IMPLEMENTATION OF PENNSYLVANIA CORE MATHEMATICS STANDARDS: ELEMENTARY TEACHERS’ PERCEPTIONS

A dissertation submitted to the faculty of Immaculata University by Carol C. Kelsall in partial fulfillment of the requirements for the degree of Doctor of Education

Immaculata, Pennsylvania March 2015
TITLE OF DISSERTATION:
Implementation of Pennsylvania Core Mathematics Standards: Elementary Teachers’ Perceptions

AUTHOR: Carol C. Kelsall

Mary A. Calderone, Ed.D.
Chairperson

Stephen E. Tish, Ed.D.
Committee

Heini Capitano, Ed.D.
Committee

Reader

ON BEHALF OF IMMACULATA UNIVERSITY:

Janet F. Kane, Ed.D.
Dean, College of Graduate Studies

Thomas Compitello, Ed.D.
Chairperson, Education Division

DATE: March 31, 2015
Abstract

The purpose of this qualitative study was to examine elementary teachers’ perceptions regarding changes in mathematics instruction due to implementation of the Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement these standards. Fourteen elementary teachers from 3 public school districts participated in the study. Six teachers were individually interviewed which provided further insight regarding their perceptions. Results of the study indicate that mathematics instruction changed due to implementation of the Pennsylvania Core Mathematics Standards, along with changes to curriculum, textbooks, other resources, lesson planning, and instructional strategies. Results suggest that the instructional changes have benefitted students, but that more changes are needed. The research findings also show that elementary teachers participated in professional development prior to implementing the Pennsylvania Core Mathematics Standards and that district-provided professional development was beneficial to teachers. The study found that not all teachers felt prepared to implement the Pennsylvania Core Mathematics Standards and that more professional development was needed to effectively implement Pennsylvania Core Mathematics Standards.
Acknowledgements

And looking at them Jesus said to them, “With people this is impossible, but with God all things are possible.” Matthew 19:26  I thank God for helping me through this process. I appreciate and am humbled by all of the prayers said on my behalf.

Words cannot express my gratitude to those who have supported me throughout my doctoral work. Their faith in me means more than I can say.

• My wonderful chairperson, Dr. Mary Calderone, who encouraged me and provided me with her invaluable expertise and wisdom.
• My committee members, Dr. Heidi Capetola and Dr. Stephen O’Toole. Their insightful comments and questions helped clarify my ideas.
• The teachers of the participating school districts, who gave their time and honest feedback for this study.
• My informal mentors from elementary school to the present, for their belief in me.
• My friends and colleagues, who supported me in more ways than I can count.
• My parents, Donald and Arlene, who always encouraged and supported me.
• My son, Jason, for his sense of humor when I really needed it.
• My daughter and son-in-law, Becky and Derrick, for their support and proof-reading of many papers.
• My grandchildren, Alyssa and Derrick, for their hugs and kisses.
• My husband, Rich, for his untiring support and love throughout all of my educational pursuits.
Table of Contents

Abstract ......................................................................................................................... iv

Acknowledgements ...................................................................................................... v

List of Tables ................................................................................................................ ix

Chapter One – Introduction ....................................................................................... 1
  Overview ...................................................................................................................... 1
  Need for the Study ...................................................................................................... 5
  Statement of the Problem .......................................................................................... 6
  Definition of Terms .................................................................................................... 7
  Limitations .................................................................................................................. 8
  Research Questions ................................................................................................... 9
  Summary ..................................................................................................................... 9

Chapter Two – Literature Review ............................................................................. 11
  Introduction ............................................................................................................... 11
  History of Standards ................................................................................................. 12
  Time in School and Instructional Time ..................................................................... 18
  Teacher Considerations ............................................................................................ 21
  Instructional Strategies .............................................................................................. 24
  Classroom Environment ............................................................................................ 28
  Textbooks .................................................................................................................. 30
  Professional Development ......................................................................................... 34
  Summary ..................................................................................................................... 39
Chapter Three – Methods and Procedures ................................................................. 41
  Introduction .................................................................................................................. 41
  Subjects .......................................................................................................................... 41
  Setting .............................................................................................................................. 42
  Instruments ....................................................................................................................... 43
  Design of the Study ........................................................................................................ 46
  Procedure ......................................................................................................................... 46
  Data Analysis .................................................................................................................. 48
  Summary .......................................................................................................................... 48

Chapter Four – Results .................................................................................................... 50
  Introduction ....................................................................................................................... 50
  Research Question One ................................................................................................... 50
  Research Question Two ................................................................................................. 59
  Summary .......................................................................................................................... 66

Chapter Five – Discussion ............................................................................................... 69
  Summary of the Study ..................................................................................................... 69
  Summary of the Results ................................................................................................. 70
  Limitations Found in the Study ....................................................................................... 75
  Relationship to Other Research ...................................................................................... 75
  Recommendations for Further Research ...................................................................... 77
  Conclusion ....................................................................................................................... 78
  References ....................................................................................................................... 81
Appendices ........................................................................................................ 96
A – Survey ........................................................................................................... 96
B – Interview Questions ..................................................................................... 100
C – Research Ethics Review Board Approval ................................................... 101
# List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 3.1</td>
<td>Percent of Student Enrollment by Ethnicity</td>
<td>43</td>
</tr>
<tr>
<td>Table 4.1</td>
<td>Teachers’ Perceptions of Changes to Classroom Instruction due to Implementation of Pennsylvania Core Mathematics</td>
<td>52</td>
</tr>
<tr>
<td>Table 4.2</td>
<td>Teachers’ Perceptions of the Effectiveness of Changes to Mathematics Instruction due to Implementation of Pennsylvania Core Mathematics</td>
<td>53</td>
</tr>
<tr>
<td>Table 4.3</td>
<td>Teachers’ Perceptions of the Level of Support of Professional Development for Implementation of Pennsylvania Core Mathematics</td>
<td>61</td>
</tr>
<tr>
<td>Table 4.4</td>
<td>Teachers’ Perceptions of Preparation for Implementation of Pennsylvania Core Mathematics Standards</td>
<td>61</td>
</tr>
</tbody>
</table>
Chapter One – Introduction

Overview

In May of 2010, President Barack Obama emphasized the importance of education stating the following, “Today, more than ever, a world-class education is a prerequisite for success. America was once the best educated nation in the world” (U.S. Department of Education [USDOE], 2010, p. iii). For that reason, achievement of U.S. students was examined. Achievement of U.S. students as measured in two international assessments illustrated the change in status. Results from the 2011 Trends in International Mathematics and Science Study (TIMSS) found that seven countries outperformed U.S. students in both fourth and eighth grades (TIMSS, 2011). Program for International Student Assessment (PISA) results showed even the top performing U.S. students’ mathematics achievement was not adequate (PISA 2012 Selected Findings, 2012).

The No Child Left Behind Act of 2001 (NCLB) placed a focus on the achievement of students in English language arts and mathematics. States were required to design and to administer English language arts and mathematics tests to measure the proficiency of their students (Murnane & Papay, 2010). Furthermore, 100% of students were to be proficient by 2014. Schools that did not make Adequate Yearly Progress (AYP) based on student proficiencies were sanctioned; schools also needed to employ highly qualified teachers (Murnane & Papay, 2010).

The expectation of all students being proficient in mathematics has increased the focus on changes in mathematics instruction. Common Core State Standards defined the content to be taught in classrooms. The Common Core State Initiative began in 2009 for
the purpose of developing kindergarten-Grade 12 standards so that U.S. students would be able to compete globally. These standards were released in 2010 (ASCD, 2012). CCSS Mathematics (CCSSM) increased the expectations for what students needed to know, to understand, and to apply (National Governors Association Center for Best Practices [NGS Center], Council of Chief State School Officers [CCSSO], 2010b). The standards of high achieving countries and CCSSM were found to be similar (Schmidt & Houang, 2012). Furthermore, there were significant differences such as rigor and focus between pre-CCSSM state standards and CCSSM (Dingman, Teuscher, Newton, & Kasmer, 2013; Schmidt & Houang, 2012). Pennsylvania Mathematics Standards, which were in effect when Common Core State Standards were developed, were compared with Common Core State Standards Mathematics and were found to be only 50% aligned in grades 3, 5, and 8 (Lane, 2010). Pennsylvania Core Mathematics Standards, which were developed based on Common Core State Standards Mathematics, went into effect on March 1, 2014 (PA Bulletin, 2014).

Time has an impact on mathematics instruction. Students need to be in school to learn and to be in mathematics classes (Banilower et al., 2013; Hill, Rowan, & Lowenberg Ball, 2005; Phelps, Corey, DeMonte, Harrison, & Lowenberg Ball, 2012). The amount of instructional time in mathematics varies greatly among elementary schools (Phelps et al., 2012); however, increased instructional time does not ensure mathematical gains (Bodovski & Farkas, 2007; Claessens, Engel, & Curran, 2014; Hiebert et al., 2003).

Another factor that influences student learning is the quality of the teaching (Kersting, Givvin, Sotelo, & Stigler, 2010; Marzano, 2003; Stronge, Ward, & Grant,
Effective teachers have students with achievement gains of over 30 percentile points more than students who have ineffective teachers (Stronge et al., 2011). The content knowledge of teachers also influences student achievement (Hiebert et al., 2003; Marzano, 2003; National Mathematics Advisory Panel [NMAP], 2008). Furthermore, Kersting et al. (2010) found that it is not enough that teachers know mathematical concepts; teachers need to be able to access and to organize their mathematical knowledge to be able to teach concepts to students. Teachers’ beliefs affect whether they used some or almost all of the given curriculum (Superfine, 2008) as well as the choice of instructional goals (Lee & Ginsburg, 2007).

Instructional strategies are another choice made by teachers. There is a relationship between instructional strategies and student achievement (Hiebert et al., 2003; Kanold, Briars, & Fennel, 2012; Marzano, 2003; NMAP, 2008). While there is no one best instructional strategy (Danielson, 2008; Hiebert & Grouws, 2007; Marzano, 2003, NMAP, 2008; Stronge, 2007), there are strategies which promote student achievement such as cooperative learning and the use of real-life problems (Hiebert & Grouws, 2007; McRel, 2012; Slavin & Lake, 2008).

Equally important is a positive classroom environment. Forty-one percent of public school teachers indicated student misbehavior interfered with their teaching (National Center for Education Statistics, 2013). Effective teachers manage classrooms so that all students feel valued and disruptions are kept to a minimum (Marzano, 2003; Marzano, Pickering, & Heflebower, 2011; Plank & Condliffe, 2012; Reinke, Herman, & Stormont, 2013; Slavin & Lake, 2008; Stronge, 2007; Stronge et al., 2011).
Another factor which influences mathematics instruction is textbooks. The textbooks used in classrooms impact instruction since mathematics teachers rely on textbooks for 75% of instructional time (Horizon Research, 2013). Although there have been many studies about the effectiveness of different textbooks, there is a lack of quality research using rigorous statistical methods to determine the effectiveness of textbooks (Slavin & Lake, 2008). Furthermore, there are concerns about the quality of textbooks; textbooks are not always accurate (NMAP, 2010). Also, U.S. textbooks were found to be much longer than the textbooks used in the countries with higher mathematics achievement (NMAP, 2010). Although textbook companies have changed their materials to reflect the release of new standards (Gewertz, 2010; Heck et al., 2011), some schools do not have adequate funds to purchase new textbooks (Banilower et al., 2013).

Finally, professional development supports teachers’ growth in reaching the heightened expectations of CCSS (Braun, 2011; Darling-Hammond & Richardson, 2009; Kanold et al., 2012; Marzano, 2003; McRel, 2010; NMAP, 2008; National Staff Development Council [NSDC], 2009). There are characteristics of effective professional development which include visionary, coherent, collaborative, collegial learning environment, sustainable over time, collective responsibility, continuous cycle of improvement, and job-embedded (Braun, 2011; Darling-Hammond & Richardson, 2009; Fuchs & Vaughn, 2012; Kanold et al., 2012; Marzano, 2003; McRel, 2010; NSDC, 2009; Reeves, 2010; Stronge, 2007). Effective professional development is also focused on curriculum, standards, assessment, teaching strategies, and student work (Braun, 2011; Darling-Hammond & Richardson, 2009; Kanold et al., 2012; Marzano, 2003; McRel, 2010; NSDC, 2009; Reeves, 2010; Stronge, 2007). A recommendation is that
professional development occur in professional learning communities (Anderson & Herr, 2011; Darling-Hammond & Richardson, 2009). Over 30 hours were recommended for professional development to be effective (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). While some studies found that professional development over 30 hours was effective (Carlson, Borman, & Robinson, 2011; Doabler et al., 2014; Rimm-Kaufman et al., 2014), two studies found over 30 hours did not yield positive results (Anthony & Clark, 2011; Wager & Foote, 2013).

Need for the Study

Not only was the mathematics achievement level of U.S. students found to be lacking in international comparisons as measured on TIMSS and PISA but also students’ mathematics achievement on the National Assessment of Educational Progress (NAEP) was also deficient. Only 30% of 12th grade students were considered proficient (Schmidt & Houang, 2012). NAEP 2013 results for Pennsylvania fourth grade students were 244 which was a slight decrease in scores from the 2011 assessment score of 246; 59% of fourth grade students were basic or below average (USDOE, 2013). Pennsylvania’s eighth grade NAEP 2013 results were 290 which showed an increase of four points from the 2011 score of 286 (USDOE, 2013). Although there was an increase in scores from the 2011 to the 2013 NAEP assessments, 59% of eighth grade students were basic or below average (USDOE, 2013).

