 72).

Another cause of resistance was the lack of solid relationships established within the study school between the math content area specialist and the instructional staff. In the 2017-2018 school year, the math content area specialist was part-time at the study school. Being part-time, the math content area specialist was often unable to meet the needs of teachers in a timely manner, thus causing teachers to find other sources to support them in their mathematics development. In the 2018-2019 school year, the math content area specialist was full-time at the study school. Being full-time allowed the math content area specialist to develop better relationships with the teachers on campus simply because of proximity and access to the instructional staff of the study school. Kennedy
(2016) said many of the most effective professional development programs had practitioners who were very familiar with the teachers and with the problems faced (p. 29).

The lack of reflective practices within mathematics practitioners had a negative impact on teachers becoming actively engaged in mathematics professional development and the coaching cycle. If teachers did not intentionally reflect on their practices nor desired to improve them, then teachers missed opportunities to identify ways they created obstacles that got in the way of their plans for improved professional growth and instructional practice (Wagner & Kegan, 2006, p. 55). During this study, I overheard teachers’ comments during weekly math collaboration questioning why they had to write new lesson plans each year to teach the same standards and ignored the fact that they had new students each year. It was easy for teachers to get into the rut of teaching and believe that they knew enough for their students to be successful. Embedding reflective opportunities within the mandated collaboration increased the potential for improved collaboration and more teachers taking advantage of full-time, site-based mathematics professional development delivered by content area specialists.

My secondary research question was: What professional development elements were necessary for site-based mathematics professional development to be successful? The most important element to successful professional development was the relationships built between the trainer and the trainees. When I was viewed by teachers as an asset to improve the achievement of students in their classes, they were more inclined to participate in mathematics professional development opportunities I facilitated as the math content area specialist. During this correlative study, I observed as teachers got to
know me better, they were more inclined to ask for support and work together during collaboration. When looking at teacher and student data, I noticed a trend that teachers who were consistently engaged in mathematics collaboration facilitated by the math content area specialist had higher student achievement scores on average than their peers who split their collaboration time between ELA and math. School leaders needed to devote time and money to mathematics professional development. Shaha, Glassett, and Copas (2015b) said improved student achievement on standardized assessments provided a “legitimate, rigorous, and generalizable approach” to validating professional learning experiences for teachers (p. 164).

**Interpretation**

This study sought to determine what impact a coherent, ongoing, site-based mathematics professional development program had on teacher instructional practices and students’ achievement as assessed by end of year math test scores. The results did not support the hypothesis that full-time, site-based mathematics professional development improved teacher skills nor student achievement based on data collected specific to Tier One instruction. The iReady AP3 diagnostics and the state standards mathematics assessments were designed to measure grade level or Tier One mastery. However, there was an impact upon closing the achievement gap of struggling students as those areas showed the greatest improvement in mean scores. The 27%-point increase in the school’s most struggling students supported the premise that the mathematics professional learning opportunities provided to teachers were able to begin closing the mathematics achievement gap of the school under study. Results from student assessments indicated
an increase in test scores following teacher participation in the professional development program.

Students iReady scores could have been better if the recommended forty-five minutes in math and reading were completed with fidelity by all teachers. Part of my responsibilities included monitoring the iReady program student usage. A small percentage of teachers on campus consistently achieved the goal of 45 minutes of instruction per week, but none of those teachers taught in grades two through five. Fifth and fourth grade classes seldom met the time requirements. If teachers had used the iReady program with fidelity, their achievement scores may have been better as students would have been exposed to more content.

The state assessments were a challenge for students and not always because they were uncertain regarding the mathematics content required. Taton (2015) said “the main problem with the traditional view of mathematics and mathematics learning and teaching [was] that it bears little resemblance to how mathematicians actually work” (p. 50). Students who could do the math were hampered by their reading abilities. Math tests often became reading comprehension tests as the application of math skills was influenced by reading (Rutherford-Becker & Vanderwood, 2009, p. 32). The 2018-2019 state assessment was converted from computer-based to paper-based. This conversion required students to have knowledge of certain item types and how to appropriately answer them on the paper test. If students were not exposed to equation editor, multi-select, selectable hot text, or editing task item types, then they would not be prepared to correctly answer the question, even if they had correctly done the math computation.
Not all mathematics answers within state standards assessments were strictly computation. Often students needed to problem solve and rigorously analyze the data given to determine the best answer. As a test proctor, I observed students who solved the equations correctly but answered incorrectly because they were unfamiliar with the item type. This was a surprise and disappointment to me because all item types were addressed during collaboration and additional mathematics professional development sessions. Pellegrino, Chadowsky, and Glaser (2001) said “assessments do not function in isolation; an assessment’s effectiveness in improving learning depends on its relationship to curriculum and instruction” (p. 222).

Less deviation in student scores could have been attributed to the math content area specialist facilitated grade level collaborative lesson planning sessions teachers were required to attend twice a week. Improved alignment of teacher instructional strategies, as supported by the math content area specialist, led to a more consistent level of mathematics standards instruction. Though there was student growth in the majority of classroom averages, the student growth was insufficient to be considered statistically relevant within the context of this study. Student learning gains of third through fifth grade students equated to improved Tier One instruction provided by instructional staff, that was enhanced through collaboration facilitated by the math content area specialist. The decrease in the student achievement gap could have been a direct consequence of improved Tier One instruction delivered after mathematics professional development and weekly grade level collaboration facilitated by the math content area specialist. Teachers and administrators at the study school cited full-time, on-site mathematics professional development and twice a week grade-level collaboration facilitated by the math content
area specialist as the primary reasons for the improved scores.

Teachers of exceptional students and school administrators identified on-site coaching and participation in collaboration with grade level peers as significant reasons why the scores of students with disabilities improved. Classes of exceptional students suffered the same inconsistency of instructional staff as did students in second, fourth, and fifth grade during the 2018-2019 academic year. Coaching support allowed teachers of exceptional students to align their instruction with general education classrooms, as did participation in grade level specific collaborative mathematics planning.

The decreased student scores in fifth grade could be attributed to the teacher turn over in fifth grade during the 2018-2019 academic year combined with new teachers' limited knowledge of fifth grade math content as evidenced during grade level collaborative planning and one-on-one coaching experiences. During collaboration sessions when the grade level planned with the end in mind, teachers new to the grade level were often unable to perform the mathematics necessary to pass the end of unit assessment. Fifth grade classes were not departmentalized like third and fourth grade classes were and the four teachers new to fifth grade had to master content in reading, math, and science. The fifth-grade student scores were 8% below district scores and 23% below state scores in mathematics.

The fourth-grade student scores were equal to the scores of students across the district, but 10% below the state scores of students. Though student scores increased within the fourth grade, a more significant growth may have been achieved if fourth grade students had experienced less transitions regarding teachers. Lack of teacher departmentalization might have been detrimental to fourth grade teachers’ instructional
practices. Like new fifth grade teachers, teachers new to the fourth-grade level had to master content in reading and math for students to be successful. Teachers A4 and D4 started as departmentalized teachers but took on the responsibility for all subjects as a result of the loss of teachers within the fourth-grade team. The lack of departmentalization limited teacher A4 and D4’s access to math collaborative planning and math coaching, as those teachers had to divide and prioritize their planning time.

The third-grade students and their teachers were the driving force behind the study school moving from a D rating to a C rating. In addition to the 20% increase in student math score proficiency from 2018 to 2019, the scores of third graders increased 17% compared to third grade students across the district and increased 4% compared to third grade students across the state. Third grade did not have any teacher transition during the 2018-2019 school year. Of the seven classes assigned to the study school, three teachers were departmentalized. The three departmentalized teachers were actively involved in all collaboration sessions and shared all their lessons with teacher A3.

This continuity of lesson design and implementation was identified by third grade teachers and school administrators as a primary reason for the improved student scores in third grade. There was one new teacher in third grade, but the veteran teachers and math content area specialist were able to support teacher D4 in mastering grade level math content. I observed the third-grade team was more engaged than other grade-level teams during collaborative planning sessions I facilitated as the math content area specialist. Third grade teachers’ instruction was more aligned than other grade-level teams to the lesson plans jointly created during collaborative sessions with the math content area specialist and third grade teachers were more willing than other grade-level teams to
allow teachers with perceived weaknesses to observe more experienced teachers during instruction.

Judgments

Bishop (2016) said it is “difficult to determine if the ongoing aspect of the professional development was more or less impactful than the content of the professional development” (p. 92). Full-time, site-based mathematics professional development provided by a math content area specialist allowed for job-embedded on-demand mathematics professional learning opportunities to blossom as needed to support teachers’ instructional practices and students’ achievement growth. Substantial student academic growth, as demonstrated on end of year assessments, was shown in all demographic sub-groups after a year of site-based mathematics professional development delivered by a math content area specialist.

The single overarching research question that drove this program evaluation was: Did site-based teacher professional development in mathematics influence positively student achievement? Yes and no. The data illuminated that struggling students benefitted more from the professional development of their teachers than their general education counterparts. The learning gains of the bottom quartile were influenced positively though not statistically significantly.

Collaboration was a compliance measure by most teachers and continued to be met with resistance by most of the teachers at the study school. At the onset of the 2019-2020 school year grade level teams were already requesting a decrease in the time allotted for grade level collaboration despite the growth achieved in mathematics the previous school year. Collins (2005) said “the moment you think of yourself as great,
your slide toward mediocrity will have begun” (p. 9). A growth mindset needed to be established that supported the premise that we were greater together than we were apart. Not only should collaboration be an expectation of teachers, but they should come to collaboration prepared to participate and contribute for the greater good. If we were all to succeed, we could not sit back nodding our heads in agreement but then return to our classrooms and do whatever we wanted despite the evidence that better practices yielded higher student achievement levels. “The move from teaching traditionally to teaching to build understanding [was] difficult” (Brendefur et al., 2016, p. 105).

Mathematics professional development should extend to administrators who were required to evaluate teachers based on their instructional practices and content knowledge. Lack of knowledge among administrators regarding mathematics content and skills resulted in inadequate instructional practices continuing in classrooms. When teachers were not departmentalized, a priority was placed on observing teachers during reading instruction. Departmentalization of math and reading within the study school provided administrators with greater opportunities to observe mathematics instruction, necessitating increased mathematics content knowledge in administrators. Belay (2016) said administrators should maintain a portfolio of each teacher to evaluate their professional progress in a “well-planned manner” (p. 224).

Math content area specialists were responsible for multiple grade levels but did not always have experience teaching all the grade levels they were required to support. Additional training for math content area specialists on all aspects of mathematics standards would be beneficial to support classroom teachers and ultimately improve student achievement. Elementary school math content area specialists were responsible
for supporting pre-kindergarten, kindergarten, first, second, third, fourth, and fifth grade teachers in general education and exceptional education classes. Lack of content knowledge and skills not only limited math content area specialists’ abilities to support teachers but could negatively impact relationships when teachers did not see them as a support.

**Recommendations**

I recommended all struggling schools maintain a minimum of one full-time mathematics content area specialist to help close the achievement gap between on-level students and below-level students in mathematics. For over three decades the National Council of Teachers of Mathematics advocated for mathematics specialists at elementary school and recommended mathematics professional development for teachers and administrators (Ellington et al., 2017, p. 146). The math content area specialist provided mathematics professional development and facilitated grade-level mathematics collaboration which impacted positively student achievement as observed in the longitudinal data collected from end of year state mathematics assessments from 2015-2016 to 2018-2019, with students’ pass rates in 2018-2019 being the highest in all categories.