Teachers are accountable for the education of students in their classrooms and the expectation is for students to make at least one year of growth for every year in school. To measure the effectiveness of classroom teachers, Pennsylvania has adopted an Educator Effectiveness Rating Tool which began implementation during the 2013-2014
school year (Pennsylvania Department of Education [PDE], 2013b). Teacher Observation and Practice are 50% of the overall rating. Furthermore, the Teacher Observation and Practice rating is determined by four sections; two of the sections are Classroom Environment (30%) and Instruction (30%) which translates to each section yielding 15% of the overall rating (PDE, 2013b).

Another factor in a teacher’s rating is student achievement as measured on state assessments – Pennsylvania System of School Assessment (PSSA), Keystone Exams, and Pennsylvania Alternate System of Assessment (PASA) (PDE, 2013b). PSSAs will be changed to reflect Pennsylvania Core Mathematics Standards and students will be assessed on this content during the 2014-2015 school year; Keystone Exams have been aligned to PA Core Mathematics (PA Core Standards Teacher Fact Sheet, 2014).

Additional research is needed to ascertain elementary teachers’ perceptions of changes to mathematics instruction and professional development needed due to implementation of Pennsylvania Core Mathematics Standards.

**Statement of the Problem**

The purpose of this study was to investigate elementary teachers’ perceptions of the changes which have been made due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement Pennsylvania Core Mathematics Standards. The researcher sought the opinions of elementary teachers who instruct in Pennsylvania public schools to determine if the teachers perceived changes have been made to mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards. Furthermore, the researcher sought to determine if the teachers perceived the professional development on
Pennsylvania Core Mathematics Standards had been sufficient for the effective implementation of these standards.

**Definition of Terms**

For the purpose of this study, the following terms are defined as follows:

*Application* – using procedures from one context in another context (Hiebert et al., 2003).

*Classroom discourse* – communication of mathematical thinking clearly and with precision (Griffin, League, Griffin, & Bae, 2013).

*Cognitive demand* – “the extent which the mathematics tasks involved connections between concepts, procedures, and facts” (Agodini, Harris, Seftor, Remillard, & Thomas, 2013, p. 4).

*Coherence* – “standards that are articulated over time as a sequence of topics and performances that are logical and reflect where appropriate, the sequential and hierarchical nature of the disciplinary content from which the subject matter derives” (Schmidt & Houang, 2012, p. 295).

*Conceptual understanding* – learning with understanding of concepts and operations (NCTM, 2000).

*Elaboration* – making new meaning based on previous understanding (Kilic, Cene, & Demir, 2012).

*Explicit instruction* – an instructional approach for teaching foundational concepts and skills (Doabler et al., 2014).

*Focus* – the number of topics covered at each grade (Schmidt & Houang, 2012).
Learning progression – sequence of learning for a domain (NGA Center, CCSSO, 2010b).

Mathematical disposition – “habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy” (NGA Center, CCSSO, 2010b).

Pedagogical knowledge – an understanding of the instructional strategies (Marzano, 2003).

Procedural understanding – skill in carrying out procedures (NCTM, 2000).

Professional learning community – teachers working together to accomplish goals such as improved student learning (Darling-Hammond & Richardson, 2009).

Problem solving – “engaging in a task for which the solution method is not known in advance” (NCTM, 2000, p. 52).

Proof – “a formal way of expressing particular kinds of reasoning and justification” (NCTM, 2000, p. 56).

Reform-oriented instruction (R-OI) – “instruction that engages students as active participants in their own learning and seeks to enhance the development of complex cognitive skills and processes” (Le, Lockwood, Stecher, Hamilton, & Martinez, 2009, p. 200).

Rigor – the level of cognitive demand (NGA Center, CCSSO, 2010b).

Limitations

This study was limited to the elementary teachers who taught mathematics in three public school districts. Since central office administrators, building administrators, non-mathematics teachers, first-year teachers, secondary teachers, specialists, and district
non-teaching personnel were not included in the study, results may not be generalized for these groups.

Furthermore, location of the participating districts was a limitation. Districts A and B were suburban public school districts located within the same county in south central Pennsylvania. District C was a rural public school district located in central Pennsylvania. Districts A and C were comprised of four elementary schools; District B had two elementary schools. The results may not be able to be generalized to districts in other geographic areas or to urban public school districts.

**Research Questions**

The following research questions guided this study:

1. What are elementary teachers’ perceptions regarding changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards?
2. What are elementary mathematics teachers’ perceptions regarding the professional development needed to effectively implement Pennsylvania Core Mathematics Standards?

**Summary**

Comparisons of student achievement on international assessments from 2011-2013 found that U.S. students do not achieve at the same levels as students from the top performing countries (PISA 2012 Selected Findings, 2012; TIMSS, 2011). There has been a focus on mathematics achievement of U.S. students and NCLB legislation required all students to be proficient in mathematics by 2014 (Murnane & Papay, 2010). The development of CCSSM provided a change to current state standards (ASCD, 2012); one of the goals of CCSSM was to provide focused and coherent standards comparable to
those of high performing countries (NGS, CCSSP, 2010b). Furthermore, the state standards used in Pennsylvania are based on CCSM (Lane, 2010).

Since teachers are accountable for the education of their students and student achievement is impacted by what happens in classrooms, it is important to understand the perceptions of elementary teachers regarding mathematics instruction and professional development. Therefore, this study examined the perceptions of elementary teachers regarding changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement Pennsylvania Core Mathematics Standards.
Chapter Two – Literature Review

Introduction

U.S. students have been outperformed in mathematics by students in many other countries. Trends in International Mathematics and Science Study’s (TIMSS) 2007 results showed that five countries scored significantly higher in mathematics than U.S. eighth grade students; fourth grade results showed eight countries significantly outperformed U.S. students (TIMSS, 2007). The 2011 TIMSS results showed mathematics gains for U.S. fourth and eighth grade students; however, the students in Singapore, Republic of Korea, Hong Kong-CHN, Chinese Taipei-CHN, Japan, and Russian Federation still outperformed U.S. students (TIMSS, 2011). U.S. students had difficulty on another international assessment, Program for International Student Assessment (PISA), which measured students’ abilities to apply their mathematical knowledge and skills in a real life context (PISA 2012 Results Introduction, 2012). The top performing U.S. students scored lower than the average score of all students (PISA 2012 Selected Findings, 2012).

The Common Core State Standards for Mathematics (CCSSM) were written to respond to the challenge of other countries’ students’ outperforming U.S. students. The premise of CCSSM was to take “a mile wide and an inch deep” (p. 3) curriculum and to develop learning progressions that emphasized conceptual understanding of key ideas (NGA Center, CCSSO, 2010b). In addition to key concepts, CCSSM included Standards for Mathematical Practice which outlined mathematical dispositions for students (NGA Center, CCSSO, 2010a).
The existence of standards did not guarantee that the standards were implemented in classrooms (Marzano, 2003). With the change to CCSSM, even teachers who were previously considered effective may need professional development (McRel, 2010). Also, the quality of instruction has an impact on student learning (Heck, 2007; Kersting et al., 2012; Marzano, 2003; Stronge et al., 2011). Furthermore, in a longitudinal study of elementary students, Heck (2007) observed that schools with more quality teachers had students with higher rates of growth in mathematics. In addition, Stronge et al. (2011) found, “Students who had teachers in the top-quartile of effective practice scored on average, 30 percentile points more than students who had teachers in the bottom-quartile of effective practice” (p. 345).

This literature review will examine the current research on changes in mathematics instruction due to implementation of CCSSM and the professional development needed for implementation of CCSSM. The historical perspective of standards and research on CCSSM and Pennsylvania Core Mathematics Standards will also be included. In addition, time in school and instructional time will be examined. Furthermore, teacher factors including knowledge and beliefs, classroom environment, instructional strategies, and the impact of textbooks will be addressed. Finally, research on professional development will be conveyed.

History of Standards

A Nation at Risk of 1983 was considered the beginning of the standards movement in the United States (Easley, 2011). The decline of the economy and the decrease in the United States’ prominence in science were the impetus for the report (The National Commission on Excellence in Education, 1983). A Nation at Risk called for
reform and focused on mathematics and four other content areas (The National Commission on Excellence in Education, 1983). The report’s reform recommendations included a focus on content standards, length of study for courses, and minimum high school graduation credit requirements (The National Commission on Excellence in Education, 1983). In 1989, the National Council of Teachers of Mathematics (NCTM) issued the *Curriculum and Evaluation Standards*, which were designed to “establish a broad framework to guide reform in school mathematics in the next decade” (NCTM, 1989, p. v). These standards were used by most states (Dingman et al., 2013). The standards included content standards such as measurement and standards which described the way mathematics was taught (NCTM, 1989).

An emphasis on standards reemerged in 1994 when Goals 2000: Educate America Act became law (Easley, 2011). Goals 2000 emphasized the need for well-defined standards and for high expectations for learning (Easley, 2011). This was followed by the 2000 release of NCTM’s *Principles and Standards for School Mathematics* (NCTM, 2000). *Principles and Standards for School Mathematics* went beyond content standards; they expressed the need for students to understand mathematical concepts and processes (NCTM, 2000).

No Child Left Behind legislation (NCLB), which took effect in 2002, furthered the emphasis on standards (Dingman et al., 2013; Murnane & Papay, 2010). NCLB required each state to determine mathematics standards for grades 3 through 8 and to administer annual assessments based on these standards (Dingman et al., 2013; Murnane & Papay, 2010). Furthermore, schools needed to make Adequate Yearly Progress (AYP), which was dependent on an increasing percentage of proficiency; 100% of students were
to be proficient by 2014 (Murnane & Papay, 2010). Finally, NCLB required that all teachers be highly qualified as defined by each state (Murnane & Papay, 2010). Highly qualified in Pennsylvania means teachers needed to hold a minimum of a bachelor’s degree, to hold a valid Pennsylvania teaching certificate, and to demonstrate subject competency for the content area they taught (NCLB’s Highly Qualified Teacher Requirements, 2014).

The latest in the standards movement was the 2010 release of Common Core State Standards (NGA Center, CCSSO, 2010a). This initiative was led by the National Governors Association Center for Best Practices, Council of Chief State School Officers (NGA Center, CCSSO, 2010b). CCSS were to “provide a consistent, clear understanding of what students are expected to learn” (para. 1) with the outcome that “with students fully prepared for the future, our communities will be positioned to compete successfully in the global economy” (NGA Center, CCSSO, 2014, para. 2). CCSS were written after examining standards of high performing countries; standards were more rigorous than current state standards (NGA Center, CCSSO, 2010b). CCSSM included grade level content standards and mathematical process standards (NGA Center, CCSSO, 2010a) which have been adopted by 45 states (ASCD, 2012). An example of a kindergarten content standard is “Count to 100 by ones and by tens” (NGA Center, CCSSO, 2010b, p. 11). The mathematical process standards were the same for all grade levels; an example is, “Make sense of problems and persevere in solving them” (NGA Center, CCSSO, 2010b, p. 6). The mathematical process standards were described as the types of capabilities that teachers “at all levels should seek to develop in their students” (NGA Center, CCSSO, 2010a, p. 6). Furthermore, the emphasis on the mathematical process
standards by teachers should enhance students’ mathematical dispositions (NGA Center, CCSSO, 2010a).

On July 1, 2010, the Pennsylvania State Board of Education adopted CCSSM with the expectation of full implementation during the 2013-2014 school year (PDE, 2010). Pennsylvania Core Mathematics Standards went into effect on March 1, 2014 (PA Bulletin, 2014). The change in the time for implementation of Pennsylvania Core Mathematics Standards necessitated an alteration in the timetable for assessment; students will be assessed on Pennsylvania Core Mathematics Standards in the 2014-2015 school year (PA Core Standards Teacher Fact Sheet, 2014).

**Mathematics standards.**

*States standards pre-Common Core State Standards Mathematics.* Schmidt, Wang, and McKnight (2005) compared the content standards of Singapore, Korea, Japan, Hong Kong, Belgium, Czech Republic, the countries with the highest TIMSS scores, with United States individual states’ content standards. The focus was on coherence which Schmidt et al. asserted as one of the most important factors of quality standards. In the TIMSS countries, the topics were organized in a logical structure but the U.S. standards appeared to be “an arbitrary, laundry-list approach of topics” (Schmidt et al., 2005, p. 542). The study by Polikoff (2012) also examined the states’ standards but used teachers’ reports of the mathematical topics taught in their kindergarten through eighth grade classrooms. There was significant redundancy across grades and from 68 to 90 days of instruction were used to teach topics that were already introduced in earlier years (Polikoff, 2012).
McLaughlin et al. (2008) compared state standards based on proficiency levels on state mathematics assessments with 2003 NAEP scores. There was significant variation of proficiency levels among states. Furthermore, states with high standards for proficiency had few students meet this level while states with lower standards had most of their students score proficient (McLaughlin et al., 2008). This process was repeated using the 2009 NAEP scores (USDOE, 2011), and there remained a wide variation among states. Seven states had fourth grade achievement proficiency standards below NAEP standards and 12 states had eighth grade achievement standards below NAEP standards (USDOE, 2011).