Odden (2011) said “schools [should] employ one instructional coach for every two-hundred students” (p. 30). Blazer (2014) said there was a relationship between “teachers’ knowledge of math and the way that this content [was] enacted in the classroom” (p. 27). Hill et al. (2017) said students’ scores in mathematics increased as the number of hours of teacher professional development in mathematics increased (p. 72). Full-time, site-based math content area specialists should provide mathematics
professional development workshops based on elementary mathematics standards and pedagogy. Math content area specialists should design professional development opportunities with a focus on teachers’ learning needs and prior experiences.

I recommended provisions be established that ensured enough time was embedded within a math teacher’s workday for collaboration, coaching, mentoring, and follow up learning activities aligned to state mathematics standards and professional learning opportunities. There should be sacred time for grade level collaborative planning and for mathematics content knowledge professional development. Pemberton et al. (2016) said schools should provide teachers with a minimum of “50 hours of learning and practice in an area to improve their skills and their students’ learning” (p. 16). Taton (2015) said teachers should spend 60% of their workday providing student instruction while the remaining 40% should be devoted to professional learning and collaboration (p. 49). Bruner (1964) said “in ordinary adult learning a certain amount of motoric skill and practice seems to be a necessary precondition for the development of a simultaneous image to represent the sequence of acts involved” (p. 3).

Qualitative teacher data collected from surveys showed patterns of improved instructional practices as a result of full-time, ongoing, job-embedded professional development provided by the math content area specialist. Qualitative teacher data collected from interviews showed a trend of improved student achievement resulting from full-time, ongoing, job-embedded professional development provided by the math content area specialist. All teachers who participated in the study self-rated an improvement in their instructional practices as a result of full-time, ongoing, job-embedded professional development provided by the math content area specialist. The
trend I observed in the data was that student scores in grades two through five showed growth toward proficiency and students’ proficiency percentages increased with the support of a full-time, site-based math content area specialist.

The standard deviation scores of teachers in grade two through five within this study decreased from the 2017-2018 to 2018-2019 academic year. In iReady, the standard deviation of 2nd grade math student scores decreased from 9.53 to 3.09. In iReady, the standard deviation of 3rd grade math student scores decreased from 24.87 to 1.89. In iReady, the standard deviation of 4th grade math student scores decreased from 15.52 to 4.64. In iReady, the standard deviation of 5th grade math student scores decreased from 16.81 to 2.87.

The trend of decreases in the standard deviation of students’ scores in grade three through five carried over into the end of year state assessment in mathematics. The standard deviation of 3rd grade math student scores decreased from 8.01 to 3.09. The standard deviation of 4th grade math student scores decreased from 7.72 to 2.16. The standard deviation of 5th grade math student scores decreased from 14.52 to 2.62. The pattern of decrease in standard deviations across grade level student scores could be attributed to a closer alignment in classroom instruction of state mathematics standards as a result of once a week, grade level collaboration facilitated by the full-time math content area specialist and mathematics professional development provided by the full-time math content area specialist.

I recommended a grade level specific math assessment for all teachers prior to the onset of the instructional school year. Teachers cannot teach what they do not know. This pre-assessment would drive math content knowledge professional development for
teachers at school sites. Garet et al. (2016) said “elementary school teachers may especially benefit from content-focused PD because they [were] less likely to formally study math in college than secondary teachers” (p. ES-1). During the study, I observed teachers requested more professional development after struggling to complete the standards assessment connected to the unit being planned for during mathematics collaboration. During the study, assessing teachers’ knowledge of mathematics content prior to instruction allowed teachers to use their own agency to drive their specific mathematics professional development needs. By identifying teacher proficiency in mathematics, administrators could place teachers in appropriate instructional positions and minimize the teacher turnover percentage at the study school.

I recommended the district create a mathematics specialist endorsement (McGatha, 2017, p. 68). “In 1981, the National Council of Teachers of Mathematics recommended that states provide a teacher credential endorsement for elementary specialists” (Ellington et al., 2017, p. 146). Math content area specialists should be well trained in all mathematics standards so that they can support all grade levels effectively. District level training for math content area specialists should include mathematics content knowledge for teaching of mathematics, pedagogical content knowledge for teaching mathematics, and leadership knowledge and skills as a site-based math coach (McGatha, 2017, p. 74). “Coaches should have a deep knowledge of instructional practice and theory so they can support teachers in assessing their own practice and making connections between theory and practice” (McGatha, 2017, p. 75). Wagner (2008) said a mismatch existed between what was taught to students and what students were tested on, what was needed for school and what was needed for life, and what math coaches needed
to support math instruction specific classroom teachers (p. 92). “Virtually every state offers certification for reading specialists, while fewer than half of the states have enacted certification for mathematics specialists” (Ellington et al., 2017, p. 147).

I recommended all math teachers participate in math collaboration at least once a week. The collaboration should be standards based, data driven, and facilitated by a trained math content area specialist. The collaboration should include scheduling times for the math content area specialists to observe the teacher implementing the lessons designed and opportunities for the teachers to reflect upon the lesson with feedback from the math content area specialist. The observations, reflections, and feedback should be job-embedded expectations of teachers, coaches, and administrators. School administrators identified the quality of mathematics collaboration as a defining factor in the improvement in student mathematics scores on the 2018-2019 end of year state mathematics standards assessments. When participating in the study surveys and interviews, teachers stated collaboration was beneficial to their instructional practices and increased student achievement. Wagner (2008) said “we continue to teach the same tired content in the same old ways” but we can change this cycle through collaboration, coaching, and professional development focused on mathematics (p. 92).

Guskey (2014) said mathematics teachers should use a reverse plan during grade level mathematics collaboration so they know student learning goals and develop a plan to reach those same goals specific to student achievement (p. 14). “The planning needs to begin with [a] discussion of intended effects on student learning” (Guskey, 2014, p. 14). When teachers planned in collaboration, teachers needed a shared vision of student’s goal and created specific, concrete, and actionable ways for students to attain those goals.
Lemov (2015) said when teachers plan in collaboration, they “progress from unit planning to lesson planning” by defining the objects, deciding how they will access the objective when it is completed, and choosing activities that were appropriate to the objective (p. 132).

Mathematics professional development experiences must be designed with the end in mind through the backward planning process (Guskey, 2014, p. 13). Rather than evaluating the participants skill set first, professional learning practitioners must identify “intended effects of student learning,” the desired student outcomes, and what evidence will be used to determine if the desired outcome was achieved. After the student goal was identified, then professional development personnel must determine what practices needed to be implemented along with the required organizational supports. Using this design, professional development facilitators supported teachers as they increased their content knowledge through focused professional learning opportunities.

Math content area specialists were responsible for multiple grade levels but did not always have experience teaching all the grade levels they were required to support. Additional training for math coaches on all aspects of mathematics standards would be beneficial to support classroom teachers and ultimately improve student achievement. Elementary school coaches were responsible for supporting pre-kindergarten, kindergarten, first, second, third, fourth, and fifth grade teachers in general education and exceptional education classes. Math content area specialists’ lack of content knowledge and skills not only limits math coaches’ abilities to support teachers but negatively impacted relationships when teachers did not see them as a support. “Most mathematics specialists in school districts across the country [were] appointed to their position, often
without the proper knowledge and skills in mathematics content, pedagogy, and school-based leadership” (Ellington et al., 2017, p. 147).

**Conclusion**

This mixed methods, correlative study of elementary site-based mathematics professional development’s impact on student achievement was not as positive as I had hoped. The minimal improvements in Tier One students’ scores might not have justified a full-time, site-based math content area specialist, but the increase in the bottom quartile of students’ scores showed the potential for closing the achievement gap between students proficient in mathematics and those students not yet proficient in mathematics that a math content area specialist could offer an elementary school. School grades were tabulated using three measures of student success: math achievement, math learning gains, and math learning gains in the bottom quartile. The points students and teachers earned for each component were added together and divided by the total number of possible points to determine the percentage of points earned. Though not statistically significant, the improvement in students’ mathematics achievement were substantive.

Student learning gains were generally perceived as easier to earn because there were sublevels within the five levels, giving students more opportunities to show growth. Growth in below level sub-groups was easier to identify because of the large range of areas that student scores could fall into and be considered growth. Students who score Level Four or Five were generally perceived by educators at the study school as having difficulty maintaining or increasing such high scores. Though the gains in the bottom quartile student scores were hoped for, the increases in the percentages of students scoring Level Four and Five were unanticipated. Teacher qualitative data collected from
surveys and interviews supported the benefits to students’ achievement and teachers’ instructional practices as a result of full-time, ongoing, job-embedded, on-demand professional development. Wagner et al. (2006) said considerable impact could be made on individuals’ behaviors and performance through small modifications (p. 129).
Section Five: To-Be Framework

The purpose of this correlative evaluation was to determine the impact school-based mathematics professional development opportunities for teachers had on students’ mathematics achievement in primary grades at an elementary school in a mid-sized school district. The demographic population of the students attending the study school were 36% Hispanic, 36% White, 23% Black, and 6% other ethnicity. 70% of the student population of the study school lived in low-socioeconomic households. Throughout the 2018-2019 academic year, the study school’s student population maintained an average of 870 students. The study school’s teachers were supported by one principal, two assistant principals, one dean, one resource officer, two guidance counselors, three ESE support facilitators, one MTSS coach, one ELA content area specialist, and one math content area specialist.

During the 2018-2019 academic year, the kindergarten team consisted of six female teachers. During the 2018-2019 academic year, the first-grade team consisted of seven female teachers. During the 2018-2019 academic year, the second-grade team originally consisted of six female teachers and one male teacher, though at the beginning of the year six of the teachers worked in a team-teaching model with three of the teachers exclusively providing instruction in mathematics. Though as previously noted the teacher transitions within the second-grade team often had uncertified substitute teachers covering classrooms or the seven allocated units combined into four or five classrooms.

During the 2018-2019 academic year, the third-grade team had six female teachers and one male teacher, though six of the teachers worked in a team-teaching model with three of the teachers exclusively providing instruction in mathematics. During
the 2018-2019 academic year, the fourth-grade team had seven units allocated, though as previously noted all the units were filled for an only few months. Originally there were three female and three male teachers at the onset of the year, but at the end of the year there were four female and two male teachers. During the 2018-2019 academic year, the fifth-grade team initially consisted of seven females but as previously noted the seven-unit allocations were condensed down to six classrooms.

I observed, during this study, repeated issues at the study school: resistance to mathematics collaboration and coaching, lack of mathematics content knowledge, lack of stable instruction in grade-levels, and a low academic identity. Through collaboration and coaching with the faculty, a change plan could be developed to move from a fixed mindset to a growth mindset that allowed for actively engaged participation in collaboration and coaching, consistent grade-level math content knowledge possessed by stable and focused instructors, and an academically high-achieving academic identity throughout the school (Dweck, 2016). All stakeholders needed to be a part of a system of “practice dedicated to continuous improvement” (Wagner et al., 2006, p. 25).

**Envisioning the Success To-Be**

If my organizational change plan were realized, future teachers at all elementary schools with similar demographics would have strong content knowledge and pedagogy in mathematics and receive on-demand, job-embedded, site-based professional learning provided by a full-time math content area specialist to reduce the achievement gap in mathematics between proficient students and students not yet proficient in mathematics. All elementary schools would have a minimum of one full-time mathematics content area specialist to support teachers’ realities as today’s economy demands teachers and
students acquire through new sets of skills (Wagner et al., 2006, p. 5). When administrators and math coaches supported adult professional learning, elementary schools become “better places of learning for both children and adults” and student achievement increases “when adults learn and grow in schools” (Drago-Severson, Blum-DeStefano, & Asghar, 2013, p. 13).

My To-Be Diagram 4Cs Analysis focused on the potential context, culture, conditions, and competencies of the stakeholders of the study school (See Appendix H). Context referred to how well the staff of the study school could impact the “core competencies students will need for work, citizenship, and continuous learning” (Wagner et al., 2006, p. 108). Culture was how the identity of the school was characterized by stakeholders and outsiders. Conditions were defined as whether we were able to “create and maintain” the “external architecture” necessary to support student learning (Wagner et al., 2006, p. 101). Competencies were how well we evolved to a growth mindset (Wagner et al., 2006, p. 108).

**Context.** When implemented with fidelity, my recommendations would be evident within the social structure of the school. All teachers would be actively engaging in weekly mathematics collaboration facilitated by the full-time math content area specialist. All teachers would have equitable access to site-based, on-demand, job-embedded mathematics professional learning opportunities facilitated by the full-time math content area specialist. Equal focus would be placed on math instruction in all grade levels, with equal accountability for student achieving mathematics mastery of grade-level standards. As the achievement gap continues to close, as a direct result of the implementation of my recommendations, the students and staff of the study school would
reach the final stage of the Cycle of Excellence and shine as a premier elementary school within the school district (Hallowell, 2011, p. 6).

The historical academic identity would be replaced with a high-achieving academic identity as the student achievement levels at the school continued to improve the school grade earned from the state department of education representatives. The students’ scores at the study school would earn an A or B rating consistently from the state department of education representatives after my recommendations were implemented with fidelity. The students at the study school earned the highest percent of points in math achievement, in four years, with the improved instructional practices developed in twice a week grade-level collaboration facilitated by the math content area specialist and site-based professional development provided by the math content area specialist. The trend of student’s math achievement increasing will continue when my recommendations are implemented with fidelity. When the students at the study school earn an A rating from the state department of education representatives and continue to close the achievement gap by performing at grade level on end of year state mathematics standards assessments, the students and staff at the school would reflect the high-achieving academic identity of other high performing elementary schools in the district.

Huinker (2019) said:

It [was] our collective responsibility to ensure that each and every student [had] experiences throughout one’s prekindergarten through grade 12 education to develop deep mathematical understandings, a positive mathematical identity, strong agency, and a sense of competence and pride in one’s mathematical abilities. (p. 287)
School administrators should prioritize mathematics professional development and collaboration as a school initiative and provide monetary support of enough content area specialists to meet the needs of the instructional staff. Administrators will budget funds to pay for content area specialists’ base salaries, $55,000 annually per math content area specialist plus an additional $10,000 for fringe benefits. In addition to salaries, school administrators will budget funds to pay for materials necessary to support site-based professional development, $1000 annually.

Teachers would have job-embedded accountability for mathematics collaboration and professional development. The math content area specialist would provide follow-up and feedback subsequent to grade-level mathematics collaboration and site-based professional development. The math content area specialist would schedule follow-up observation with teachers to observe the implementation of collaborative lessons designed in facilitation with the math content area specialist and professional development delivered by the math content area specialist. The math content area specialist would schedule post-observation feedback sessions with teachers to continue the coaching cycle and develop rigorous instructional practices. Guskey (2014) said “the most valuable feedback to teachers [was] regular, specific, and based on trusted measures of students learning” (p. 15). Teachers involved in the change process were in disequilibrium, but even though improvement was uncomfortable teachers “continue their implementation efforts if they see positive student results” (Guskey, 2014, p. 15).

Culture. Wagner et al. (2006) said moving from good to great required the creation of a shared vision of “rigorous instruction” (p. 90). The academic identity of the study school needed to change to one of high-achieving and successful academic
achievement in mathematics. In order to meet the current and future requirements of teaching, teachers needed the additional training and support provided by a full-time mathematics content area specialist who offered on-demand, site-based, job-embedded professional development as the academic identity of the school evolved (Bishop, 2016, p. 75). All stakeholders would share the same high-expectation academic identity for all students. As administrators, teaching staff, coaches, and the student population focused on achieving resonance within the academic identity of the study school, “hope [was] the driver, compassion enables it, and mindfulness makes the path smoother and more understandable” (Boyatzis & McKee, 2005, p. 88).

Site-based math content area specialists were needed to “refocus mathematics instruction toward inquiry and concept-based teaching” (Blazer, 2015, p. 27). As a universal acceptance of the philosophy of early learning demonstrated with equal focus on primary and intermediate grades, student achievement would increase as a direct result of easier transitions between grade levels within the developmental continuum. Stakeholders should possess a universal acceptance of the philosophy of early learning and brain development in mathematics. Transitions were eased between grade levels as the primary grades were considered a developmental continuum with fewer gaps in instructional delivery and students’ mastery of grade-level mathematics skills.

All stakeholders would possess a growth mindset as the study school increased its instructional capacity. All students were supported through the directed, noncompeting efforts of all stakeholders who shared the vision of becoming the premier elementary school in the district. Equal focus was placed on primary and intermediate grades as all students were provided with the best resources to be academically successful. Dweck
(2016) said “people with the growth mindset [were] clued in to all the different ways to create learning” (p. 62). The students and staff of the study school would be defined by a reputation of “academic care, challenge, task-focused goals, active learning, engagement and vitality, cooperative learning, meaningfulness, student-anchored learning, and evidence-based decision making and feedback” (Murphy, 2016, p. 102).

Teachers would drive their own mathematics professional development through reflective practices developed by their own agency. Teacher self-reflection would become a cultural norm to all instructional personnel to improve their teaching skills and increase student engagement. Teacher self-efficacy would be used strategically to improve instructional practices and ultimately student achievement. At the onset of the academic year, teachers would take a grade-level specific math assessment to determine their prior content knowledge and areas in need of support from a math content area specialist. The math content area specialist would develop professional learning opportunities to “suit the individual needs and learning orientations” of teachers, while offering teachers the choice of “designing and implementing” their personal mathematics professional development experiences (Drago-Severson et al., 2013, p. 146-147).

Teachers would develop the shared values and adopt the shared vision of the study school becoming the premier elementary school in the district. The instructional and administrative staff members would share a growth mindset that perpetuated the cycle of high-student achievement at the study school. Administrators and content area specialists would embrace the development of all instructional staff members, while all instructional staff members would embrace the development of all students (Dweck, 2016, p. 142). Huinker (2019) said a “shared responsibility for teachers of all grades can
empower every student as a capable lifelong learner and confident doer of mathematics” (p. 283). The beliefs and behaviors of instructional staff would translate into improved student achievement in mathematics and a closing of the achievement gap between students proficient in mathematics and those struggling in mathematics, facilitated by the full-time mathematics content area specialist. As stakeholders rescued their “core values from banality” and developed the same beliefs and behaviors, the culture of the study school would become a culture of reflective excellence (Duckworth, 2016, p. 257).

As school stakeholders “update [their] beliefs about intelligence and talent” and “practice optimistic self-talk” about their students and co-works, they would build positive relationships between themselves and their students (Duckworth, 2016, p. 192-193). Instructional staff would focus on teaching state mathematics standards rather than curriculum, and all curriculum used for instruction would align to state mathematics standards and provide students with the best learning opportunities. Teachers and the math content area specialist would share best instructional practices during grade-level collaboration facilitated by the math content area specialist and schedule time for the math content area specialist to observe their classroom delivery of best instructional practices related to state mathematics standards being taught by teachers. During grade level mathematics collaboration and mathematics professional development, the math content area specialist would share with instructional staff best instructional practices, cultural competencies, and current scholarly trends as identified in academic resources.

**Conditions.** Full-time, site-based math content area specialists at every elementary school would provide on-demand, job-embedded professional development as identified by teachers and administrators. Mathematics professional learning
opportunities would be specialized and aligned with pre-kindergarten through fifth grade standards and developmental norms. Enough sacred time would be embedded within the workday to allow teachers to participate in mathematics collaboration, coaching, mentoring, and follow-up learning activities aligned to state mathematics standards. Leaders in effective schools would be diligent in protecting time for coaching and collaboration specific to mathematics (Murphy, 2016, p. 55).

Grade level mathematics collaborations would occur a minimum of once a week facilitated by the math coach. State mathematics standards would be taught with fidelity as a result of grade-level collaboration and math coaching to gain understanding by all practitioners. During collaboration, co-teachers and team-teachers would be able to focus on standards instruction and increasing student achievement. Murphy (2016) said the nature of collaboration was to “forge joint understanding of and shared practices in the service of students” through productive inquiry that was “analytic, dynamic, continuous, and constructive” (p. 78). Grade-level mathematics collaboration provided opportunities for teachers to implement strategies introduced through site-based professional learning (Bishop, 2016, p. 20).

Elementary schools would have stable teacher forces of qualified personnel with growth mindsets in all grade levels. All stakeholders would have a vested interest in students succeeding in mathematics in all grade levels and mastering the grade-level mathematics content. Murphy (2016) said it was important to match teachers with grade-levels and subjects for which they were “formally prepared” to provide instruction, thus aligning the talents of teachers with the needs of students (p. 52).

Ideally, administrators at the study school would have autonomy to use their
budget as they saw fit to improve the student achievement of their school and meet the financial challenges specific to the school. Ideally, the study school would have enough time scheduled to provide a 90-minute mathematics block which included time for whole group instruction, small group instruction, and independent practice every day. Ideally, teachers would have enough space in their classrooms to maintain math centers that include manipulatives to be used daily. Ideally, the math content area specialist would have a budget of $1000-$3000 a year to supply teachers with resources to support mathematics instruction: updated professional literature, manipulatives, and classroom supplies. Ideally, the math content area specialist would have enough time embedded within teachers’ workdays to review current mathematics research, updated mathematics professional literature, and best practices on mathematics instruction with all mathematics instructional staff. Ideally, the math content area specialist would have a space devoted to mathematics collaboration where mathematics strategies and exemplars could be displayed for teachers during mathematics professional development and grade-level mathematics collaboration.

**Competencies.** As a result of site-based, on-demand mathematics professional development and weekly grade-level mathematics collaboration, the students and staff of the study school would improve the letter grade assigned to the school by representatives of the state department of education from a C to an A rating based on student achievement on state assessments. Once the A rating was achieved, the teaching staff and student population would continue to work to maintain the A rating awarded by representatives of the state department of education. Once designated an A school, the study school would no longer require oversight by representatives of the state department
of education. The students and staff of the study school would neither fall into the state’s bottom three hundred of schools nor would it be targeted by representatives of the state department of education for needing improvement but would continue as a model school within the district. The study school would provide equal focus on grades pre-kindergarten through five. “Quality professional development matters and when implemented well can affect student achievement” (Brown et al., 2018, p. 105).

The mathematics achievement gap between students performing below-grade level expectations and students performing at or above grade-level expectations would be reduced and closed when teachers were provided equal access to quality on-demand, site-based, job-embedded mathematics professional development facilitated by a full-time math content area specialist. Through coaching and collaboration, teachers and the math content area specialist would engage in conversations about rigor to prompt elementary teachers to reflect on “their own practices and to make gradual changes to instruction that [focused] on student thinking rather than right answer responses” (Wagner, 2008, p. 162). The highly capable individuals at the study school would make “productive contributions through talent, knowledge, skills, and good work habits” as the mathematics achievement gap between students performing below-grade level expectations and students performing at or above grade-level expectations was closed (Collins, 2005, p. 12).