State standards influence schools and mathematics classrooms (Banilower et al., 2013; Easley, 2011). Over 85% of teachers agreed that there had been school wide efforts to align mathematics instruction with state mathematics standards and that most teachers in their schools taught to state standards (Banilower et al., 2013). Furthermore, 50.8% of elementary teachers and 41.1% of secondary teachers agreed with the statement that state or district content standards have had a positive influence on their satisfaction with teaching (National Center for Educational Statistics, 2013). High school graduates had a different perception of standards. High school graduates believed that mathematics standards narrowed the curriculum and limited their educational experiences (Easley, 2011).

Common Core State Standards Mathematics. One major aspect of CCSSM was that they were written by examining the standards of high performing countries and the states with the best standards; standards were focused, coherent, and rigorous (NGA Center, CCSSO, 2010b). CCSSM and pre-CCSSM states’ standards were compared and
states’ standards would need significant changes because of the lack of alignment (Porter, McMaken, Hwang, & Yang, 2011; Schmidt & Houang, 2012). A change to CCSSM would require states to make changes in grade placement of content and the emphases on content (Dingman et al., 2013).

CCSSM were also found to be more focused than pre CCSSM states’ standards (Porter et al., 2011). Cobb and Jackson (2011) replicated the Porter et al. (2011) study and concluded even a higher degree of focus. Additionally, Schmidt and Houang’s (2012) study of CCSSM found the standards to be focused and coherent; there were no major differences between CCSSM and the standards of the highest achieving countries based on TIMSS data.

States’ Superintendents of Education or their designees were surveyed about their perceptions of CCSS (Kober & Rentner, 2012). Thirty-two of the 38 respondents agreed or strongly agreed that CCSSM were more rigorous than previous standards. They further indicated that curriculum and instruction would need to change (Kober & Rentner, 2012). Also, teachers indicated that they lacked in-depth knowledge of CCSSM (ASCD, 2014).

States are in the process of implementing CCSSM and CCSSM aligned assessments. The timetable for implementation of CCSSM aligned assessments varied with the majority of states in the 2014-2015 school year (ASCD, 2014). Heck et al. (2011) suggested that effectiveness of CCSSM should focus on implementation and assessment results. A review of the research on Sage Premier and Education Resources Information Center via U.S. Department of Education (ERIC) yielded no studies of the impact of CCSSM on classroom instruction.
Pennsylvania Mathematics Standards. Pennsylvania Mathematics Standards (pre-CCSSM) and CCSSM were considered closely aligned in content and rigor (PDE, 2010). Lane (2010) compared the two sets of standards in grades three, five, and eight and found 50% alignment; grade 11 had a moderate alignment of 61%. Additionally, the cognitive rigor between the Pennsylvania Mathematics Standards and CCSSM was found to be similar (Lane, 2010). Pennsylvania Mathematics Standards did not contain practice standards so the comparison was limited to content (Lane, 2010).

Pennsylvania Core Mathematics Standards went into effect on March 1, 2014 (PA Bulletin, 2014), and students will be assessed on Pennsylvania Core Mathematics Standards beginning the 2014-2015 school year (PA Core Standards Teacher Fact Sheet, 2014). Additionally, Pennsylvania developed grade level curriculum maps for mathematics which provided modules of instruction aligned to Pennsylvania Core Mathematics Standards (PA Core Standards Instructional Frameworks, 2014).

**Time in School and Instructional Time**

The amount of time students were in school was a factor affecting classroom instruction (Banilower et al., 2013; Hill et al., 2005; Phelps et al., 2012). In a 2012 nationwide study of 7,742 science and mathematics teachers, 8% of the elementary teachers considered high student absenteeism as a serious problem for mathematics instruction; middle school teachers (13%) and high school teachers (16%) reported an even larger concern (Banilower et al., 2013). Additionally, the U.S. Department of Education’s Schools and Safety Survey (2013) reported that elementary and secondary teachers indicated student absenteeism was a serious problem in their schools which was a 2% increase from the 2007-2008 survey. In a study of first and third grade student
achievement, Hill et al. (2005) found students who were absent 20% of the time had lower scores than other students.

Student absence was not the only concern. Teacher absenteeism was also a problem. The results from the 2009 Civil Rights Data Collection estimated approximately one million full time equivalent teachers were absent more than 10 days during the school year; approximately 144,500 of these teachers were from Pennsylvania (USDOE, 2012).

The amount of mathematics instruction which students received varied. In Pennsylvania, school districts were required to have at least 180 student days with at least 900 hours of instruction for elementary and 990 hours of instruction for secondary students, but there was not a required number of hours for mathematics instruction; the amount of hours of mathematics instruction was a district decision (PDE, 2013a). In a longitudinal study of 112 elementary schools from 15 states, Phelps et al. (2012) found that the average student received 140 hours of mathematical instruction per year.

Furthermore, Phelps et al. compared classrooms with the most instructional time with those classrooms with the least instructional time and found the amount of instructional time of students in the top sixth of classrooms based on the most instructional time could have between 80 and 160 hours more mathematics instruction than students in the bottom sixth of classrooms who received the least amount of instructional time.

Due to increased emphasis on standards, some schools increased instructional time in mathematics for kindergarten students (Claessens et al., 2014). Adding instructional time in kindergarten did not guarantee improved student achievement. Bodovski and Farkas (2007) found that increased instructional time for some students
may have contributed to a decrease in student achievement because the teacher spent time instructing students on skills that the students had already mastered. Weinberg, Basile, and Albright (2011) also studied the effect of additional instruction time; however, the additional time was in the summer. Middle school students who voluntarily attended a mathematics summer camp indicated an increase in interest and motivation in mathematics but a decrease in their beliefs of their abilities in mathematics (Weinberg et al., 2011).

Besides adding instructional time due to an increased emphasis on standards, other schools changed their schedules to have blocks of mathematical instruction. Biesinger, Crippen, and Muis (2008) studied the time schedules of 35 comprehensive high schools. Thirteen of the 35 comprehensive high schools in a school district changed to an alternating block schedule in which classes met every other day for an extended length of time (Biesinger et al., 2008). Students on the alternating block schedule made significant gains in self-efficacy and had no change in attitude towards mathematics while students in a traditional schedule had a significant decrease in attitude towards mathematics (Biesinger et al., 2008).

Finally, Hiebert et al. (2003) examined mathematics instructional time of eighth grade classes in the U.S., Australia, Czech Republic, Hong Kong SAR, Japan, Netherlands, and Switzerland. All of these countries had 1999 TIMSS scores higher than the U.S. The median instructional time of lessons ranged from 36 to 50 minutes with 46 minutes reported for the U.S. (Hiebert et al., 2003). Additionally, Hiebert et al. (2003) found there was more variation of instructional time of lessons within the U.S. than other
countries. Furthermore, increased instructional time did not ensure increased student achievement (Hiebert et al., 2003).

**Teacher Considerations**

**Teacher content knowledge.** The content knowledge of a teacher can influence student achievement (Hiebert et al., 2003; Horizon Research, 2013; Marzano, 2003; NMAP, 2008). Data from the TIMSS study found 96% of Czech Republic teachers had college majors of either a mathematics field or mathematics education in comparison to 57% of U.S. teachers (Hiebert et al., 2003). The National Survey of Science Mathematics Education of U.S. teachers found that 73% of high school teachers, 35% of middle school teachers, and 4% of elementary teachers had degrees in mathematics or mathematics education (Horizon Research, 2013). Although 77% of elementary teachers indicated they were very well prepared to teach mathematics, when responding to questions regarding how well prepared they were to teach specific elementary mathematics topics, results ranged from 77% who felt prepared to teach numbers and operations to 46% who also felt prepared to teach early algebra (Horizon Research, 2013).

The National Mathematics Advisory Panel indicated, “You can’t teach what you don’t know” (NMAP, 2008, p. 17) and teachers’ college coursework was not sufficient to determine teachers’ mathematical knowledge for teaching. Ottmar, Rimm-Kaufman, Berry, and Larson (2013) found having a higher level of mathematics knowledge was not predictive of using effective teaching practices. Additionally, Varghese (2009) found in a study of 17 student teachers who had at least 12 three-credit courses of mathematics that most student teachers were unable to explain the mathematical concept of proof or to
provide an explanation to students on the need for a proof. Griffin, Jitendra, and League (2009) also studied pre-service teachers and found that the mathematics knowledge of five pre-service special education majors was not predictive of student achievement; even though one of the pre-service teachers had taken more mathematics classes in high school and college, her students scored lower on a curriculum based assessment than the students whose pre-service teachers had taken fewer mathematics courses in high school and college.

Since college course work was not a sufficient measure of a teacher’s mathematical knowledge, researchers developed other measures. Hill et al. (2005) developed a questionnaire for elementary teachers, which had measures for mathematics content teaching knowledge; these measures required more than a procedural understanding of mathematical skills. They concluded that teachers’ content knowledge for teaching mathematics was a better predictor of student gains than instructional time (Hill et al., 2005). Furthermore, students taught by the 20% lowest ranking first grade teachers scored 10 fewer points on the Terra Nova, a national achievement test, than the students taught by the top scoring teachers (Hill et al., 2005). Hill (2007) developed a tool which examined teachers’ common content knowledge, specialized content knowledge, and pedagogical knowledge. Hill found most teachers had common content knowledge for the grade level taught, but they experienced more difficulty with the specialized content knowledge that required a deeper understanding of mathematical concepts. Hill also concluded that stronger mathematics preparation through courses taken, similar to the preparation of high school mathematics teachers, supported a higher
specialized content knowledge. Finally, Hill recommended that middle school mathematics teachers be certified in high school mathematics.

Kersting et al. (2010) also assessed a teacher’s knowledge but focused specifically on mathematics knowledge for teaching; scores were derived from a written assessment. The study examined teachers’ analyses of classroom videos of a fraction lesson; teachers’ results were scored based on mathematics content, student thinking, suggestions for improvement, and depth of interpretation (Kersting et al., 2010.). Kersting et al. (2010) found a positive relationship between the total scores on the video analyses and mathematics knowledge for teaching. Suggestions for improvement for the lesson, such as spending more time talking about equivalent fractions, were associated with student gains (Kersting et al., 2010). Kersting et al. (2010) concluded the following about teachers’ mathematical knowledge, “Just having the knowledge is not enough; it may be equally important that knowledge be organized and accessible” (p. 177). Kersting, Givvin, Thompson, Santagata, and Stigler (2012) extended Kersting et al.’s 2010 study adding video observations of the participants and rating the quality of instruction. In addition to replicating earlier results, teachers with higher results on the video analyses also had higher results in quality instruction (Kersting et al., 2012).

**Teachers’ beliefs.** Teachers’ beliefs impact classroom instruction through planning for instruction and choosing instructional practices (Beswick, 2008; Le, Lockwood, Stecher, Hamilton, & Martinez, 2009; Lee & Ginsburg, 2007; Polly et al., 2013; Superfine, 2008). Superfine (2008) studied the planning processes of three experienced teachers who had used and were currently using a middle school reform curricula. Superfine (2008) found that teachers’ beliefs of instruction influenced their
planning; while one teacher used very little of the curricula, another teacher used all of the curricula. Beliefs also differed between pre-kindergarten teachers who taught low socio-economic status (SES) students and pre-kindergarten teachers of middle SES students (Lee & Ginsburg, 2007). The teachers agreed that arithmetic was important and children should find mathematics enjoyable but the teachers differed on the focus of instruction. Teachers of low SES students felt that the priority was organized instruction focused on preparing students for the future; teachers of middle SES students indicated instruction should be child centered with goals based on children’s interests (Lee & Ginsburg, 2007). Polly et al. (2013) examined elementary teachers’ beliefs about mathematics, teaching, and learning. Polly et al. (2013) found teachers who believed in teacher-directed teaching used more teacher-directed strategies such as lecture than teachers who believed in student centered and discovery approaches (Polly et al., 2013). Finally, some teachers changed their instructional practices based on their beliefs concerning student motivation (Turner, Warzon, & Christensen, 2011).

**Instructional Strategies**

Instructional strategies employed by teachers were linked to student learning (Hiebert et al., 2003; Kanold et al., 2012, Marzano, 2003; McRel, 2010; NMAP, 2008). Marzano (2003) asserted that a teacher’s pedagogy was more important than a teacher’s content knowledge. Furthermore, Fuchs and Vaughn (2012) underscored the importance of instruction, “Research suggests that well-implemented and effective instruction leads to fewer students requiring intervention and reduction in referrals to special education” (p. 197).
Hiebert et al. (2003) studied instructional practices of eighth grade teachers from Netherlands, Australia, Czech Republic, Hong Kong SAR, Japan, Switzerland, and the U.S. Hiebert et al. found that teachers from Netherlands, Switzerland, and Australia used more real-life situations to introduce mathematics problems than U.S. teachers; U.S. teachers used mathematical language and symbols three times more than real-life situations. The problems presented in U.S. classes were 34% application, which was lower than the other countries; the percent of application problems in the other countries ranged from 35% to 74% (Hiebert et al., 2003). U.S. teachers spent less instructional time on developing conceptual understanding than all of the countries but Australia. In all of the countries, the teachers talked more than the students; in comparison to student talk, the U.S. teachers talked more than the teachers from the other countries (Hiebert et al., 2003). Another international comparison of countries used the 2009 PISA results to examine the instructional practices of Turkey, Bulgaria, Greece, Azerbaijan, Russian Federation, Israel, Serbia, Romania, and Jordan (Kilic, Cene, & Demir, 2012). The instructional practice of elaboration had a positive effect on achievement while memorization had a negative effect on achievement (Kilic et al., 2012).