All teachers would participate in a minimum of once a week grade level mathematics collaboration facilitated by the math content area specialist. In addition to planning for grade level math skills, collaboration would provide teachers with mathematics professional learning experiences pedagogy that was specific to grade level and students’ developmentally appropriate practices to enhance students’ instructional
Mathematics professional development experiences. Additionally, math content area specialists would participate in regular mathematics standards professional learning for all elementary grades to better support the diverse population within district elementary schools. Math content area specialists would receive math professional development from mathematicians working at the college partnered with our local high schools. Trained math content area specialists would assist teachers in “making connections between theory and practice” while improving individual teacher’s instructional practices in mathematics (McGatha, 2017, p. 75). Murphy (2016) said teacher learning “rests on the understanding that what teachers do outside their classrooms [was] as important as what unfolds inside those settings and that collective work done well can accelerate their learning and the achievement of their students” (p. 74).

Wagner et al. (2006) said that competencies were the “repertoire of skills and knowledge that influences student learning” (p. 99). The ever-evolving nature of the field of education required educators to “change the way they go about their jobs and redesign the culture in which they work” in order to meet the needs of students (Guskey, 2000, p. 3). Mathematics professional development must include strong ties to both primary and intermediate education. The goal of professional learning for elementary mathematics teachers was to “improve teachers subject-matter knowledge based on the content of the curriculum and the teaching approaches which require teachers to engage students in the development of higher-order thinking skills” (Belay, 2016, p. 219).

Relationships would be built between the math content area specialist, teachers, and administrators to support the needs of the student population. Math content area specialists should be a stable force to support teachers, students, and administrators on
school campuses. Relationships take time and shared experiences to build, and the effectiveness of a math content area specialist would increase as deeper relationships evolved through coaching and collaboration in mathematics. Being an effective math content area specialist required an intimate knowledge of teachers’ deficiencies and strengths so they could maximize instructional best practices. Elementary school stakeholders would create a holding environment of safety and caring by developing a culture that supported continued mathematics professional growth (Drago-Severson et al., 2013, p. 117). “Our relationships [were] an essential part of our environment and [were] key to sustaining personal transformation” (Boyatzis & McKee, 2005, p. 104).

Adequate knowledge among math content area specialists, teachers and administrators on data use, pedagogy, and content knowledge would ultimately lead to gains in student achievement. All stakeholders would engage in reflective practices regularly to improve their instructional capacity. Teachers’, administrators’, and coaches’ self-efficacy should drive their professional development to improve mathematics content knowledge. Content knowledge instruction in all grade levels will be compulsory for all elementary math content area specialists to support classroom teachers and improve student achievement.

Teachers would be actively engaged in mathematics professional development through collaboration and coaching. All grade level teachers would benefit from the support of a site-based mathematics content area specialist to deliver quality on-demand, job-embedded professional learning experiences. The achievement gap between students performing at grade-level expectations and students performing below grade-level expectations in mathematics could be reduced through equal access to quality site-based
professional development in all elementary grade levels. Representatives of the state department of education continue to change the standards for mathematics as the knowledge base of content and pedagogy expanded forcing teachers to acquire new types of expertise at all levels of mathematics instruction (Guskey, 2000, p. 3). For schools to improve, we must first improve the abilities and skills of the educators within them (Bayer, 2014, p. 319). Improvement in educational quality resulted in increased student achievement was linked to the continuous mathematics professional learning of teachers (Belay, 2016, p. 218).

Conclusion

My future vision of the study school was to develop a growth mindset and instructional capacity in all stakeholders while encouraging more mathematics collaboration and greater commitment to the learning and growing of all students, teachers, and administrators (Dweck, 2016, p. 144). When teachers commit “to continuous improvement with the target of student achievement clearly the focus” students succeed (Hoge, 2016, p. 91). Students, teachers, and administrators would benefit from site-based, on-demand, on-going, job-embedded mathematics professional development provided by a full-time mathematics content area specialist. Wagner (2008) said there were seven skills that were prerequisite to developing a culture of learning: inquiry, expression, critical thinking, collaboration, organization, attentiveness, involvement, and reflection (p. 244-245). All seven skills were embedded within the mathematics professional development provided by the math content area specialist and within the grade-level collaboration facilitated by the math content area specialist. With ongoing support from a full-time site-based math content area specialist, the study school
would continue to close the achievement gap in mathematics between students performing at grade-level and those performing below grade-level.
Section Six: Strategies and Actions

This Strategies and Actions Section represented my conceptualization of changes needed in the areas of context, culture, conditions, and competencies. These changes were necessary to foster the effective implementation of an organizational change plan within the study school with the purpose of improving student achievement. The organizational change plan for student achievement improvement was based on the implementation of full-time, ongoing, job-embedded mathematics professional development provided by a mathematics content area specialist and weekly grade-level math collaboration facilitated by a mathematics content area specialist. My intent was to correlate the instance of effective mathematics professional development with improved student achievement in mathematics. The strategies and actions to be introduced in this section were in response to my “As Is” diagram (See Appendix G) needs identification and purposed to effect the obtainment of my vision of what a premier elementary school in the school district would be as depicted in my “To Be” diagram (See Appendix H). The strategies and actions I have selected were based upon organizational change theory, professional development research, best practices leadership strategies, growth mindset psychology, instructional capacity frameworks, and communication strategies. If enacted by the administrative team at the study school, the strategies and actions contained in this section would be used by the instructional staff to support the academic success of at-risk student populations as a means for meeting the requirements of ESSA. Ultimately, it was the students at the study school who would benefit from the mathematics professional knowledge gleaned from the findings contained within this correlative, mixed-methods evaluation of the study school.
Strategies and Action

Hallowell (2011) said there were five steps within the Cycle of Excellence: select, connect, play, grapple and grow, and shine (p. 6-7). If the study school translated these steps into actions, then the achievement gap at the study school could be closed. My analyses of the quantitative data collected during this study displayed increases in students’ mathematics scores in all tested grades and may have indicated that teachers were more effectively delivering mathematics instruction. However, the majority of fifth grade students still scored below proficiency level on the end-of-year state standards mathematics assessment. My consideration of the below proficiency level scores caused me to wonder if the right people were in place as instructional content delivery agents to delivery maximum effect on student learning. Therefore, I identified the first step for becoming a premier elementary school in the district was to make sure that the “right people” were put in the appropriate grade level and content area instructional positions (Hallowell, 2011, p. 43).

To ensure that teachers were in the most effective instructional position, elementary teachers of mathematics would take a mathematics assessment before the onset of the instructional year that accessed the teacher’s competence level in all the standards that would be taught to students at that grade level. Teachers would take this assessment as part of a grade-level collaborative pre-planning session and as an extension of the concept that we must plan with the end in mind (Guskey, 2014, p. 14). During the year, teachers would continue to participate in grade-level mathematics collaborations that include teachers’ content level skills assessments prior to collaborative design of the instructional delivery of the state mathematics standards which were aligned to the
assessment. The teacher assessments would be modeled on the questions that students were expected to pass in order to demonstrate mastery of grade level mathematics skills. The assessments would be used as a learning tool and as a screening tool. When the mathematics content area specialist implemented this strategy during the 2018-2019 academic year, teachers consistently used the knowledge gained from the assessments as a reflective practice to drive their lesson designs and to inform their requests for mathematics professional development support. The mathematics pre-assessment would be designed by the mathematics content area specialist to reflect grade-level mathematics standards and the state student assessment content.

Teachers would be provided with 45 minutes per week of mathematics focused, grade level collaboration using a backward planning format. The content of the backward planning teacher collaborative sessions would include a preplanning assessment, scheduled observations of instructional delivery of instructional design developed during collaboration, constructive feedback from the mathematics content area specialist, and reflective activities for teachers interwoven within collaboration. The mathematics content area specialist would facilitate all mathematics focused collaboration sessions with teachers of mathematics and perform post-collaboration nonevaluative observations of mathematics teachers. The mathematics content area specialist implemented this strategy during the 2018-2019 academic year and teachers consistently used the knowledge gained from these strategies to drive their lesson designs and request mathematics professional development support.

Administrators at the study school needed to devote time to professional development in a way that supported teachers’ learning. There needed to be a transition
from administration driven compliance mathematics professional development to teacher driven mathematics professional development occurring over an extended period.

Marquis (2015) said “effective professional development clearly indicates that professional development that takes place over an extended time achieves greater results than that which provides a lesser degree of contact time for and among participants” (p. 125). Teachers needed repetition of action and practice in mathematics skills to refine their instructional skills, with a minimum of 50 hours of professional development to maintain professional growth (Pemberton et al, 2016, p. 16).

The necessary amount of time during an extended time period required planning and a schedule. Administrators at the study school would create a master schedule that provided the math content area specialist with half an hour of sacred time each week to provide site-based, job-embedded, ongoing mathematics professional development to the instructional staff, para-professionals, and administrators. In addition to the half an hour of mathematics professional development each week, administrators at the study school would devote five hours during the pre-service week and five hours during the post-service week to site-based mathematics professional development facilitated by a full-time math content area specialist. Taton (2015) said the best way to distribute a teacher workday was to have teachers spend 60% of their workday providing student instruction while the remaining 40% be devoted to professional learning and collaboration (p. 49).

Professional development facilitated by the math content area specialist would include, but not be limited to, grade-level mathematics collaboration. Professional learning experiences would be offered one-on-one, in small group for teachers, and by grade level to differentiate professional development to the needs and wants of the
instructional staff. Smith (2015) said quality professional development should be “focused on authentic student learning and improvement rooted in classroom instructional practices” (p. 28). The mathematics content area specialist would deliver professional learning experiences during the weekly half hour professional development sessions and would be embedded within the weekly 45-minute mathematics focused, grade level collaboration sessions. The mathematics content area specialist would base mathematics professional learning activities upon teacher reflective needs assessment surveys, administrator observations, math content area specialist observations, teacher insights during collaboration and mathematics pre-assessment, and grade level team requests. The mathematics content area specialist would deliver site-based professional development experiences for teachers that would include, but not be limited to, sessions in mathematics standards content knowledge and pedagogy.

The study school administrators would budget funds for two full-time, mathematics content area specialists to support the teachers who served nearly 900 students (Odden, 2011, p. 30). This would require that the study school’s principal budgets $130,000 annually to pay the salaries and fringe benefits of the content area specialists by assigning funds from Title I and Title II to offset the expense of the salaries. Additionally, the principal would allocate $1000 a year from the general fund budget for mathematics materials and supplies required for curricular advancement based on the collaborative planning outcomes.

Teachers’ instructional practices were accessed for effectiveness using the teachers’ evaluative rubric created by district personnel and aligned with the goals and visions of district leaders and school administrators. Teachers would improve their
instructional practices in the areas of instructional design and lesson planning, participation in professional development as part of continuous professional improvement, demonstrating knowledge of content and pedagogy, establishing a culture of learning, and reflecting on teaching (Citation withheld to preserve the anonymity of the school district under study). During the study, I anticipated teachers at the study school would earn an effective or highly effective rating as a result of administrators’ implementation of the strategies and actions recommended in this section.

Study school administrators’ implementation of the actions and strategies recommended in this section were anticipated to improve students’ achievement levels. The study would use improved student achievement levels to assess the effectiveness of the implementation of the strategies and actions recommended in this evaluation. Another anticipated result was students and staff would earn improved letter grades from as assigned by representatives of the state department of education. District leaders would be able to determine the validity of the recommendations presented in this section by the state grades earned by students and staff at the study school. The recommendations would be demonstrated effective as a method to advance teacher and student performance levels by the study school maintenance of an A or B letter grade for the school as a whole as assigned by representatives of the state department of education and in alignment with the vision and goals developed by state leaders.

The stakeholders at the study school would share a unified high-expectation of academic excellence. Teachers would receive direct and embedded mathematics professional development from the mathematics content area specialist that supported the instructional staffs’ transition to a growth mindset. Teachers would participate in a book
study using Dweck’s (2016) book titled *Mindset* to develop the instructional staff’s and the students’ full potential. The book study was initially started in the 2018-2019 school year by the principal but was not implemented with fidelity nor were the teachers accountable for their participation.