Evidence exists showing the effectiveness of instructional strategies. Slavin and Lake (2008) conducted a review of research related to elementary student achievement and found four cooperative learning programs which had strong positive outcomes on student achievement. The four cooperative learning programs were Classwide Peer Tutoring (CWPT), Peer-Assisted Learning (PALS), Student Teams – Achievement Divisions (STAD), and Team Accelerate Instruction (TAI) Math. The mean of the overall effect size for each program was CWPT +0.33, PALS +0.17, STAD +0.34, and
TAI +0.18 (Slavin and Lake, 2008). Slavin and Lake (2008) described the four cooperative learning programs as follows: CWPT used reciprocal peer tutoring and group reinforcement; PALS was a form of classwide tutoring in which students taught other students specific skills; STAD used heterogeneous small groups with shared learning goals; and TAI Math combined cooperative learning and individualized instruction.

In addition, Le et al. (2009) studied the relationship between reform-oriented instruction and mathematics achievement of elementary and middle school students. Students were assessed using the Stanford Achievement Test Series and the mathematics section included multiple-choice and open-ended questions. These questions were identified as problem solving or procedures. Reform-oriented instruction was positively related to open-ended scores but not to multiple-choice scores (Le et al., 2009). In consideration of problem solving and procedure scores, reform-oriented instruction resulted in lower scores on procedures but if the outcome was problem solving, there was a significant positive relationship to reform-oriented instruction (Le et al., 2009).

Doabler et al. (2014) studied the frequency of teachers’ use of explicit instruction and instructional quality in classrooms, which used Early Learning in Mathematics (ELM) curricula compared to the classrooms which used standard district curricula. ELM was a core mathematics program that used “an explicit instructional framework” which was aligned to Common Core State Standards for Mathematics (Doabler et al., 2014, p. 100). ELM classrooms had significantly higher rates of individual student responses and higher rates of group responses than the standard district mathematics classrooms (Doabler et al., 2014). Explicit instruction has been recommended as an effective strategy for students with learning disabilities (Sayeski & Paulsen, 2010). Also,
the classroom discourse strategies of definitions, checking for understanding, and student-to-student communication were studied for students with learning disabilities in mathematics and who were included in core instruction (Griffin et al., 2013). In Griffin et al.’s (2013) study, both teachers used all three discourse strategies for at least 40% of instructional time. Although both teachers gave incorrect or incomplete mathematical definitions, Griffin et al. (2013) concluded that classroom discourse may be effective for students with disabilities. Finally, traditional instructional practices of using worksheets, textbooks, and mathematical problems solved on a chalkboard, and group/interactive activities of explaining how problems were solved, working in mixed groups, using real-life problems, and peer tutoring were found to be significantly associated with kindergarten mathematics achievement (Bodovski & Farkas, 2007).

Kanold et al. (2012) recommended the following instructional strategies which supported the Common Core State Standards Mathematical Practices: “active engagement; solving challenging problems; connecting ideas, concepts, and skills; communicating mathematically; engaging students’ prior knowledge; using ongoing, distributed practice with appropriate feedback; using appropriate tools strategically; and promoting students’ positive self-beliefs” (p. 24). Other instructional strategies which promoted students’ mathematical reasoning included comparing and clarifying, and summarizing through analyzing information (McRel, 2010).

Hiebert and Grouws (2007) recommended instructional practices be informed by high-quality instruction practices. Hiebert and Grouws also found that even though some strategies were more effective for teaching for skill efficiency and conceptual understanding, other factors such as curricular materials could impact their efficacy. The
National Mathematics Advisory Panel (2008) concurred but acknowledged that instructional practices may differ on effectiveness based on the circumstances. Furthermore, there was not one best instructional strategy (Danielson, 2008; Hiebert & Grouws, 2007; Marzano; 2003; NMAP, 2008; Stronge, 2007).

Classroom Environment

Banilower et al.’s (2013) study of mathematics teachers found that 10% of elementary school teachers, 10% of high school teachers, and 16% of middle school teachers believed that inappropriate student behavior was a serious problem for mathematics instruction. Also, in a 2011-2012 national survey, approximately 41% of public school teachers indicated the level of student misbehavior interfered with their teaching (National Center for Education Statistics, 2013). Furthermore, student respect for teachers was considered a serious problem by 21% of public education teachers (National Center for Education Statistics, 2013).

Research on classroom environment found effective teachers created and maintained a classroom environment conducive to learning while ineffective classroom management was associated with negative outcomes (Marzano, 2003; Marzano et al., 2011; Plank & Condliffe, 2012; Reinke et al., 2013; Slavin & Lake, 2008; Stronge, 2007; Stronge et al., 2011). Classroom environment components included creating an environment of respect and rapport, establishing a culture for learning, managing classroom procedures, managing student behavior, and organizing physical space (Danielson, 2008; Marzano, 2003; Marzano et al., 2011; Stronge, 2007).

Stronge et al. (2011) studied classroom practices of 307 fifth grade teachers from rural, suburban, and urban school districts. Stronge et al. found a significant difference
between teachers in the top quartile of effectiveness and the teachers in the bottom quartile of effectiveness. The classrooms of the teachers in the bottom quartile had disruptions about every 20 minutes while the classrooms of the teachers in the top quartile had disruptions once an hour (Stronge et al., 2011). Additionally, Stronge et al. (2011) found effective teachers were better organized, had more positive relationships with their students, established routines, used time effectively, and had students who assumed greater responsibility.

The studies of elementary schools by Reinke et al. (2013) and Plank and Condliffe (2013) furthered the research of Stronge et al. (2011). The results of Reinke et al.’s study of 33 kindergarten through third grade classes found classrooms with positively stated classroom rules had fewer disruptions; teachers with higher rates of praising students were more effective. Furthermore, the teachers with higher rates of disruptive behavior reported feeling less effective and reported higher rates of emotional exhaustion (Reinke et al., 2013). Finally, in a two-year study of second and third grade classrooms, Plank and Condliffe found that students had more opportunities to learn when teachers effectively managed their classrooms. Plank and Condliffe also found that some classrooms, which were effectively managed, had low levels of instruction.

Sebastian and Allensworth (2012) studied public high schools in Chicago; teachers who believed that the instructional programs were coherent also believed classroom behavior was better. In addition, schools in which the teachers highly rated their principals were likely to have strong learning climates and fewer disruptions (Sebastian & Allensworth, 2012). Furthermore, LeMire, Melby, Haskins, and Williams’ (2012) study of high schools found that high school students who reported feeling
devalued by mathematics teachers had lower achievement than students who reported that they never or sometimes felt devalued.

Specific interventions were also researched regarding classroom management. Stichter et al. (2009) studied four kindergarten through fifth grade elementary schools in which teachers used school-wide positive behavior support techniques. Stichter et al. found that with the increase of instructional talk, inappropriate student talk decreased. Furthermore, teachers who had poor classroom management had classes with more verbal outbursts and disruptions (Stichter et al., 2009). Stichter et al. (2009) concluded that the consistent use of the evidence-based behavior support techniques enhanced instruction.

Another intervention researched was Responsible Classrooms which included “a set of practical teaching strategies to support children’s social, academic, and self-regulatory skills” (Rimm-Kaufman et al., 2014, p. 569). In a longitudinal study of students beginning their second grade year through their fifth grade year, Responsible Classrooms schools with one standard deviation (SD) of higher fidelity to the use of Responsible Classrooms strategies resulted in gains in mathematics scores (Rimm-Kaufman et al., 2014). Furthermore, students who were low in initial achievement experienced significant gains (Rimm-Kaufman et al., 2014). Finally, in a review of 87 studies, Slavin and Lake (2008) found the use of the programs of Missouri Mathematics Project and Consistency Management and Cooperative Discipline (CMCD) resulted in improved classroom management.

Textbooks

The textbooks and programs that were used in classrooms impacted instruction (Akuyz & Berberoglu, 2010; Doabler, Fien, Nelson-Walker, & Baker, 2012; Horizon
Research, 2013; Mayrowetz, 2009; Rakes, Valentine, McGatha, & Ronau, 2010). In a national survey, it was found that “80% of classes at all grade levels use commercially published textbooks or programs” (Horizon Research, 2013, p. 19). Also, mathematics teachers indicated textbooks were used at least 75% of class time (Horizon Research, 2013).

There were concerns about textbooks even though they were extensively used in classrooms. NMAP (2010) found that U.S. textbooks were extremely long in comparison to the textbooks in other countries that had higher mathematics achievement. Additionally, textbooks were not always accurate (NMAP, 2010). Furthermore, although 70% of elementary classrooms were using textbooks published after 2007, less than 50% of high schools had current materials (Horizon Research, 2013). An added concern was an inadequate supply of textbooks and a lack of funds for purchasing materials (Banilower et al., 2013). Finally, decisions for the purchase of textbooks were often made without research (Arbaugh et al., 2008).

The effectiveness of textbooks was also a concern. The U.S. Department of Education funded What Works Clearinghouse reviewed studies and used criteria to determine the effectiveness of textbooks (Schoenfeld, 2006). Schoenfeld (2006) suggested that What Works Clearinghouse reviews were not sufficiently detailed to determine the effectiveness of textbooks. Slavin and Lake (2008) also reviewed studies of elementary mathematics textbooks and found, “One surprising observation is the lack of evidence that it matters very much which textbook schools choose” (p. 480). Slavin and Lake (2008) further noted the lack of quality research on the effectiveness of textbooks.
However, several studies have added to the research on textbooks. Agodini et al.’s (2009) study took place in 39 elementary schools and focused on first grade. Four curricula, *Investigations in Number, Data, and Space; Math Expressions; Saxon Math;* and *Scott Foresman-Addison Wesley Mathematics* were chosen for the study (Agodini et al., 2009). After one year, the mathematics achievement of students who used *Math Expressions* and *Saxon Math* was significantly higher than those who used *Investigations in Number, Data, and Space* and *Scott Foresman-Addison Wesley Mathematics*; there was not a significant difference between the top two curricula nor the lower two curricula (Agodini et al., 2009). The study by Agodini, Harris, Seftor, Remillard, and Thomas (2013) furthered the research of Agodini et al. (2009) and examined student achievement after the second year of the use of the four curricula. *Scott Foresman-Addison Wesley Mathematics* was revised and renamed *enVision Math* prior to the start of the second year (Agodini et al., 2013). Students who had *Math Expressions* or *Saxon Math* for both years or had *Scott Foresman-Addison Wesley Mathematics* followed by *enVision Math* gained in mathematics achievement by similar amounts; this gain was significantly more than that of students who had *Investigations in Number, Data, and Space* (Agodini et al., 2013).

Furthermore, after the two years, there was not a significant difference between achievement of students who had *Math Expressions* or *enVision Math* (Agodini et al., 2013). Although it was the intent for all students to stay with the same curricula for two years, it was not possible for all of the students. Students who had *Scott Foresman-Addison Wesley Mathematics* for first grade followed by *Saxon Math* had gains in achievement; these gains were significantly higher than students who stayed with *Scott
Foresman-Addison Wesley Mathematics (Agodini et al., 2013). Agodini et al. (2013) concluded that a change between the curricula did not result in a decrease in achievement.

The studies by Doabler et al. (2012) and Doabler et al. (2014) examined core mathematics programs with a focus on students who had learning disabilities in mathematics or who were at risk for mathematics difficulties. Doabler et al.’s (2012) study was a curricular review of three elementary curricula: (a) a popular reform-based program; (b) a popular traditional program; and (c) a national curriculum from a top-performing TIMSS country. Doabler et al. (2012) identified key topics at second and fourth grades and developed a rubric which included eight principles of instruction that supported learning for students who had learning difficulties in mathematics. When combining the ratings for the three curricula, less than 50% of the summary scores in either grade met the minimum requirements; when examined individually, none of the curricula rated higher than the others in all of the categories. Furthermore, none of the curricula provided sufficient instructional support (Doabler et al., 2012). Doabler et al.’s (2014) study examined the effect of the use of the curricula Early Learning in Mathematics (ELM) for kindergarten students with a focus on the use of explicit instruction. ELM classrooms had significantly higher rates in responses and concluded that teachers benefited from having a textbook that included explicit instructional strategies (Doabler et al., 2014).

In Mayrowetz’s (2009) study of fourth grade teachers, 92% of the teachers reported that they believed that their textbooks addressed all of the standards for their state. Many textbook publishers have indicated materials have been adapted to align to
CCSS (Gewertz, 2010; Heck et al., 2011). A team consisting of mathematics educators, mathematics supervisors, mathematicians, and two past presidents of NCTM, funded by the Brookhill Foundation and Texas Instruments and with support from the Council of Chief State Officers and National Council of Supervisors of Mathematics, developed three tools to support educators’ review of textbooks (Bush et al., 2011). The three tools incorporated an analysis of content across key mathematical domains, the extent to which the mathematical practices were embedded and integrated within materials, and considerations of equity, assessment, and technology (Bush et al., 2011). A review of the research on Sage Premier and Education Resources Information Center via U.S. Department of Education (ERIC) yielded no studies of the use of these tools.