In conjunction with the culture shift in mindset, the stakeholders’ and students’ academic identity would evolve to that of an academically high achieving elementary school. Teachers would use growth mindset verbiage, such as “the student has not mastered the skill yet” instead of “the student cannot do it”. By removing the barrier of low academic identity, the instructional staff and administrators would change the culture of the study school to transform into the premier elementary school in the school district. The high achieving academic identity culture would extend to all stakeholders. “When a true growth mindset culture takes hold, it will always extend to everyone in the building, from administrators to students” (St. Clair, 2019, p. 302).

Celedon-Pattichis et al. (2018) said community partners, parents, and students were all academic resources that contribute to the “teaching and learning of high-quality mathematics” (p. 375). Sheldon, Epstein, and Galindo (2010) said “having a strong partnership climate with families may help schools improve the percentage of students successful on math achievement tests” (p. 37). The role of a full-time, site-based math content area specialist would include the coordination of the resources available from the expertise of community partners. A full-time, site-based math content area specialist would work with community partners to develop family math nights at the study school that bring families and community partners together to support the advancement of mathematics education. Community partners could attend grade-level collaborative
sessions facilitated by the math content area specialist and volunteer in classrooms to support math instruction and student learning of mathematics.

Greenfeld et al. (2009) said parents’ involvement in students’ mathematics learning and parents’ monitoring of students’ mathematics learning was related to higher degrees of academic achievement in mathematics from elementary school through high school (p. 1). When community partners actively participated in school-based learning opportunities, student achievement improved. Study school administrators needed to welcome community partners into the school to support mathematics instruction. Community partners were invaluable as added value through their ability to share their expertise in mathematics and participate in collaborative sessions that aligned content knowledge with real world applications of the state mathematics standards.

**Conclusion**

The benefits of full-time, site-based mathematics content area specialists to close the achievement gap were evident in the data collected in this mixed methods, correlative study. Teachers participating in weekly, mathematics focused, grade-level collaboration facilitated by the mathematics content area specialist impacted positively student achievement on end of year state mathematics standards assessments. Student achievement scores improved in all tested grade levels and all subgroups within the quantitative data collected during this study. Teachers’ instructional practices better aligned to mathematics standards and deviations in instructional delivery diminished, strengthening the Tier One instruction and decreasing outliers in nonproficient levels. As a driver of change, the mathematics content area specialist would affect the coordination of resources and coordination of effort in support of the advancement of professional
practice and student academic performance. The mathematics content area specialists would provide transformational coaching that would “build emotional resilience in educators, bring teams together in healthy ways, and change systems” (Aguilar, 2013, p. 289).
Section Seven: Implications and Policy Recommendations

Within this correlative evaluation of full-time, site-based mathematics professional development, I identified two issues at the study school for consideration. First, student scores on state end of the year mathematics standards assessments dropped when instructional staff lacked the support of a full-time, site-based mathematics content area specialist (See Figure 30). Second, teachers’ instructional practices specific to teaching of standards-based mathematics deviated significantly without once a week, mathematics focused, grade-level collaboration facilitated by the math content area specialist (See Figure 31). The issues I identified at the study school, based on quantitative and qualitative data collected from a correlated mixed methods evaluation, were indicative of a larger policy issue: academic success for at-risk populations.

At the study school, students’ scores in mathematics were trending toward academic success for at-risk populations after the implementation of weekly, mathematics focused, grade level collaboration facilitated by a full-time, site-based math content area specialist (See Figure 30). Students were identified as at-risk for a variety of reasons: low-socioeconomic status, race, ethnicity, cultural or linguistic diversity, disabilities, mental health disorders or chronic health problems. On the end of year state standards mathematics assessments, students at the study school improved their scores from 2017-2018 to 2018-2019 in all subgroups: students with disabilities, English language learners, Black, Hispanic, and students who qualified for free or reduced-price lunch due to low-socio economic status (See Figure 31). When teachers accessed a full-time, site-based math content area specialist to support their mathematics instruction, teachers met the needs of all students at the study school through teacher’s participation.
in ongoing mathematics professional development and increased high expectations for academic success through development of teachers’ growth mindset. When teachers participated in weekly, math focused, grade level 45 minute collaboration facilitated by a math content area specialist, teachers’ mathematics instructional practices were more aligned to grade-level state standards in mathematics as evidenced by the increases in all component subgroups on end of year state standards mathematics assessments and the decreases in standard deviation among teachers (See Figure 31 and Figure 26).

**Policy Statement**

I recommend the administrators at the study school maintain a full-time, site-based mathematics content area specialist who provides on-demand, ongoing, job-embedded professional development in mathematics. If it were within my power as a district leader, I would make a district initiative of putting a mathematics content area specialist in every school. If administrators enacted this policy, the academic success for at-risk population students could increase. Students’ academic success would continue to increase as teachers aligned their teaching to instructional outcomes through weekly, mathematics focused, grade level collaboration facilitated by a math content area specialist. In addition to providing mathematics professional learning experiences, the math content area specialist would facilitate mathematics grade-level collaboration sessions.

I recommend teachers at the study school participate in a once a week, mathematics focused, grade level 45 minute collaboration facilitated by a math content area specialist. Teacher collaboration sessions would meet a minimum of weekly to plan for upcoming instruction using a reverse plan design to develop lessons that would
MATHEMATICS PROFESSIONAL DEVELOPMENT

support student achievement in mastering state standards in mathematics (Guskey, 2014, p. 14). The National Council of Teachers of Mathematics representatives (2014) said “mathematics teachers [were] professionals who [did] not do this work in isolation. They cultivate and support a culture of professional collaboration and continual improvement” (p. 99). To instill an effective collaborative culture of continual improvement, a bold strategy of best practices needs to be enacted by visionary educational leaders and based upon strong foundations of support and the right people in the right positions moving students to ever higher levels of performance. If administrators enact a policy of full-time, site-based mathematics content area specialist driven on-demand, ongoing, job-embedded professional development in mathematics at the study school site, the academic success of the school’s at-risk student population could continue to improve. With the support of a full-time, site-based math content area specialist, students’ scores on the end of year state mathematics standards would continue to increase and the achievement gap between on-level and below-level students would continue to diminish.

Analysis of Needs

Through this analysis of needs, I was seeking to make choices and trace implications through the six distinct disciplinary areas to more fully understand the problems involved within my study. This analysis of needs was limited in scope, as the position of math content area specialist was unique within the school system under study. Though classified as district support personnel, the math content area specialist worked in and for the study school. The math content area specialist had limited interaction with the community, with no significant change foreseeable in the future. Though I had hoped my study would have larger implications, the findings of this study may be limited to schools
with similar educational, economic, social, political, legal, and moral and ethical demographics as the study school.

**Educational Analysis.** Among the student population who attended the study school 68.9% lived in low-socioeconomic conditions (See Figure 5). Jensen (2013) said students in the United States who grew up in low-socioeconomic conditions were less likely to graduate from high school, with 70% of those not graduating from high school having spent a minimum of one year living in low-socioeconomic conditions (p. 1). 35.5% of the student population who attended the study school were Hispanic and 23% of the student population who attended the study school were Black (See Figure 5). Study school students of color who lived in low-socioeconomic conditions had a 50% high school incompletion percentage (Jensen, 2013, p. 1). The student population of the study school represented a percentage of students identified as having the potential to not graduate high school. A full-time, site-based math content area specialist could support teachers and students in reaching academic success for at-risk student populations at the study school as evidenced by the student subgroup state mathematics standards assessment test result in 2018-2019 (See Figure 31).

Prior to this study, the teachers and students at the study school earned a school grade of D upon completing the 2017-2018 academic year. The average student pass rate on the end of year state mathematics standards assessment remained low with 40% of students in grades three through five performing at grade-level proficiency. The student mathematics test scores averaged 40% of grade level proficiency for three consecutive years prior to the implementation of a full-time, site-based math content area specialist and once a week, mathematics focused, 45-minute grade level collaboration facilitated by
the math content area specialist. The average student pass rate increased to 50% grade level proficiency of students in grades three through five performing at grade level proficiency and improved to a C school grade at the culmination of this study after the implementation of weekly mathematics focused collaboration facilitated by the math content area specialist who also provided site-based mathematics professional development.

Additionally, the teacher turnover rate increased from 23% to 27% during the study. The policy problem of having a part-time, site-based math content area specialist and math-focused collaboration every other week decreased the academic success of students and may have increased the teacher turnover rate within the study school. Student achievement could increase when teachers learn and grow within the holding environment of the study school (Drago-Severson, 2013, p. 13). Olson (2018) said “while rigorous student standards and expectations result in new classroom content and instructional processes, support for most teachers to make these shifts has been limited” (p. 13). A full-time, site-based math content area specialist was essential to support teachers through the shift and improve students’ academic achievement as evidenced in this study.

Sutton (2017) said “math has been a subject where [students] perceive that success may not be attainable” (p. 192). An educational challenge to students and teachers continued to be the accepted social norm of not being proficient in math and not being able to learn math concepts. All teachers and students at the study school had the ability to become smarter and learn how to be good at mathematics (Sutton, 2017, p. 192). A full-time, site-based math content area specialist supported teachers and students
in developing the growth mindset needed to change the academic identity of the study
school’s stakeholders to one of mathematics proficiency.

When discussing policy and prioritizing curriculum, school and district leaders
focused on English Language Arts (ELA). Teachers’ mathematics instruction was
considered less vital to students as compared with the need for ELA instruction. Teachers
at the study school were required to have a schedule with 90 minutes of uninterrupted
time to provide students with instruction in ELA. ELA students often feel more
comfortable with mathematical symbols as a symbolic language that eases the academic
barriers often confronted during English language learning. Mathematically acute ELA
student academic success experiences during mathematics class time may deeply foster
the ELA student’s feelings of academic efficacy. Teachers at the study school had
assorted times for math instruction, ranging from 45 to 60 minutes. Teachers’ and
students’ time for math instruction could be interrupted by recess, specials, and/or lunch.

This inequality of prioritization was especially difficult on students who identified
with Gardner’s logical/mathematics intelligence but struggled with verbal/linguistic
intelligence, especially when teachers did not adjust classroom instruction to meet the
needs of students’ Multiple Intelligences. Within Gardner’s Multiple Intelligences
Theory, students should be provided with the opportunity to develop their strengths
(Wang, 2018, p. 14). The mathematics classroom was a context for the development of
mathematics identity and for making connections between mathematics and the real-
world applications of mathematics. To deny students time in mathematics subject area
content classes was counterproductive in terms of increasing academic performance
indicator gains.
In terms of the importance placed on STEM learning and careers and in terms of the current focus on expanding the participation in mathematics careers among underrepresented populations, the need for an emphasis on professional practice supports and gains as never been greater. Students must experience high quality mathematics learning environments in which their mathematical identities of math-efficacy were fostered. Walker (2012) said regarding the formulation of a mathematical identity:

It is important to consider how people’s mathematics identities might be cultivated in spaces within schools, outside of schools, and in-between, and how these experiences might contribute to the development of a mathematical identity as well as the development and dissemination of mathematics knowledge. (p. 66)

A school that fostered teacher professional growth and advancement of best practices classroom instruction in mathematics would be a school that cultivated vigorously viable student mathematic identities.