**Professional Development**

Professional development has been a factor in supporting teachers’ changes in practice and behavior (Braun, 2011; Darling-Hammond & Richardson, 2009; Fuchs & Vaughn, 2012; Kanold et al., 2012; Marzano, 2003; McRel, 2010; NMAP, 2008; National Staff Development Council [NSDC], 2009). Professional development is even more important due to the changes in standards and the skills needed by students (Darling-Hammond & Richardson, 2009). Although professional development is considered a professional obligation of teachers, not all professional development was found to be effective (Marzano, 2003; Reeves, 2010; Stronge, 2007). Quality professional development has the following characteristics:

- visionary and coherent (Marzano, 2003; Reeves, 2010);
- collaborative (Darling-Hammond & Richardson, 2009; Kanold et al., 2012);
- collegial learning environment (Darling-Hammond & Richardson, 2009; Stronge, 2007);
- sustainable over time (Darling-Hammond & Richardson, 2009; Fuchs & Vaughn, 2012; Kanold et al., 2012; NSDC, 2009);
- collective responsibility (NSDC, 2009);
- continuous cycle of improvement (NSDC, 2009; Stronge, 2007);
- job-embedded (Darling-Hammond & Richardson, 2009; McRel, 2010; NSDC, 2009).

Additionally, professional development should be focused on curriculum, standards, assessment, teaching strategies, and student work (Braun, 2011; Darling-Hammond & Richardson, 2009; Kanold et al., 2012; Reeves, 2010). Furthermore, there were suggestions that professional development should happen in professional learning communities (PLCs) (Anderson & Herr, 2011; Darling-Hammond & Richardson, 2009). Although NMAP (2008) supported the need for quality professional development, NMAP asserted, “Research does not yield sufficient evidence on the features of any particular approach to permit detailed conclusions about the forms of or approaches to effective professional development” (p. 40).

One of the recommendations for quality professional development concerned time. Yoon et al. (2007) found that 30 to 100 hours of professional development offered over six to 12 months showed the largest gain in student achievement. However, many teachers did not receive 30 to 100 staff development hours in a school year; over 85% of the teachers averaged 35 hours in total the last three years (Horizon Research, 2013).
There were three studies which had over 30 hours of staff development as recommended by Yoon et al. (2007) which yielded positive results. Prior to the implementation of an elementary program, there was staff development consisting of information on research based mathematics instruction, design of the program, and design of the lessons (Doabler et al., 2014). There were additional workshops throughout the year; teachers were able to ask about the program and to get feedback on lessons (Doabler et al., 2014). This resulted in fidelity in the use of the program and an increased use of researched based practices; teachers had significantly higher rates of individual student responses which included an explanation of mathematical thinking (Doabler et al., 2014). Another study was on the implementation of Responsive Classrooms (RC) (Rimm-Kaufman et al., 2014). There was one week of training during the summer prior to implementation and there were three workshops during the school year (Rimm-Kaufman et al., 2014). Materials and resources were given to teachers; there was also school based coaching (Rimm-Kaufman et al., 2014). Also, there was fidelity to implementation and student achievement improved (Rimm-Kaufman et al., 2014).

In a third study, a three year initiative from the Center for Data-Driven Reform in Education (CDDRE) included training all three years (Carlson et al., 2011). Consultants also worked with teachers and administrators in understanding and interpreting data, developing research based interventions, and monitoring for effectiveness of the interventions (Carlson et al., 2011). The results of the CDDRE initiative showed a significant positive effect on mathematics achievement (Carlson et al., 2011). Finally, teachers in a school with sixth, seventh, and eighth grades were trained in all of the aspects of PLCs; grade level PLCs met weekly (Graham, 2007). Although all of the
grade level PLCs talked about students, discipline, and grading, the sixth and the seventh grade PLCs also talked about curriculum and instruction and were collaborative (Graham, 2007). Teachers who taught sixth and seventh grades rated the PLCs as high quality professional development and they reported a high level of change in knowledge and skills; teachers of eighth grade rated the PLCs lower and reported only some change in knowledge and skills (Graham, 2007).

Not every study in which there were over 30 hours of professional development had positive results. Anthony and Clark (2011) studied the professional development of mathematics teachers in an urban high school who participated in five professional development sessions in preparation for integrating technology into their classrooms. As a part of the initiative, students were given laptop computers. The content of the professional development was on basic computing skills and software but teachers were not taught how to use the technology to enhance student learning (Anthony & Clark, 2011). Along with using technology for students to learn mathematics, teachers were to meet technology standards. Through interviews and observations, the researchers found that the administrators and the teachers were not clear about the vision of the initiative, there was no measurable goal, and there was mainly low level use of the technology (Anthony & Clark, 2011). Finally, Anthony and Clark (2011) recommended development of a shared vision and planning with consideration of teacher capacity prior to implementing an initiative; they did not make a recommendation for a change in the number of professional development hours.

Wager and Foote’s (2013) study took place in an ethnically diverse elementary school. Wager and Foote examined the impact of professional development on teachers’
mathematics pedagogy with a focus on multicultural education. The professional
development focused on equity and took the form of a book study, videos, and discussion
of students (Wager & Foote, 2013). The results were mixed; some teachers changed their
instructional practices, some teachers had ideas of potential changes to instruction, and
other teachers did not make changes nor have ideas for changing instruction (Wager &
Foote, 2013). Lastly, Turner et al. (2011) researched if teachers’ beliefs and practices
would change based on professional development on student motivation. The three
participating teachers were given materials, participated in discussions of readings on
student motivation, and watched mathematics videos; additionally, teachers were
observed and given feedback (Turner et al., 2011). Two of the teachers increased their
mathematics teaching effectiveness. Two of the teachers had a better understanding of
student motivation and how to change instruction; the third teacher continued to blame
the students for their lack of motivation (Turner et al., 2011).

Finally, in Beswick’s (2008) study, teachers had fewer than 30 hours of
professional development. Beswick’s study examined elementary teachers’ beliefs about
numeracy instruction for students with mathematics learning difficulties. Teachers were
given information about mathematics difficulties and sessions focused on instructional
strategies and teachers’ needs; teachers were also encouraged to share any concerns
(Beswick, 2008). As a result of the staff development some teachers changed their
beliefs about mathematics and some teachers changed instruction (Beswick, 2008).
There was a concern that a few teachers still had beliefs about mathematics which were
counter to the professional development (Beswick, 2008).
Summary

International comparisons as measured on TIMSS (2011) and Program for International Student Assessment have found that U.S. students were not keeping pace with those students from high achieving countries (PISA 2012 Selected Findings, 2012). Also, there has been an increased emphasis on the mathematics achievement of U.S. students. NCLB required that schools have 100% of students proficient in mathematics or be sanctioned (Murnane & Papay, 2010).

With the increase of expectations for students, what happened during mathematics classes became even more important. The creation of academic standards has been an element in improving U.S. mathematics education from the enactment of A Nation at Risk in 1983 until the present (Dingman et al., 2013; Murnane & Papay, 2010). CCSSM were developed from the standards of high performing countries and most states have adopted CCSSM (ASCD, 2014; NGS Center, CCSSO, 2010b). There were differences between CCSSM and pre-CCSSM states’ standards (Porter et al., 2011). Since many states will not begin assessing students on the CCSSM until the 2014-2015 school year (ASCD, 2014), there have been no studies assessing the impacts of CCSSM on classroom instruction.

One change impacting mathematics instruction was instructional time (Banilower et al., 2013; Hill et al., 2005; Phelps et al., 2012). There was variation across the U.S. in number of hours of mathematics instruction received by students (Phelps et al., 2012). Teachers also influenced mathematics instruction by what they knew and what they believed (Hiebert et al., 2003; Horizon Research, 2013; Marzano, 2003; NMAP, 2008). Teachers needed to have the mathematical background to provide effective instruction
Teachers’ beliefs impacted instructional planning (Beswick, 2008; Le et al., 2009; Lee & Ginsburg, 2007; Polly et al., 2013; Superfine, 2008). The instructional strategies teachers employed impacted student learning although there was not one best strategy (Hiebert et al., 2003; Kanold et al., 2012, Marzano, 2003; McRel, 2010; NMAP, 2008).

Classroom management also affected instruction and was a concern of teachers; teachers with poor classroom management skills had their classrooms disrupted regularly (Banilower et al., 2013; Stronge et al., 2011). Furthermore, many teachers relied on textbooks for their curricula and some teachers used outdated textbooks that were not aligned to CCSSM (Horizon Research, 2013; NMAP, 2010).

Finally, there is an increased need for professional development due to the focus on mathematics achievement (Darling-Hammond & Richardson, 2009). Quality professional development had certain characteristics and there was a recommendation that staff development happen in PLCs (Anderson & Herr, 2011; Braun, 2011; Darling-Hammond & Richardson, 2009; Fuchs & Vaughn; 2012; Kanold et al., 2012; Marzano, 2003; McRel, 2010; NMAP, 2008; NSDC, 2009). At the same time, NMAP (2008) asserted that research was insufficient to determine effective characteristics of professional development.
Chapter Three – Methods and Procedures

Introduction

This qualitative study investigated elementary teachers’ perceptions of the changes made in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement Pennsylvania Core Mathematics Standards. Perception data were collected by surveying and interviewing elementary teachers. The responses of the surveys and the interviews were reviewed to determine the themes concerning the specific changes made to mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the effectiveness of these changes. Finally, the responses were examined to determine the professional development given due to implementation of Pennsylvania Core Mathematics Standards and the level of support of this professional development.

Subjects

Elementary teachers from 10 public education schools in three school districts were contacted for participation in the survey. All teachers who taught mathematics and had at least one year of experience had the choice of participating in the study. There were 14 elementary teachers who participated in the study. The researcher gathered the demographic information of the participants. Demographic information included the number of years of teaching experience and the area(s) of certification. Two teachers had between one and five years of experience in teaching mathematics; two teachers had between six and 10 years; eight teachers had between 11 and 20 years; one teacher between 21 and 30 years; and one teacher more than 30 years of experience.

Additionally, teachers identified their current teaching assignments. Eight of the teachers
were assigned to grades k-2; five were assigned to grades 3-6; and one teacher was assigned to grades k-6. Finally, teachers reported their areas of certification. All of the teachers were elementary certified; one of the teachers was also certified in special education; one teacher was certified in Middle School Mathematics; and one teacher was certified in Middle School Mathematics, English, and Science.

In addition, six of the 14 teachers participated in the interviews. Four teachers from District A and two teachers from District B were interviewed; no teachers from District C volunteered to be interviewed. Two of the interviewees had additional certifications. Participant A2 was certified in Middle School Mathematics and Participant A4 was certified in Middle School Mathematics, English, and Science. Two of the participants taught first grade. The other grade levels taught were fourth grade, fifth grade, sixth grade, and one participant taught grades 4 through 6. All of the participants were experienced teachers. Participant A2 had the least experience with seven years and Participant A3, the most experience with 31 years. The years of experience of the other participants ranged from 15 to 17 years.

**Setting**

The study took place in 10 public elementary schools from three public school districts in Pennsylvania. Districts A and B are suburban districts located in the same county in south central Pennsylvania; District C is a rural district from central Pennsylvania. Additionally, the four schools in District A are K-6 schools. The two District B schools and the four District C schools are K-5 schools. In addition, Table 3.1 presents 2012-2013 demographic information from the elementary schools. Furthermore, the average of the percents of economically disadvantaged students for the elementary
schools were District A 35.78%, District B 44.13%, and District C 46.03%. Finally, the average of the Pennsylvania Performance Profile scores for the elementary schools from District A, District B, and District C were 87.8, 86.25, and 86.35 respectively (Pennsylvania Department of Education, 2014).

Table 3.1

Percent Student Enrollment by Ethnicity

<table>
<thead>
<tr>
<th>Race</th>
<th>School A 1</th>
<th>School A 2</th>
<th>School A 3</th>
<th>School A 4</th>
<th>School B 1</th>
<th>School B 2</th>
<th>School C 1</th>
<th>School C 2</th>
<th>School C 3</th>
<th>School C 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian</td>
<td>4.02</td>
<td>4.78</td>
<td>5.16</td>
<td>3.27</td>
<td>1.24</td>
<td>1.40</td>
<td>0.93</td>
<td>1.52</td>
<td>0.27</td>
<td>1.59</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>9.20</td>
<td>7.06</td>
<td>2.80</td>
<td>9.35</td>
<td>2.74</td>
<td>0.35</td>
<td>1.87</td>
<td>0.00</td>
<td>0.27</td>
<td>1.20</td>
</tr>
<tr>
<td>Black</td>
<td>13.65</td>
<td>18.91</td>
<td>5.81</td>
<td>17.91</td>
<td>10.45</td>
<td>2.46</td>
<td>3.27</td>
<td>0.76</td>
<td>0.27</td>
<td>0.00</td>
</tr>
<tr>
<td>Hispanic</td>
<td>68.39</td>
<td>63.10</td>
<td>84.52</td>
<td>66.04</td>
<td>82.84</td>
<td>91.93</td>
<td>89.25</td>
<td>95.82</td>
<td>96.25</td>
<td>94.82</td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-Racial</td>
<td>4.74</td>
<td>6.15</td>
<td>1.51</td>
<td>3.43</td>
<td>2.74</td>
<td>3.86</td>
<td>0.23</td>
<td>1.90</td>
<td>2.95</td>
<td>2.39</td>
</tr>
</tbody>
</table>

Instruments

Survey. A Teacher Survey (Appendix A) was used to gather data on teacher perceptions regarding the changes to mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to
effectively implement Pennsylvania Core Mathematics Standards. The survey consisted of 14 statements which teachers answered using the Likert scale and 10 open-ended questions. Eight of the Likert scale statements had four responses from which the teachers chose to best describe their level of agreement or disagreement with the given statement. Three of the other six statements had four responses from which teachers chose to best describe the level of support; the other three statements had four responses from which teachers chose to best describe the level of effectiveness. Two of the open-ended questions were used to gather demographic information, one of the open-ended questions gathered information on the current teaching assignment, and one of the open-ended questions was used to determine hours of professional development. The other open-ended questions provided the participants the opportunity to expand on their responses to the statements and to add additional information not addressed in the statements. Participants accessed the researcher’s designed online survey through the researcher’s account at SurveyMonkey.com, an online survey company. The survey took participants approximately 15 minutes to complete.