**Economic analysis.** To ensure the success of once a week, mathematics focused, 45 minutes grade level collaboration, the study school’s administrators should commit to budgeting a minimum of $65,000 per year to pay the base salary and benefit contributions for a math content area specialist. Though student reading literacy was a national focus and continued to drive educational policy changes, “there [was] no funding earmarked nationally to support the hiring of mathematics coaches,’ therefore the expense of a math content area specialist would fell on the study school (Davis, 2015, p. 9). The policy problem inherent in requiring school administrators to budget for math content area specialists was school administrators had a limited budget and had restrictions as to how they could spend the money received based on students’ Full Time
Equivalent (FTE). The study school’s administrative team would be unable to budget enough monies to afford a math content area specialist without fringe money from Title I. Though two math content area specialists were recommended to meet the needs of elementary school staff with the largest student population in the district, the administrative team did not have access to sufficient funds to pay for two math content area specialists without monetary assistance from the school district’s director of staff development offsetting the expense. The majority of the study school’s budget was allocated for teacher salaries and the principal could only afford two math content area specialists at the expense of eliminating teacher positions and student counts in classrooms exceeding class size requirements as mandated by constituents and legislators of the state.

**Social analysis.** At the end of the 2017-2018 school year, the teachers and students at the study school earned a school grade of D. The school grade reflected a rigid mindset prevalent within the school that students were unable to attain mastery of grade-level mathematics standards. Though overtures were made by the principal to change the culture of the school from a fixed-mindset to a growth-mindset, teachers persisted in expressing doubt in their students’ abilities during collaboration and professional development activities facilitated by the math content area specialist. Peters (2006) said when teachers believed in the academic abilities of their students, students believed they were smarter than they previously thought and rose to the academic expectation (p. 63).

Peters (2006) said “nobody rises to low expectations” (p. 63). Teachers with a fixed mindset knew “which students to give up on before they’ve even met them;” while, “great teachers set high standards for all their students, not just the ones who are already
achieving” (Dweck, 2016, p. 200). A full-time, site-based math content area specialist could assist in transforming the culture of the study school to one of a growth mindset through professional development opportunities, including but not limited to a book study of *Mindset: The New Psychology of Success - How We Can Learn to Fulfill Our Potential* (Dweck, 2016). Additionally, weekly, mathematics focused, 45 minute grade level collaboration facilitated by the math content area specialist could encourage the development of a holding environment that would create a nurturing atmosphere and encourages high expectations (Dweck, 2016, p. 200).

Smith (2015) said successful schools shared similar social factors: “school level, viable curriculum, goals and feedback, parent and community involvement, safety and order, and collegiality and professionalism” (p. 30). A full-time, site-based math content area specialist provided feedback, worked with teachers to set professional goals, modeled professionalism, and developed collegiality among teachers as the school staffed evolved toward becoming a more successful school. Sutton (2017) said an emotionally safe environment was essential for the social development of students within our schools, especially in mathematics where students needed to feel safe to take risks, collaborate with other students, and engage in rigorous application of mathematics (p. 193). A full-time, site-based math content area specialist supported stakeholders in changing the culture of the classrooms within the study school to allow students holding environments that permitted students to fail without ridicule, be included by peers, and try harder instead of giving up.

**Political analysis.** Teachers perceived content area specialists as political players aligned with the administrative team. Administrators included content area specialists in
the school-based leadership team and assigned them leadership responsibilities within the study school. District personnel included content area specialists within the same level as teachers, as instructional personnel; though content area specialist were identified as part of the district staff development department personnel. Instead of the name of the school at which they work, the identification badge that a coach was required to wear stated “staff development.” Despite the nebulous nature of the math content area specialist’s position, politically speaking, the math content area specialist was dedicated to the goal of improving the academic identity of the study schools’ stakeholders (Davis, 2015, p. 1).

The math content area specialist was the legislative aide of the study school: focused on one topic, acted as the liaison between teachers and administrators, briefed administrators on issues, organized the logistics of school events, and researched pertinent information as needed by teachers and administrators.

Teachers were resistant to a math content area specialist being in their classrooms, watching their instructional practices. Teachers have been resistant to maximizing the potential that having a full-time, site-based math content area specialist could have on their student achievement. The administrative team mandated most of the coaching delivered to instructional staff by the math content area specialist. Though the mathematics content area specialist could be the flywheel with the potential to deliver solid teacher performance, support the needs of students, and keep the instructional cycle of the school running smoothly, the math content area specialist was not utilized to maximum potential by an instructional staff stuck in the cycle of a fixed mindset.

As a representatives of the study school’s administrative team, content area specialists disseminated information to the instructional staff to drive professional
development, grade-level collaboration, and the coaching cycle. As part of the district’s staff development team, content area specialists disseminated information to the administrative team and instructional staff to drive professional development, grade level collaboration, and the coaching cycle. As a representative for the instructional staff, content area specialists shared the ideas and concerns of teachers with the administrative team and district personnel. Hirsh and Crow (2017) said the math content area specialist’s job responsibilities included “communicating teacher and team learning needs to school and district leaders and advocating for greater coherence across schools and departments” (p. 63).

Drago-Severson et al. (2013) said the best political policies for schools were developed through a “reciprocal exchange of ideas and expertise between researchers, lawmakers, and practitioners” (p. 241). Wagner et al. (2006) said school leaders and staff were responsive to school board members priorities, concerns, and needs though those priorities, concerns, and needs were subject of the vulnerability of political trends and whims (p. 65). School district constituents made demands on elected school board members and district leaders increasing the politicization and distracting leaders from instructional improvement and support student learning while increasing external accountability of the study school (Wagner et al., 2006, p. 65). The school board members and district leaders of the school district within this study were often at odds with each other, and this lack of cohesiveness created a political quagmire for district personnel. I was diligent in remaining neutral to the political strife within the school district while maintaining my dedication to achieving the goal of mathematics proficiency for all students at the study school.
Legal analysis. The study school was legally bound to abide by the collective bargaining agreement between the school district’s teachers’ union and district school board members. The current teachers’ collective bargaining agreement was effective through 2019. Though not all teachers were members of the teachers’ union, the collective bargaining agreement pertained to all instructional personnel. Union representatives wrote Section 6.18(b) to include the stipulation that teachers were not required to participate in more than 30 minutes of collaboration per week (Citation withheld to preserve the anonymity of the school district under study). Legally, school administrators violated the teachers’ collective bargaining agreement when they mandated that teachers participate in compulsory 45 minutes of ELA and 45 minutes of mathematics grade level collaboration during the same week. Teachers who put their union rights above the best interests of their students perpetuated the policy problem of insufficient mathematics focused grade level collaboration facilitated by a math content area specialist with the goal of improving student achievement.

Teacher unions were active in educational policy since the 1850’s (Cowen & Strunk, 2014, p. 4). Cowen and Strunk (2014) said teacher union representatives negotiated increased salaries for their own members and improved working conditions at schools but provided no commensurate improvements to student achievement (p. 6). Though a full-time, site-based math content area specialist had the potential to impact positively teachers’ instructional practices in mathematics and students’ achievement in mathematics, their time working with teachers at the study school was hampered when union members felt their rights were being violated. Study school administrators would have to negotiate with teacher union representatives to increase the allowable time for
collaboration. School board members could “revise, alter, or enhance” existing policies on professional development based on the outcomes of this study (Hoge, 2016, p. 21).

**Moral and ethical analysis.** A full-time, site-based math content area specialist had the moral and ethical obligation of maintaining the confidence of teachers at the study school. Math content area specialists needed the trust of teachers to build relationships that could develop a thriving site-based professional development program. If teachers were to make themselves vulnerable to the critique and support of a math content area specialist, then teachers needed to know that math content area specialists would maintain confidentiality regarding their specific coaching cycle. Aguilar (2013) said if a math content area specialist may never regain the trust of a teacher if their confidentially agreement were violated (p. 82). “There is no coaching without trust” (Aguilar, 2013, p. 40). As a school leader, it was my responsibility to “demonstrate personal and professional behaviors consistent with quality practices in education and as a community leader” as written in the educational leadership standards (Citation withheld to preserve the anonymity of the school under study).

**Implications for Staff and Community Relationships**

Sheldon et al. (2010) said “better implementation of math-related practices to family and community involvement predicted stronger support from parents” and helped predict students who would rate as proficient in mathematics on the end of year assessments (p. 27). To ensure all students were provided with a challenging learning environment and to ensure the study school stimulates connectedness with the community, study school administrators, study school staff, parents of study school students, and the study school community needed to develop an academic identity by
creating conditions to offer differentiated learning opportunities aligned with high expectations for success. The staff would benefit if the study school’s administrative team maintained a full-time, site-based math content area specialist who was able to provide ongoing, on-demand professional development and facilitate weekly grade-level math collaboration. Based on the findings from this study, the implications for the staff and community of the study school would be the closing of the achievement gap between students proficient or nonproficient in mathematics. The administrators of the study school wrote the study school’s school improvement plan to include opportunities for academic family involvement: fall family night, math night, science night, and reading on the lawn. Within the family involvement activities there was an opportunity for the math content area specialist to act in the capacity of a school liaison and extend the outreach events into the community. The math content area specialist could work with teachers to develop monthly family nights at the community center to offer homework support.

**Conclusion**

Upon completion of my correlative, mixed-methods study, I advocate for the study school to maintain a full-time, site-based math content area specialist whose job responsibilities include facilitating weekly, grade-level collaboration focused on mathematics. Within this section, I included evidence of the six distinct disciplinary areas: education, economic, moral and ethical, social, political, and legal. When enacted, my policy changes could close the achievement gap of the at-risk student population between students proficient in grade level mathematics and students not yet proficient in grade level mathematics, maybe even change the cycle of poverty.
Section Eight: Conclusion

The overall impact of my proposed policy provided a solution to the teacher mathematics professional development issues outlined throughout this paper. Students’ low performance on state mathematics standards assessments placed the students and staff of the study school under the scrutiny of representatives from the state department of education. The academic growth trends I observed in my study could have a positive effect on student achievement as a result of full-time, site-based support from a math content area specialist who facilitated weekly mathematics collaboration.

I began this study to be more effective in my job. I wanted to know the best form of professional development for teachers and, by extension, students. As a classroom teacher, I had often been forced to participate in professional development that did not improve my instructional abilities. I had even been forced to participate in school-based professional learning experiences that I had taught at the district level. I did not want the teachers with whom I was working to feel the same frustrations and professional disrespect that I had felt when I was a classroom teacher. As a math content area specialist, my job was providing professional development to support the needs of teachers, with the goal of improving student achievement. My goal was to find out if my job was impactful.

Teacher professional development and student achievement in mathematics were reciprocal. Student achievement improved as teachers participated in mathematics professional development; teaching practices improved as teachers focused on student learning and pedagogy (Hill et al., 2017, p. 68). Hoge (2016) said “teachers who reported working with a subject specialist had student achievement scores nearly twelve points
higher than the average of all teachers’ students’ supporting the need for a math content area specialist at the study school (p. 90). I collected and analyzed data during this study that was presented in Section Four. The results of my analyses were not statistically significant but did display a strong trend in student growth in mathematics and a narrowing of the achievement gap between on-level mathematics students and below-level mathematics students.

**Discussion**

The intended purpose of my correlative, mixed-methods program evaluation was to determine which types of site-based teacher professional development were the most effective on the enhancement of teacher instructional practices in mathematics as identified in Section One. I wanted to determine the impact on the effectiveness of school-based professional development opportunities for teachers to increase students’ mathematics achievement performance gains in primary grades at the study school. I hoped to identify the necessary elements of a successful site-based professional development program and a highly effective strategy for the implementation of an effective job-embedded professional learning plan for maximizing mathematics teacher professional effectiveness.