**Interview.** Additional data were collected through interviews. A Teacher Interview Form (Appendix B) was used for the six individual interviews. There were nine interview questions. The data collected during the interview included demographic information, current teaching assignment, and the participant’s perspective regarding the changes made to mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the effectiveness of these changes. The participants’ perspectives regarding professional development needed to effectively implement Pennsylvania Core Mathematics Standards were also collected. The interview subjects
were elementary teachers who responded to the invitation to participate in the interview process which took participants approximately 20 minutes to complete. The interviews took place in-person at a time and location agreed upon by the participant and the researcher and were audio-taped with permission of the participants.

**Reliability and Validity.** One factor in determining the validity of an instrument is if the instrument measures what is intended to be measured (Marshall & Rossman, 2011). To increase the validity of the survey and the interview, the researcher piloted the Likert scale statements, the open-ended questions, and the interview questions with a panel comprised of three elementary teachers. No member of the panel was a part of the study. The panel evaluated the directions, the statements, and the questions. Modifications of the directions, the statements, and the questions were based on feedback from the pilot group.

Finally, the results of the three methods of collecting data, Likert scale statements, open-ended questions, and interviews, were triangulated. Triangulation refers to cross referencing data gathered using different tools (Marshall & Rossman, 2011). Marshall and Rossman (2011) reported that triangulation of multiple sources of data enhances the validity of a study.

Another important aspect of qualitative research is reliability or consistency in results if the study was replicated (Marshall & Rossman, 2011). The researcher increased the reliability of the study in several ways. First, the same Likert scale statements and open-ended questions were asked of each participant using the same method of an online survey. Secondly, the researcher conducted the interviews in the same method of face-to-
face meetings. Lastly, the researcher provided a detailed procedure so that if the study was replicated, similar results would likely occur.

**Design of the Study**

A qualitative case study design was used for this study. According to Marshall and Rossman (2011), a qualitative case study approach is one that gathers the participants’ views. In this study, the researcher examined elementary teachers’ perceptions of changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement Pennsylvania Core Mathematics Standards; the data were collected through the use of a survey consisting of Likert scale statements and open-ended questions and interviews.

**Procedure**

The researcher first piloted the instruments with the teacher panel and made the necessary changes. Next, the researcher received permission, by letter, from district superintendents for inclusion of their districts in the study. After obtaining permission from the superintendents, the researcher requested permission from the Immaculata University Research Ethics Review Board. Following approval of the Research Ethics Review Board (Appendix C), the researcher was in email communication with the district contact for each of the superintendent-approved districts. During this communication, two of the district contacts (Districts B and C) requested an electronic copy of a letter explaining the study and this letter was forwarded to the elementary teachers. The district contact from District A requested that the researcher contact each elementary building principal. The researcher and each principal determined the method to introduce
the study to the faculty. The researcher delivered sufficient copies of a letter for each potential participant to the principal or the principal’s designee at three of the elementary schools. The principal of the fourth elementary school requested that the researcher meet with the faculty and the researcher and the principal set a mutually agreed upon date and time. The researcher followed a script based on the information contained in the letter. Copies of the letter were disseminated at this meeting.

The letter contained information about the study, the process to access the survey questions, and the process for contacting the researcher to indicate interest in participating in the interview. The letter also contained information explaining that participation in the study was voluntary, the responses to the survey would be anonymous, and the identity of the interview participants would be kept in confidence. Finally, the letter contained information that participants’ consent was required prior to participating in the survey or the interview and that participants may decide to end the survey or the interview at any time.

Teachers who chose to participate in the survey accessed the survey via the link contained in the letter provided by the researcher to the potential participants. At the beginning of the survey prior to answering any survey questions, the prospective participants completed consent information which indicated their voluntary agreement to participate in the survey and included how they could exit the survey at any time. Only those teachers who consented to participate in the survey were able to access the survey questions. Teachers were asked to complete the survey questions within a three-week window; however, the window was extended to six weeks due to a lack of survey responses. Furthermore, teachers who were interested in participating in the interview
contacted the researcher by email; the researcher contacted by email, the six responding elementary teachers to make arrangements for the interviews.

The interviews were conducted individually, in-person, and at a time, date, and location that were mutually agreed upon by the teacher and the researcher. The researcher obtained permission in writing at the time of the face-to-face interviews prior to the researcher asking the interview questions. The researcher used the same set of interview questions for each participant. The interviews were recorded with the participants’ permission and transcribed by the researcher.

**Data Analysis**

The data collection consisted of the Likert scale survey statements, open-ended survey questions in which participants could expand on their responses to statements and add additional information not addressed in the statements, and the teacher interviews. The Likert scale survey statements, the open-ended survey questions, and the interviews were sorted according to the two questions related to the study. The responses were examined to identify the major themes which emerged from the perceptions of elementary teachers regarding changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards, and the professional development needed to effectively implement Pennsylvania Core Mathematics Standards.

**Summary**

The purpose of this qualitative research study was to examine the perceptions of elementary teachers related to the changes to mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement Pennsylvania Core Mathematics Standards.
Elementary teachers who had at least one year of experience teaching mathematics from 10 public schools in Pennsylvania were eligible to participate in this study. The researcher used Likert scale statements, open-ended survey questions, and interviews to collect the data. A panel of elementary teachers who were not participants in the survey reviewed the directions, statements, and questions prior to the dissemination of the surveys and the interviews. Furthermore, the responses from the Likert scale statements, the open-ended questions, and the interviews were triangulated to increase the validity of the study. The researcher analyzed the participants’ responses and determined themes. These themes are the foundation for the research findings which are reported in Chapter Four.
Chapter Four – Results

Introduction

This qualitative research study examined elementary teachers’ perceptions regarding changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement Pennsylvania Core Mathematics Standards. This study also focused on the teachers’ perceptions of the effectiveness of these changes and of the professional development. In addition, any further changes or professional development needed for successful implementation of Pennsylvania Core Mathematics Standards were investigated.

This chapter reports the findings of the researcher’s analysis of the survey and interview data. Fourteen elementary teachers participated in the online survey. The survey contained 14 Likert scale statements and 10 open-ended questions; six of the open-ended questions provided the opportunity for teachers to expand on their responses to the statements and to add additional information. Also, six elementary teachers participated in the in-person interviews. Participants’ responses were analyzed to identify trends in elementary teachers’ perceptions about changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement these standards.

Research Question One

What are elementary teachers’ perceptions regarding changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards?
Research question one was addressed using data from the survey responses and interview data. The survey included nine Likert scale items and three open-ended items intended to elicit the participants’ views about changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards, the degree of the effectiveness of these changes, the most significant change, and how these changes have benefitted students. The survey questions were also designed to determine the respondents’ perceptions of further changes needed for the effective implementation of Pennsylvania Core Mathematics Standards. In addition, three interview questions addressed research question one.

**Reporting of survey responses.** To determine elementary teachers’ perceptions of changes made to mathematics instruction, six Likert scale questions were provided with possible responses of strongly agree, agree, disagree, and strongly disagree. In addition, three questions utilized the Likert scale with possible responses of very effective, effective, not effective, and not applicable to ascertain elementary teachers’ perceptions of the effectiveness of specific changes.

All of the responses for the six Likert scale questions indicated an overall strong agreement that elementary teachers have changed mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards. Table 4.1 indicates the frequency of the data sources from the six Likert scale questions. All of the respondents who answered (14) strongly agreed or agreed that they changed mathematics instruction due to implementation of Pennsylvania Core Mathematics Content Standards and also that curriculum changed.
### Table 4.1

**Teachers’ Perceptions of Changes to Classroom Instruction due to Implementation of Pennsylvania Core Mathematics Standards**

<table>
<thead>
<tr>
<th>Question</th>
<th>Participant Response</th>
</tr>
</thead>
</table>
| **4.** I have changed classroom instruction due to the implementation of PA Core Mathematics Content Standards. | Strongly Agree: 8 (57%)     
Agree: 6 (43%)                  
Disagree: 0 (0%)               
Strongly Disagree: 0 (0%)       |
| **5.** I have changed classroom instruction due to the implementation of PA Core Mathematics Practice Standards. | Strongly Agree: 5 (36%)     
Agree: 8 (57%)                  
Disagree: 1 (7%)                
Strongly Disagree: 0 (0%)       |
| **6.** The mathematics curriculum in my classroom has changed due to the implementation of PA Core Mathematics Standards. | Strongly Agree: 9 (64%)     
Agree: 5 (36%)                  
Disagree: 0 (0%)                
Strongly Disagree: 0 (0%)       |
| **7.** I have changed instructional strategies due to the implementation of PA Core Mathematics Standards. | Strongly Agree: 7 (50%)     
Agree: 5 (36%)                  
Disagree: 2 (14%)               
Strongly Disagree: 0 (0%)       |
| **8.** I have changed lesson planning due to the implementation of PA Core Mathematics Standards. | Strongly Agree: 6 (43%)     
Agree: 6 (43%)                  
Disagree: 2 (14%)               
Strongly Disagree: 0 (0%)       |
| **9.** I have changed assessments due to the implementation of PA Core Mathematics Standards. | Strongly Agree: 9 (64%)     
Agree: 4 (29%)                  
Disagree: 1 (7%)                
Strongly Disagree: 0 (0%)       |

*Note: N=14.*

Only one teacher indicated instructional changes were not made due to implementation of Pennsylvania Core Mathematics Practice Standards. Assessments were reported to be changed by all but one teacher. Although two (14) respondents disagreed that either
instructional strategies or lesson planning changed, 12 (86%) teachers believed that both had changed.

Respondents were also asked to rate the effectiveness of specific changes to mathematics instruction. Seventy-one percent or 10 teachers who responded to the three questions indicated that changes in both mathematics instructional time and mathematics resources were effective. In contrast, only 50% (7) respondents answered that the change in mathematics textbooks was effective. Table 4.2 indicates the frequency of the data sources from the three Likert scale questions.

Table 4.2

*Teachers’ Perceptions of the Effectiveness of Changes to Mathematics Instruction due to Implementation of Pennsylvania Core Mathematics Standards*

<table>
<thead>
<tr>
<th>Question</th>
<th>Participant Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Effective</td>
</tr>
<tr>
<td>12. Change in mathematics instructional time.</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>13. Change in mathematics textbooks.</td>
<td>3 (21%)</td>
</tr>
<tr>
<td>14. Change in mathematics resources (other than textbooks).</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

*Note: N=14. The total percentage in some questions will not equal 100% due to rounding.*

**Reporting of open-ended responses.** In addition to the Likert scale survey items, the researcher gathered data through the use of open-ended questions. Three open-ended questions provided elementary teachers the opportunity to describe what they believed changed the most and what still needs to be changed due to implementation of
Pennsylvania Core Mathematics Standards. The most reported change identified by seven out of the nine respondents was curriculum. Teachers described that fewer concepts were taught at each grade level. One teacher described this as, “Less breadth, more depth.” Two teachers indicated that concepts for their grade levels shifted; concepts which had been taught at higher grades were now being taught at lower grades. One teacher wrote, “I feel the second grade standards are looking more like what the third grade standards used to look like,” and another noted, “There are some hard standards.” An emphasis on the curriculum has improved grade level expectations. One teacher reported, “Teachers know what should be taught at the grade levels above and below them.”

In addition, there were instructional changes. One teacher described the changes as, “Instruction goes deeper not necessarily on more concepts, which allows the students and teachers to concentrate on fewer concepts.” Three teachers noted the increase of the use of problem solving and that problems were more rigorous. Furthermore, a teacher described “an increase in a balance of skills and reasoning.”

Lastly, seven out of eight respondents stated that expectations for students have increased. Students were expected to think more and to persevere when solving problems. While some respondents thought students had a better understanding of concepts, one noted, “Student confidence has seen a drop.”

Although there have been many changes, five respondents indicated more were needed. One teacher requested more specific examples of Pennsylvania Core Mathematics and PSSA types of problems. Another teacher mentioned the need for a plan which included rigor and also filled the gaps between students’ current mathematical
understandings and the new increased levels. More instructional time so that students were able to master information was also listed as a need. One teacher expressed a concern about parental support and recommended “elementary teachers serve on a committee to give advice to administrators so that the powers-to-be understand the difficult time students have due to parental indifference. Parents are not helping their children learn the content nor helping them in developing a care for learning.” Additionally, a teacher indicated the Pennsylvania Core Mathematics Standards should be changed to be more age appropriate.

Another open-ended question gathered the elementary teachers’ perceptions of the benefit of the changes for students. Three out of the six responding teachers noticed changes in their classrooms; students demonstrated a deeper level of understanding of concepts and displayed improved problem solving skills. One teacher added that this deeper understanding of concepts increased the students’ love of mathematics. Another benefit for students was less repetition of content. Two teachers also stated the belief that having common state standards would benefit transient students. Lastly, a teacher cautioned that it was too soon to determine the benefits for students.

**Reporting of interview data.** Data collected from interviews provided further insight into the first research question. Six elementary teachers from two of the three school districts participated in face-to-face interviews with the researcher to further explore their perceptions of changes made to mathematics instruction.

All of the participants perceived that mathematics instruction changed due to implementation of Pennsylvania Core Mathematics Standards. Participant A1 stated, “Yes, definitely. At first we were all a little shocked concerning the higher standards,”
and Participant B2 emphatically responded, “Drastically.” Conversely, Participant A3 described the changes as minor. All of the participants said their districts changed textbooks in response to Pennsylvania Core Mathematics Standards. While one participant (B1) believed the textbook was fully aligned to these standards, another participant (B2) was not convinced that was the case. A third participant (A2) made a distinction that the main part of the textbook was aligned to Common Core Standards and teachers needed to remember to access Pennsylvania-specific information in the back of the book. Even though the participants indicated the change to the new textbook series was effective, three participants (A1, A2, and A4) had to supplement the textbook with information from the internet such as worksheets. Information from the previous textbook was also used.

All six participants indicated that instructional strategies changed. They talked about the necessity of students developing a deeper understanding of concepts. Participant A2 remarked, “There is much more time and emphasis on vocabulary development.” She added, “The concentration on academic vocabulary has been effective. Students in third grade are able to transfer the vocabulary to the next grade level.” Three participants explained their changes to instructional strategies. Participant A4 incorporated pictorial representations and also “chunked the information in smaller pieces so that students learn more about the process instead of rote memorization.” Participant B2 used more think, pair, share and partner talk than she did in previous years adding, “Now I pose a problem and they solve it with a partner.” Four of the participants (A1, A3, A4, and B2) also discussed teaching strategies such as varied addition procedures, visual representations, error analysis, and problem solving. In addition, one
participant’s (A4) students kept math journals in which students wrote notes and examples.

These changes in pedagogy necessitated a change in lesson planning. Four of the participants (A2, A2, B1, and B2) explained that students in their classrooms had gaps in their mathematical knowledge of concepts. They all believed these gaps were a result of implementation of Pennsylvania Core Mathematics Standards. Participant B2 said she needed to teach concepts that in past years were just reviewed. Participant A1 said, “If the book says two days for a lesson, it is taking us three to four. We may spend two days filling the holes. The children don’t have the background knowledge.” “Differentiation is huge,” according to Participant B1. There was optimism that the time needed to fill these gaps would decrease in future years. Participant A1, a fourth grade teacher, stated, “When the present kindergarten students get here, they will have the jargon, the perspective in math. It will be the golden year.”

Three teachers indicated there was a change in mathematics instructional time. Participant A4 said they had an additional 20 minutes for mathematics instruction; Participant B2 said the change was 15 minutes. Participant B2, a fifth grade teacher stated, “I am embarrassed to say that last year we only had 45 minutes for math. This year we have an hour. This is significant; more than one hour added to each week.” One of the districts changed to all day Kindergarten and increased the amount of mathematics instructional time; however, one interviewee (A3) was not positive the change was due to implementation of Pennsylvania Core Mathematics Standards. The interviewee did not offer any reasons for this change.
The final change was teaching personnel. Participant A4 relayed that in the past, all of the grade level teachers taught mathematics. This year, one teacher taught mathematics to all of the students. She added that the teaching assignments were made by examining the curricular strengths of the grade level teachers.

Three participants (A1, A2, and A3) felt that there were no other changes needed to effectively implement Pennsylvania Core Mathematics Standards although all three stressed the importance of continuing to monitor both the implementation of their textbooks and of Pennsylvania Core Mathematics Standards. One teacher (B2) wanted an increase in the amount of explanation included with her textbook. Participant B1 indicated that additional personnel in classrooms would be helpful stating:

More adults who can sit down and actually work with small groups. I feel that I have more low math students. To effectively be able to reach all them, I can’t have 10 in a small group which is where we are at this point.

Participant A4 also mentioned personnel; however, the personnel would be used to monitor consistency among teachers and between schools. Furthermore, Participant A4 believed that parental resources were needed to effectively implement the standards adding:

There is a real disconnect at this time. There are so many emotions. Some parents think Common Core is ridiculous; others are frustrated. I get emails from them about the math and I help them. It is like putting out little fires. The math is difficult for them. The sixth grade math is more than some parents learned.

The implementation of Pennsylvania Core Mathematics Standards resulted in many changes in mathematics instruction and all six participants identified the benefit of
these changes to students. One teacher (A1) made a global comparison indicating that U.S. students will be better able to compete with students from other countries. Other participants spoke about what they were observing in their classrooms. Students had improved basic facts. Students did not just know more content but also had a deeper understanding of the content. Two participants (A3 and A4) said students were able to solve higher order problems and three participants (A1, A2, and B2) added students were able to use multiple methods to solve problems. Participant B2 stated:

I like that we aren’t telling them one strategy to figure something out. I tell them my job is to have you work. When I see you work, then I know that I am working. Some get it. They figure it out every time. It is awesome. It is really cool. I think kids are learning more and understanding it better. It is a good feeling and it is just November.

Although one participant (A1) noted student benefits, he added that students’ confidence decreased because of their content knowledge gaps.

**Research Question Two**

*What are elementary mathematics teachers’ perceptions regarding the professional development needed to effectively implement Pennsylvania Core Mathematics Standards?*

Research question two was addressed using data from the survey responses and interview data. The survey included five Likert scale items and four open-ended items intended to elicit the participants’ views about the professional development needed to effectively implement Pennsylvania Core Mathematics Standards including (a) the types, (b) the level of support, (c) the number of professional development hours, and (d) needs for further professional development. In addition, the survey questions were designed to
determine the respondents’ perceptions of their levels of preparation to effectively implement Pennsylvania Core Mathematics Standards. Finally, the survey questions were designed to elicit teachers’ perceptions of needed additional supports. The interview included three questions which also addressed research question two.

**Reporting of survey responses.** To determine elementary teachers’ perceptions of the professional development received for implementation of the standards, three questions utilizing the Likert scale were provided with possible responses of strongly supported, supported, did not support, and not applicable. In addition, two Likert scale questions with possible responses of strongly agree, agree, disagree, and strongly disagree were used to ascertain elementary teachers’ perceptions of being prepared to teach Pennsylvania Core Mathematics Standards.

All respondents (14) participated in district provided professional development and this professional development supported implementation of Pennsylvania Core Mathematics Standards. Also, 11 teachers (79%) who participated in self-directed professional development noted the support. Conversely, teachers who participated in professional development provided by intermediate units did not concur about the benefit; four out of the eight teachers indicated that this training did not support their implementation of Pennsylvania Core Mathematics Standards. Table 4.3 indicates the frequency of the data sources from the three Likert scale questions.

Even though all of the 14 respondents said the district professional development supported the implementation of Pennsylvania Core Mathematics Standards, 29% (4) indicated that they were not fully prepared for implementation. Furthermore, 57% (8) of teachers disagreed or strongly disagreed that their undergraduate or graduate work
prepared them for teaching these standards. Table 4.4 indicates the frequency of the data sources from the two Likert scale questions.

Table 4.3

**Teachers’ Perceptions of the Level of Support of Professional Development for Implementation of Pennsylvania Core Mathematics Standards**

<table>
<thead>
<tr>
<th>Question</th>
<th>Participant Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>District provided</td>
<td>Strongly Supported: 7(50%)</td>
</tr>
<tr>
<td>Intermediate Unit (IU) provided</td>
<td>Strongly Supported: 1(7%)</td>
</tr>
<tr>
<td>Self-Directed</td>
<td>Strongly Supported: 4(29%)</td>
</tr>
</tbody>
</table>

*Note: N=14. NR=No Response.*

Table 4.4

**Teachers’ Perceptions of Preparation for Implementation of Pennsylvania Core Mathematics Standards**

<table>
<thead>
<tr>
<th>Question</th>
<th>Participant Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am fully prepared to teach the PA Core Mathematics Standards.</td>
<td>Strongly Agree: 2(14%)</td>
</tr>
<tr>
<td>My mathematics undergraduate or graduate work fully prepared me for teaching the PA Core Mathematics Standards.</td>
<td>Strongly Agree: 0(0%)</td>
</tr>
</tbody>
</table>

*Note: N=14.*

**Reporting of open-ended responses.** In addition to the Likert scale survey items, the researcher gathered additional data through the use of open-ended questions. One open-ended question was used to gather information about the number of hours
devoted to professional development; this question was answered by all 14 respondents. The amount of hours varied greatly and ranged from 1-10 hours to 31 or more hours. Fifty percent (7) of the respondents received 1-10 hours of professional development; 21% (3), 11-20 hours; 14% (2), 21-30 hours; and 14% (2), 31 or more hours.

Another open-ended question asked the teachers to identify additional professional development needed to effectively implement Pennsylvania Core Mathematics Standards. Six teachers responded. One teacher identified a need in understanding the standards. Also, a respondent sought hands-on practice with theories and practice. Time was mentioned by three teachers; two teachers indicated time for developing standards-aligned lessons and practice lessons and the other teacher wanted time to work with peers “to address concerns as you begin teaching to the PA Core.” Lastly, one teacher wanted professional development for “dealing with students who do not meet the standards after instruction and for students who are advanced and still need to make a year of growth.”

The third open-ended question was used to discern teachers’ perceptions as to what was most helpful in preparation for implementing Pennsylvania Core Mathematics Standards. Five of the eight respondents stated that information provided by their school districts was the most beneficial in preparing for implementation of the standards. Teachers noted the advantages of the following: (a) a textbook aligned to the standards, (b) a district developed continuum of content, (c) a summary sheet of eligible content and the standards, (d) a review of specific grade level standards as well as the previous and the next grade level standards, and (e) committee work which included a review of the standards and the new textbook. Additionally, teachers noted the usefulness of working
with colleagues either informally or during grade level meetings. Two teachers also indicated they benefited most by their own work; one studied Common Core Standards and the other searched for materials and resources.

The last open-ended question provided teachers the opportunity to identify additional needed supports for effective implementation of Pennsylvania Core Mathematics Standards. Three of the six teachers identified curriculum materials. One teacher stated, “I feel that a more thorough math program for our district would have been helpful.” Another teacher needed standards-aligned materials. The third teacher requested “specific examples of each assessment anchor listed in the PA Core Standards.” Instructional strategies for teaching higher-level mathematics were also identified as a need. Support in the form of math data meetings and collegial collaboration was also listed. Finally, one teacher indicated that support was needed but did not identify a specific form of support.

**Reporting of interview data.** Data collected from interviews provided further insight into the second research question. All of the participants received professional development due to implementation of Pennsylvania Core Mathematics Standards. Also, all of the participants received professional development in their districts. Five out of the six participants indicated their professional development focused on the new textbook series. The amount of this training varied from one-half day to one and one-half days. Furthermore, two teachers (B1 and B2) indicated that school district personnel provided professional development on the textbook series; the textbook company provided the training for the other three teachers (A1, A2, and A4). Although all five of the participants thought the training was helpful, it was deemed insufficient. Participant A1
stated, “I thought it was the initial overview and I thought it was good then it became apparent that that was the training.” In addition, Participant B2 described the training as “overwhelming because there was too much information.” Two other interviewees (A4 and B2), using different textbook series, remarked that the training was too far from the actual date of textbook implementation.

Additional professional development was provided at the district level. Two participants (A4 and B1) talked about a workshop on Pennsylvania Core Mathematics Standards and two other teachers (A1 and A2) described workshops on instructional strategies. All four participants described the workshops as effective.

Three participants (A2, B1, and B2) also received professional development at the intermediate unit. All of these participants described this professional development as effective or very effective.

One teacher (A3) did self-directed professional development which she indicated was effective. She described reading articles and researching information on the internet. The other five participants talked about informal professional development through collaboration with their colleagues. Two of the interviewees (A4 and B1) were in contact with the mathematics supervisor for needed support. The other three teachers (A1, A2, and B2) talked about the value of meeting with their grade level colleagues. All three indicated they had daily communication with their colleagues. Some of these meetings were face-to-face; other methods included talking on the phone, texting, and sending emails. Some of the conversations centered on the pacing of lessons. Teachers discussed teaching strategies, working with struggling students, and assessment. In addition,
Participant B2 said, “We do a lot of planning together. We talk about what works and what doesn’t.”

Although professional development was provided to all teachers, some of the participants did not feel fully prepared to implement Pennsylvania Core Mathematics Standards. Two of the participants described themselves as fully prepared, three as not fully prepared, and one was not sure. Participant A3 who felt fully prepared said, “I have always stayed on the wave. I’m always looking around, seeing what is happening; figuring it out myself so when it comes, I am ready to go.” Participant A2 also felt prepared due to her mathematics knowledge and middle school mathematics certification. Even though both of these participants felt prepared, they expressed concerns about their colleagues. Participant A3 said, “If you were hired in this district 12 years ago, you would have never had staff development in math. It was all literacy-based. People with 0-12 years were so frustrated.” In addition Participant A2 remarked, “It is scary for some teachers.” Participant A1 stated that he goes back and forth on being fully prepared saying:

When I look at some of things that I am teaching, I see things that I learned in 11th grade and I think, whoa. I need to study the lesson intently. I make sure that I am solid with the math before I get in front of them.