The implementation of this policy would enable teachers to align highly effective instructional practices and high levels of content knowledge with state mathematics standards to maximize student achievement in all subgroups represented at the study school. When full-time mathematics content area specialists provided site-based professional development, teachers had long-term follow up, support, and collaborative context essential for the translation of professional learning experiences into highly
effective classroom instructional practice (Dixon et al., 2014, p. 115). Educational research documented the efficacy of this approach. Brendefur (2016) said effective professional development experiences for teachers required ongoing, job-embedded follow-up (p. 100). Bayer (2014) said there was a “positive relationship between teacher quality and student achievement” (p. 320). The job of a math content area specialist was to improve teacher quality and student achievement by providing site-based, on-demand, ongoing, job-embedded mathematics professional development opportunities to teachers.

Bishop (2016) said collegiate teacher education programs were not developed to adequately prepare teachers for the needs of instructing a general education classroom of students (p. 44). A full-time, site-based mathematics content area specialist provided guidance and support to teachers in acquiring the skills to be effective mathematics instructors (Bishop, 2016, p. 84). Student achievement in mathematics increased when teachers had prior instruction in content area knowledge (Blazer, 2015, p. 24). “A group of committed educators working collaboratively in an ongoing process resulting in better student achievement” was the goal of the professional development program developed by the full-time, site-based math content area specialist (Brown et al., 2018, p. 54). The goal of my proposed policy, as described in Section One, was to improve the professional development experiences of teachers and enhance teacher instructional practices, which ultimately led to the academic growth of students and increased the scholarly achievement of at-risk students.

**Leadership Lessons**

State department of education representatives created four leadership standards domains: professional and ethical behavior, student achievement, instructional leadership,
and organizational leadership (Citation withheld to preserve the anonymity of the school under study). Student achievement was the focus of the first domain: student learning results and student learning as a priority. Instructional leadership was the focus of the second domain: instructional plan implementation, faculty development, and learning environment. Organization leadership was the focus of the third domain: decision making, leadership development, school management, and communication. The standards listed have been used by state department of education representatives to develop educator certification requirements, prepare school leadership programs, evaluate school leadership, and create professional development for leaders. State department of education representatives have identified the listed standards as representational of the skill sets and knowledge necessary to maintain effective schools. Within my position as the math content area specialist at the study school, I was able to exemplify the leadership characteristics to develop an effective professional development program at the study school.

The National Council of Teachers of Mathematics representatives (2014) said within “an excellent mathematics program, educators hold themselves and their colleagues accountable for the mathematics success of every student and or personal and collective professional growth toward effective teaching and learning of mathematics” (p. 99). Hirsh and Crow (2017) said staff and leadership at successful schools aligned their goals and visions to maintain one focus, engaged in ongoing professional development, and were “collectively accountable” for student achievement (p. 59). Teachers and school leaders needed to work together to develop a set of accountability norms for teacher development and student achievement. In my position as math content area specialist, I
had the potential to provide the necessary mathematics professional development and become part of the collective accountability process.

Through this process, I learned a math content area specialist had an impact on student achievement as evidenced by students’ performances and growth on the state mathematics standards assessment (See Figure 28). I grew as a leader by building and supporting the staff of the study school to focus on student success. I “enabled faculty and staff to work as a system focused on student learning” through on-demand mathematics professional development, facilitating weekly mathematics collaboration, and generating a high-expectation for learning growth academic identity (Citation withheld to preserve the anonymity of the school under study). Going forward as a leader, I will use the information and knowledge generated to engage students and staff to continue closing the achievement gap among student subgroups within the study school (Citation withheld to preserve the anonymity of the school under study).

I learned “effective school leaders work collaboratively to develop and implement an instructional framework that aligns curriculum with state [mathematics] standards, effective instructional practices, student learning needs, and assessments” (Citation withheld to preserve the anonymity of the school under study). I grew in my abilities to communicate the interconnectedness of student performance, effective teacher instruction, and state mathematics standards (Citation withheld to preserve the anonymity of the school under study). I facilitated the implementation of the curriculum adopted by district leaders and the state mathematics standards developed by representatives of the state department of education. Going forward as a leader, I will ensure that high-quality formative assessments are aligned with the state mathematics standards.
I learned the importance of providing timely feedback on the effectiveness of instruction to teaching staff during the coaching cycle and professional development experiences (Citation withheld to preserve the anonymity of the school district under study). I grew in my ability to identify “faculty instructional proficiency needs, including standards-based content, research-based pedagogy, data analysis for instructional planning and improvement, and the use of instructional technology” (Citation withheld to preserve the anonymity of the school district under study). I provided “resources and time and engaged faculty in effective individual and collaborative professional learning throughout the school year” (Citation withheld to preserve the anonymity of the school district under study). Going forward as a leader, I will facilitate instructional staff in delivering culturally relevant, differentiated instruction though implementation of professional learning opportunities that encourage the retention of an effective and diverse faculty (Citation withheld to preserve the anonymity of the school district under study).

Conclusion

The stakeholders within the study school faced many challenges in meeting the goals of training and retaining high-quality instructional staff so that students had the supports necessary to master mathematics standards and skills. Students performed poorly on state mathematics standards assessments placed the study school in a precarious position within the structure of the state educational system. My review of literature combined with my research provided evidence that a full-time, site-based math content area specialist tasked with facilitating weekly grade-level mathematics collaboration could be the solution to improved student achievement in mathematics and
meeting the needs of at-risk student populations at the study school. Calvert (2016) said when we support our teachers through “continuous development, there is no telling what our educators and their students will accomplish” (p. 20).
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Appendices

Appendix A: Informed Consent - Principal Form to Conduct Research at School

Appendix B: Informed Consent - Teacher Form to Participate in Research at School

Appendix C: Teacher Surveys Pre- and Post-Professional Development

Appendix D: Teacher Survey Forms Content Knowledge and Demographics

Appendix E: Teacher Survey Forms Instructional Practices

Appendix F: Teacher Interview Questions

Appendix G: As-Is Diagram

Appendix H: To-Be Diagram

Appendix I: Strategies and Actions Chart
Appendix A

INFORMED CONSENT

Principal Form to Conduct Research at School

You are being asked to participate in a research study conducted by Christine Attenhofer, doctoral student at National Louis University, Tampa, Florida. The study is entitled A Study of the Impact of Mathematics Professional Development on Student Mathematics Achievement. The purpose of this evaluation is to determine what impact school-based professional development opportunities for teachers are having on students’ mathematics achievement in primary grades at [redacted] Elementary School.

Participation at your school includes the following participants: all teachers of mathematics and myself in my position as Math Content Area Specialist. The researcher will interview participants who are willing and available. All information collected during the interviews reflects the opinions and experiences of the participants related to professional development in mathematics. Interviews will be tape recorded to help ensure accuracy of information collected. These recordings will be kept confidential, as the researcher will use pseudonyms for the participants during the interview, and the identities of the participants will not be attached to the data collected during the interview. Permission to conduct the interviews requires an informed consent form to be signed and returned indicating your willingness to allow research to be conducted at your school.

Participation is voluntary and may be discontinued at any time without penalty. All identities, including that of the school, will be kept confidential by the researcher and will not be attached to the data. The researcher will keep all data collected for this project in a locked safe in her home. Only the researcher will have access to it. Participation in this study does not involve any physical or emotional risk to participants beyond that of everyday life. While each person is likely to not have any direct benefit from being in this research study, taking part in this study may contribute to decisions regarding professional development opportunities for teachers, instructional practices to enhance student achievement, as well as expansion and/or adjustments to the program’s structure.

While the results of this study may be published or otherwise reported to scientific bodies, identities of participants will in no way be revealed. Results will be made available upon request in compliance with public records requirements, and the identities of participants will in no way be revealed.

In the event you have questions or require additional information you may contact the researcher: Christine Attenhofer, National-Louis doctoral student, phone: (352) 653-7731.

If you have any concerns or questions before or during participation that have not been addressed by the researcher, you may contact my dissertation chair Dr. Carla Sparks; email: csparks3@nlu.edu; phone: (813) 928-6889, or the co-chairs of NLU’s Institutional Research Board: Dr. Shaunti Knauth; email: Shaunti.Knauth@nl.edu; phone: (312) 261-3526; or Dr. Carol Burg; email: CBurg@nl.edu; phone: (813) 397-2109. Co-chairs are located at National Louis University, 122 South Michigan Avenue, Chicago, IL.
Appendix B

INFORMED CONSENT

Teacher Form to Participate in Research at School

My name is Christine Attenhofer, and I am a doctoral candidate at National Louis University. I am asking you to participate in this study, “A Study of the Impact of Mathematics Professional Development on Student Mathematics”, occurring from 09-2018 to 5-2019. The purpose of this study is to understand how professional development impacts student achievement in mathematics. This study will help researchers develop a deeper understanding of professional development that can guide ongoing professional learning and contribute to the body of research literature. This form outlines the purpose of the study and provides a description of your involvement and rights as a participant.

By signing below, you are providing consent to participate in a research project conducted by Christine Attenhofer, doctoral candidate, at National Louis University, Chicago.

Please understand that the purpose of the study is to explore the process and impact of professional development and NOT to evaluate teaching. Participation in this study will include:

- Monthly surveys will be conducted with study participants to gather quantitative and qualitative data regarding teachers’ perceptions of professional development and their teaching practices because of professional development. Surveys will take approximately 10 minutes.
- Quarterly individual interviews will be scheduled at your convenience during the 2018-19 academic year.
  - Interviews will last up to 15 minutes and include approximately 5 questions to understand how professional development is impacting student achievement in mathematics.
  - Interviews will be recorded.
- Quarterly twenty-minute observations to gain contextual understandings and observe classroom instruction subsequent to professional development experiences and timely debriefing sessions.
  - I will take field notes during classroom observations and debriefing sessions to capture the ways professional development impacts your instructional practices (e.g. taking observational notes, asking reflective questions, whispering to students).
  - Timely follow-up reflection sessions will be schedule after each observation. Sessions will take approximately 15 minutes.
  - Some observations may use a recording device, with teacher consent.

Your participation is voluntary and can be discontinued at any time without penalty or bias. The results of this study may be published or otherwise reported at conferences, and employed to inform coaching practices at [redacted] County School District but participants’ identities will in no way be revealed (data will be reported anonymously and bear no identifiers that could connect data to individual participants). To ensure confidentiality the researcher will secure recordings,
transcripts, and field notes in a locked cabinet in her home office. Only Christine Attenhofer will have access to data.

There are no anticipated risks or benefits, no greater than that encountered in daily life. Further, the information gained from this study could be useful to the [redacted] County School District and other schools and school districts looking to initiate or refine induction coaching.

Upon request you may receive summary results from this study and copies of any publications that may occur. Please email the researcher, Christine Attenhofer at cattenhofer@my.nl.edu to request results from this study.

In the event that you have questions or require additional information, please contact the researcher, Christine Attenhofer; email: cattenhofer@my.nl.edu; phone: (352) 653-7731.

If you have any concerns or questions before or during participation that has not been addressed by the researcher, you may contact my dissertation chair Dr. Carla Sparks; email: csparks3@nlu.edu; phone: (813)928-6889, or the co-chairs of NLU’s Institutional Research Board: Dr. Shaunti Knauth; email: Shaunti.Knauth@nl.edu; phone: (312) 261-3526; or Dr. Carol Burg; email: CBurg@nl.edu; phone: (813) 397-2109. Co-chairs are located at National Louis University, 122 South Michigan Avenue, Chicago, IL.

Thank you for your consideration.

Consent: I understand that by signing below, I am agreeing to participate in the study “A Study of the Impact of Mathematics Professional Development on Student Mathematics.” My participation will consist of the activities below during the 2018-2019 academic year:

(briefly list participation activities as in example below):

- 2 Interviews lasting approximately 15 minutes each
- 2 Twenty-minute observation of my classroom
- 4 Pre- and 4 post-professional development surveys
- 1 Content knowledge and demographics survey, before study for base-line data
- 1 Instructional practices survey, mid-point of study for base-line data

_________________________ _______________________
Participant’s Signature Date

_________________________
Participant’s Name (printed)

_________________________ _______________________
Researcher’s Signature Date

_________________________
Researcher’s Name (printed)
Appendix C

Teacher Surveys Pre- and Post-Professional Development

Pre-Survey

1. How proficient are you at standards-based mathematics instruction for the current standard before professional development? (Likert Scale 1-10)
2. What are your strengths in standards-based mathematics instruction before professional development?
3. What areas of growth would you like to target in our professional development sessions regarding standards-based mathematics instruction for the current standard?

Post-Survey

1. How proficient are you at standards-based mathematics instruction for the current standard after professional development? (Likert Scale 1-10)
2. What are your strengths in standards-based mathematics instruction after professional development?
3. What areas of growth for the current standard would you like to target after our professional development sessions?
Appendix D
Teacher Survey Content Knowledge

1. How many years of experience teaching math do you have?

2. How comfortable are you teaching math? (Likert Scale 1-10)

3. What are the demographics of your room?
   - Boys ___  Girls___
   - White ___  Black___  Hispanic___  Other___
   - Economically disadvantaged___

4. What educational degrees do you hold?

5. What is your knowledge base regarding strategies for teaching mathematics to English language learners? (Likert Scale 1-10)

6. What is your knowledge base regarding strategies for teaching mathematics to students with exceptionalities? (Likert Scale 1-10)

7. What is your knowledge base regarding developmental norms regarding how students learn appropriate to your grade level? (Likert Scale 1-10)

8. What is your comfort level creating ability groupings? (Likert Scale 1-10)

9. To what degree do you effectively use mathematics manipulatives in elementary mathematics instruction? (Likert Scale 1-10)

10. To what degree do you effectively use technology in elementary mathematics instruction? (Likert Scale 1-10)

11. What is your comfort level developing formative assessments, both paper-based and observational? (Likert Scale 1-10)
Appendix E

Teacher Survey Instructional Practices

1. How can a math content area specialist support math instruction in your classroom?
2. What professional learning would support math instruction in your classroom?
3. How is technology used during mathematics instruction?
4. What mathematics remediation activities have been implemented?
5. What mathematics enrichment activities have been implemented?
6. What is your process for researching mathematics topics?
7. What supplements do you use to support the mathematics curriculum?
8. What groupings do you use during mathematics instruction?
9. What is your student engagement level during mathematics instruction? (Likert Scale 1-10)
10. Who drives participation in activities, students or teacher?
11. Do you pre-and post-assessments to drive mathematics instruction?
12. Do you set mathematics goals with students and discuss their mathematics progress with them consistently?
13. What teaching strategies do you use to meet the differentiated mathematics needs of students?
Appendix F

Teacher Interview Questions

Quarter 1 Interview starter question:

1. Do you believe that the mathematics professional development program at our school is making a positive difference in the academic achievement of students? If so, in what ways? If not, why not?

Quarter 2 Interview starter question:

2. What improvements in our mathematics professional development program do you believe are needed to improve student achievement as measured by quarterly district assessments, end-of-unit assessments, and state standardized assessments?

Quarter 3 Interview starter question:

3. How can I improve the way I design and implement mathematics professional learning to enable teachers to develop a clear vision of the program’s effectiveness and areas for improvement?

Quarter 4 Interview starter question:

4. Have you become more reflective regarding your instructional practices as a result of the mathematics professional learning you participated in this year? Why or why not?
Appendix G

As-Is Diagram:

“As Is” 4 C’s Analysis Focused on Study School Professional Development

Context
- 3rd-5th tested subjects focused on by administration
- Achievement gap present at grades 2-5
- Equity access to professional development
- Negative social stigma associated with study school
- Elementary school targeted by state DOE
- High low-socioeconomic population, high minority population

Culture
- 3rd-5th grades cannot lose focus to grades K-2 because those are the tested grade levels
- Low expectations
- Teachers suffered initiative fatigue from annual curriculum changes
- Efforts needed to be directed
- Competing priorities: state, district, school administration, schoolteachers
- Fear based decision making
- Lack of growth mindset within instructional staff
- 1/3 white, 1/3 Hispanic, 1/3 black
- Largest employer in county
- Academic identity low expectations

Competencies
- Professional Development is needed specific to mathematics content knowledge and skills
- Lack of knowledge among administrators regarding mathematics content knowledge and skills
- Lack of knowledge and understanding of state math standards
- Teacher resistance to professional development through collaborative planning
- Teacher resistance to coaching: 2017-2018 part-time coach and 2018-2019 full time – still building relationships
- Isolative nature of education
- Lack of reflective practices of practitioners

Conditions
- Understaffed, teacher turnover, teachers moving grade levels, new teachers
- Departmentalized teaching in 2nd, 3rd, and 4th grades
- Administration focused on grades 3-5
- Students lack mastery of foundational mathematics skills
- High poverty percentage of students
- State standards not implemented with fidelity
- D graded school
- Culture of fear

Poor content knowledge, alignment to standards, and instruction practices in grades 2-5 perpetuated achievement gap in mathematics, continued need for focused professional development
Appendix H

To-Be Diagram

“To Be” 4 C’s Analysis for a Focus on Site-based Professional Development in Elementary School

Context
- All teachers participate in collaboration and have access to on-demand, site-based, job-embedded professional learning.
- Study school maintains A status within state ranking
- K-2 focus is seen as equally important to grade 3-5.
- Achievement gap is reduced and there is equal access to quality on-demand, site-based professional development.

Culture
- Teacher PD driven by teacher agency and reflection.
- Growth mindset present in all stakeholders
- Directed, noncompeting efforts supporting all students.
- Shared vision of being the premier elementary school in the district
- Universal acceptance of philosophy of early learning and brain development of mathematics.
- Equal focus is placed on primary and intermediate grades.
- Transitions are eased between grade levels as the primary grades are considered a developmental continuum with fewer gaps in instructional delivery.
- Shared high- expectation academic identity.

Conditions
- State mathematics standards taught with fidelity.
- Students master grade level mathematics skills.
- Administration focused on success in all grade levels.
- Co-teaching and team-teaching model used to focus on standards instruction and increase student achievement.
- Site-based math coaches at every elementary school to provide on-demand and job-embedded PD as identified by teachers and administrators.
- Grade level mathematics collaborations occurring at minimum of once a week
- Stable teacher force of qualified personnel with growth mindset in all grade levels.
- Specialized, job-embedded mathematics.

Competencies
- All stakeholders engage in reflective practices regularly.
- Relationships build between math coach, teachers, and administration to support the needs of the student population.
- Teachers actively engaged in professional development through collaboration and coaching.
- Professional Development includes strong ties to primary and intermediate education.
- Adequate knowledge among teachers and administrators on data use, pedagogy, and content.

Strong content knowledge and pedagogy in mathematics provided by site-based math coaches reduces the achievement gap in mathematics and increases mathematics proficiency.

Appendix H
## Appendix I

### Strategy and Action Chart

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>School leaders develop and maintain a cycle of excellence at the study school.</td>
<td>• Put the right people in the right positions.</td>
</tr>
<tr>
<td></td>
<td>• Provide opportunities for teachers to “strengthen interpersonal bonds among team members” (Hallowell, 2011, p. 6).</td>
</tr>
<tr>
<td></td>
<td>• Provide opportunities for teachers to think outside of the box to benefit student achievement.</td>
</tr>
<tr>
<td></td>
<td>• Provide challenges but not frustrations to develop stellar staff.</td>
</tr>
<tr>
<td></td>
<td>• Develop loyalty and build teachers’ self-efficacy by acknowledging their achievements.</td>
</tr>
<tr>
<td>Mathematics assessments for teachers.</td>
<td>• Have grade level teachers take a grade level math content assessment before students report to class to ensure teachers are placed correctly and to provide mathematics professional development as necessary.</td>
</tr>
<tr>
<td></td>
<td>• During collaboration, have teachers complete the assessment that students will complete at the end of the instructional unit to show mastery of math skills. This will allow the teacher and the math content area specialist to plan mathematics professional development to support teacher’s classroom instruction and will allow teachers the opportunity to reflect upon their mathematics content knowledge and pedagogy.</td>
</tr>
<tr>
<td>Weekly, 45-minute, mathematics focused, grade level collaboration facilitated by a</td>
<td>• Collaboration will include preplanning assessment, scheduled nonevaluative observations by the math content area specialist of the teacher’s instructional delivery of lessons designed during collaboration, constructive feedback from the math content area specialist,</td>
</tr>
</tbody>
</table>
| Math content area specialist and using a backward planning format. | and reflective activities for teachers interwoven within collaboration.  
- All math collaboration sessions facilitated by the math content area specialist.  
- Plan instruction with the end in mind: what do students need to know and how will we get them there? (Guskey, 2014, p. 14). |
|---|---|
| Instructional and support staff transitions from compliance to agency regarding professional development through development of self-efficacy. | Devote sacred time to site-based professional development, 30-minutes weekly.  
- Takes place over an extended time with a greater amount of contact time (Marquis, 2015, p. 125).  
- Provides teachers with a repetition of action and practice in mathematics skills to refine their instructional skills.  
- A minimum of 50-hours of mathematics professional development per academic year to maintain academic growth (Pemberton et al., 2016, p. 16).  
- Site-based, job-embedded, ongoing mathematics professional development for teachers, pare-professionals, and administrators.  
- 5-hours of teachers preplanning week devoted to math professional development. |
| Mathematics professional development opportunities for all in need. | One-on-one, small group, and/or by grade level.  
- Differentiated to needs and/or wants of instructional staff, school leaders, and support staff.  
- Focused on authentic student learning and intended to improve classroom instructional practices (Smith, 2015, p. 28).  
- Provided during weekly 30-minute professional development sessions and weekly 45-minute collaborative planning sessions  
- Driven by teacher reflective needs surveys, administrator observations, |
teacher insights during collaboration, math preassessments, grade level requests, and math content area specialist observations.

- Focused on mathematics standards content knowledge and mathematics pedagogy.

| Study school principal will budget for math content area specialist. | Odden (2011) recommended 1 content area specialist per 200 students (p. 30).
- Budget $65,000 per math content area specialist to include salary and benefits.
- Use Title I and Title II funds to offset financial hardship on budget assigned to school.
- Include budget for supplies for professional development. |
| Use teacher evaluation rubric to design professional development in math. | Improve teachers’ ratings in areas of instructional design and lesson planning.
- Improve teachers’ ratings in participation in professional development as part of continuous professional improvement.
- Improve teachers’ ratings in demonstration of knowledge of content and pedagogy.
- Improve teachers’ ratings in establishing a culture of learning
- Improve teachers’ ratings in reflection upon teaching.
- Mathematics instructional staff are rated effective or highly effective. |
| Assess the fidelity of the mathematics professional development program at the study school. | Improved student achievement levels in mathematics on state standards assessments.
- Improved letter grade earned by students and staff.
- School grade maintained at an A or a B. |
| Develop a shared high-expectation mathematics academic identify for all stakeholders at the study school. | • Develop growth mindset culture.  
• Use growth mindset verbiage.  
• Professional development provided on growth mindset by math content area specialist.  
• Book study of Dweck’s (2016) book *Mindset*. |
| Use community partners and parents as academic resources. | • Bring the expertise of community partners into the school.  
• Develop family math nights at the school and in the community.  
• Community partners attend grade level collaboration.  
• Community partners volunteer at the school during math times.  
• School administrators welcome community partners as a support to student math achievement. |