Although Participant B1 felt confident in teaching Pennsylvania Core Mathematics Content Standards, she did not feel the same about the Practice Standards; she indicated, “I don’t have a good understanding of Standards of Mathematics Practice to be perfectly honest.” Participants A4 and B2 did not feel fully prepared. Participant B2 expressed the most concern and frustration stating:
There are things I don’t understand. I have to go to my grade level partner and ask her what does this mean. Sometimes when I read it, I can’t understand what it means. It makes me feel silly and feel inadequate.

Finally, the participants were asked to identify additional supports which would be beneficial in implementing Pennsylvania Core Mathematics Standards in their classrooms. One participant (B2) requested more information on Pennsylvania Core Mathematics Standards while another participant (B1) wanted to know more about the Pennsylvania Core Mathematics Practice Standards. There was a suggestion by Participant A2 for additional content training for sixth grade teachers. Two teachers (A1 and B1) sought professional development on specific teaching strategies. Participant A1 also needed more information on student strategies; for example, for solving long division problems. Training on the use of technology to find mathematics resources was suggested by Participant A4.

Although most of the additional supports were at the district level, one participant (A2) thought supports should be offered at the state level. Participant A2 elaborated stating, “These state supports should include an explanation of the differences as well as the logic behind the differences between Common Core State Standards and Pennsylvania Core Mathematics Standards; there should also be information on backmapping of foundational concepts.”

**Summary**

This chapter analyzed the results from surveys and interviews to identify elementary teachers’ perceptions regarding changes in mathematics instruction due to
implementation of Pennsylvania Core Mathematics Standards and the professional
development needed to effectively implement Pennsylvania Core Mathematics Standards.

Based on the data collected, almost all of the elementary teachers perceived that
mathematics instruction has changed due to implementation of Pennsylvania Core
Mathematics Standards. All of the participants indicated the mathematics curriculum and
the mathematics textbooks changed. Other changes to mathematics instruction included
(a) instructional strategies, (b) lesson planning, (c) instructional time, (d) assessments, (e)
resources other than the textbook, and (f) teaching assignment. Although there were
many changes, participants indicated more curricular and parental resources might
advance effective implementation of standards. Furthermore, additional personnel should
be added. Participants also described the benefits of the changes for students. Students
were able (a) to think at higher levels, (b) to problem solve using varied strategies, and
(c) to use mathematical vocabulary. Students also had a deeper understanding of
concepts and knew basic facts.

Results also showed that elementary teachers received professional development
prior to implementation of Pennsylvania Core Mathematics Standards. The amount of
professional development hours ranged from 1-10 hours to over 31 hours. The majority
of respondents received training on the use of textbooks. Although some teachers
thought this training was effective, others found it lacking. Those respondents who did
self-directed professional development found it effective. District provided professional
development was also found to support implementation. The professional development
provided by intermediate units was beneficial for some teachers, but other teachers found
the training lacking. Furthermore, working with colleagues was very beneficial and teachers communicated daily.

While some elementary teachers felt fully prepared to implement Pennsylvania Core Mathematics Standards, other teachers felt inadequate. Teachers indicated undergraduate and grade coursework did not prepare them for implementation of standards. Teachers suggested additional professional development on the following: (a) Pennsylvania Core Mathematics Standards, (b) pedagogy, (c) grade level content, (d) student strategies, and (e) technology. Finally, teachers requested time to analyze data as well as to collaborate with their peers. A summary of the study, its results, and the relationship to other research are discussed in Chapter Five.
Chapter Five – Discussion

Summary of the Study

The purpose of this qualitative study was to investigate elementary teachers’ perceptions of the changes to mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement Pennsylvania Core Mathematics Standards. The researcher examined the perceptions and beliefs of 14 elementary teachers from three Pennsylvania public school districts. Two of the school districts are suburban districts located in the same county. The third school district is a rural district in central Pennsylvania. Data were collected using an electronic survey instrument and face-to-face interviews. Fourteen teachers participated in the electronic survey which consisted of 14 Likert scale statements and 10 open-ended questions. Six of the 14 teachers from two of the school districts (A and B) also participated in the nine question interview. No teachers from District C volunteered to be interviewed.

The researcher examined and analyzed the data in relation to the study’s two research questions. The researcher also transcribed the interview data. In addition, the Likert scale survey data were placed into tables. Furthermore, the data were reported in summary form. The elementary teachers’ responses were examined to determine the themes concerning the specific changes to mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards, the effectiveness of these changes, and further needed changes. The responses were also reviewed to determine the professional development given due to implementation of Pennsylvania Core Mathematics Standards
and the level of support of this professional development. This qualitative study provided insight into understanding elementary teachers’ perceptions.

**Summary of the Results**

This study described and analyzed data gathered from Likert scale statements and open-ended questions in a survey and interview responses. Fourteen elementary mathematics teachers participated in this study. These responses were categorized and analyzed for trends related to the two research questions. The researcher identified themes which emerged from participant responses.

Several trends were ascertained through the analysis of data related to research question one. All of the 14 respondents to the study indicated mathematics instruction changed due to implementation of Pennsylvania Core Mathematics Standards. Although one respondent described the changes as minor, the other respondents indicated a significant amount of change. Teachers reported that implementation of Pennsylvania Core Mathematics Content Standards (14 out of 14) caused more of a change in instruction than implementation of Pennsylvania Core Mathematics Practice Standards (13 out of 14).

The respondents described specific changes to mathematics instruction. All of the teachers (14) surveyed and interviewed (6) indicated that curriculum changed. More teachers responded strongly agree to the survey question related to the change in curriculum than any other statement on specific changes. Furthermore, seven out of nine respondents to the open-ended question identified curriculum as the most significant change factor. Open-ended question responses and interview data indicated content shifted to earlier grade levels and the shifts caused gaps in students’ content knowledge;
students did not know concepts which had been review in previous years. Survey respondents (12 out of 14) and interviewees (6 out of 6) also changed instructional strategies. Further, teachers (6 out of 6 interviewees) increased the use of strategies such as (a) visual representations of content, (b) chunking of information, (c) think-pair-share, and (d) error analysis. Instruction focused more on problem solving. Lesson planning was identified as changed by 12 out of 14 surveyed teachers; lessons took longer to instruct than in the past. Teachers also reported changes to assessment (13 out of 14) and teaching assignment (2 out 6 interviewees).

Further changes were made to mathematics instructional time, textbooks, and other resources. Eleven out of 14 teachers surveyed reported mathematics instructional time increased and all but one teacher found that change effective. Two interviewees also reported increased instructional time due to implementation of standards. In addition, although all of the teachers surveyed (14) and interviewed (6) indicated mathematics textbooks had changed, they did not agree with the effectiveness of this change; while most found the change in textbooks helpful, seven of 14 survey respondents described the change as not effective. Furthermore, while three interviewees perceived the textbooks to be standards aligned, two interviewees raised concerns about the alignment between the textbook and Pennsylvania Core Mathematics Standards. Finally, the change to other mathematics resources was effective (10 out of 14).

Even with the number of changes already made, open-ended respondents identified other needed changes which included: (a) resources for instruction such as rigorous student problems, (b) detailed information on filling the gaps of students’ mathematics understanding, (c) additional instructional time, and (d) parental resources.
Interview data also indicated a need for parental resources. Furthermore, two interviewees suggested additional personnel.

Changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards benefitted students according to five out of six open-ended responses and interview data. Teachers’ open-ended responses and interview data indicated students knew more content, used academic vocabulary, and had a deeper understanding of concepts. Additionally, students improved in solving problems which had increased levels of rigor. Although one interviewee expressed student benefits, he also perceived a decrease in students’ confidence due to their gaps in content knowledge. Finally, a teacher cautioned that it was too soon to determine student benefits.

Research question two identified trends in professional development needed to effectively implement Pennsylvania Core Mathematics Standards. All of the survey (14) respondents participated in district provided professional development which supported implementation of the standards and all teachers (14) found the training beneficial. This finding was consistent with interview data. Five out of six interviewees reported district provided professional development on implementation of the new mathematics textbooks; although all of these respondents found the training on the textbook helpful, interviewees (four out of six) found the training insufficient or untimely. Other district provided professional development topics included: (a) Pennsylvania Core Mathematics Standards, (b) specific grade level standards, and (c) instructional strategies. Furthermore, information provided by the school districts was the most helpful in preparing for implementation of the standards. Additionally, teachers benefited by working with colleagues. Most of the survey respondents (11 out of 14) and one of the
interviewees participated in self-directed professional development and these respondents and interviewee found it effective. In contrast, professional development provided by the intermediate units resulted in mixed results of effectiveness. While four of the eight surveyed teachers who participated in this professional development found it supportive, four did not; all three of the six interviewees found this training effective. Further, all three interviewees received professional development from the same intermediate unit. The four respondents who did not find the intermediate unit’s professional development supportive did not offer any reasons for their ratings. In addition, three of these four respondents only received between one and 10 hours of professional development.

The number of professional development hours surveyed teachers received varied greatly. The range of the number of hours was from 1-10 to over 31; seven out of 14 teachers reported that the number of hours was from 1-10. Furthermore, while 10 out 14 survey respondents and two out of six interviewees felt prepared to implement the Pennsylvania Core Mathematics Standards, four survey respondents and two interviewees did not, and one interviewee was not sure. Two of the interviewees who felt prepared raised concerns about their colleagues. One interviewee described her sense of inadequacy in implementing the standards. District-provided professional development was especially important since eight out of 14 teachers surveyed did not believe that their undergraduate or graduate work prepared them for implementing the standards.

In addition, teachers described the importance of professional development through collaboration with peers. Some of the professional development happened during meetings; for example, data examination. Other professional development was informal. Teachers found opportunities to communicate with their colleagues daily
concerning (a) lessons, (b) mathematics content, (c) pacing, (d) teaching strategies, (e) working with struggling students, and (f) assessment. While some of this communication was face-to-face, teachers also texted, emailed, or called their colleagues.

The teachers identified further professional development which they believed would aid effective implementation of Pennsylvania Core Mathematics Standards. Additional professional development on (a) the standards, (b) specific grade level content, (c) technology, and (d) instructional strategies was suggested. Furthermore, professional development was requested on strategies for working with mathematically struggling or excelling students. Teachers also requested time to work with colleagues on standards-aligned lessons and other concerns related to implementation of the new curriculum.

Finally, teachers stated supports were still needed to effectively implement Pennsylvania Core Mathematics Standards. One interviewee indicated support should be offered at the state level and should include a comparison between Common Core State Standards Mathematics and Pennsylvania Core Mathematics Standards and also information on the backmapping of concepts. The other needed supports which teachers requested were at the district level. Open-ended question responses and interview data revealed teachers wanted additional information on the standards in general and more specific information on the Pennsylvania Core Mathematics Practice Standards. Also, more curriculum materials such as standards-aligned problems were requested. Equally important was time to collaborate with colleagues.
Limitations Found in the Study

While some limitations were identified in Chapter One, additional limitations emerged during the study. First, although there were over 150 elementary teachers in the three school districts, only 14 participated in the survey. Another limitation was that only teachers from two of the school districts participated in the interviews. Furthermore, the two districts have a total of six elementary schools; the teachers who were interviewed were from only three of the elementary schools. The limited number of participants and the lack of representation from all of the schools impact the generalizability of the study. Finally, since two teachers were certified in middle school mathematics, their results may have skewed the data.

Relationship to Other Research

A review of literature related to changes in mathematics instruction and professional development provided a foundation for this study. A comparison of Common Core State Standards (CCSSM) and pre-CCSSM states’ standards found that significant changes would need to be made because of the lack of alignment (Porter et al., 2011; Schmidt & Houang, 2012). In addition, Pennsylvania’s mathematics standards were changed and the resulting Pennsylvania Core Mathematics Standards went into effect on March 1, 2014 (PA Bulletin, 2014). Furthermore, state standards influence schools and mathematics classrooms (Banilower et al., 2013; Easley, 2011). The results of this study support that research. All of the teachers (14) in this study reported curriculum changed due to implementation of Pennsylvania Core Mathematics Standards, and curriculum was identified as changing the most of all of the factors.
The results of the current study found that 10 out of 14 (71%) elementary teachers felt prepared to implement Pennsylvania Core Mathematics Standards. This result is lower than the Horizon Research (2013) results which indicated that 77% of elementary teachers felt very prepared to teach mathematics.

This study also concurred with the research that some districts increased instructional time due to the emphasis on standards (Bodovski & Farkas, 2007; Claessens et al., 2014; Weinberg et al., 2011). It was recommended that instructional strategies change to support students’ understanding of mathematics (Kanold et al., 2012; McRel, 2010). This recommendation was affirmed by this study which found that teachers changed instructional strategies to include more problem solving. Furthermore, the problem solving included problems with an increase in rigor. Also, students were asked to work with partners, to analyze errors, and to communicate their thinking.

The textbooks and programs used in classrooms impact instruction (Akuyz & Berberoglu, 2010; Doabler et al., 2012; Horizon Research, 2013; Mayrowetz, 2009; Rakes et al., 2010). In a national survey, it was found that “80% of classes at all grade levels use commercially published textbooks or programs” (Horizon Research, 2013, p. 19). Furthermore, most teachers believed their textbooks addressed standards (Mayrowetz, 2009). The current study also found commercial textbooks were used and their use changed instruction; most of the elementary teachers also believed these textbooks were aligned to standards. Furthermore, interviewees stated they were told that their textbooks were aligned to standards.

Professional development has been a factor in supporting teachers’ changes in practice and behavior (Braun, 2011; Darling-Hammond & Richardson, 2009; Fuchs &
Vaughn, 2012; Kanold et al., 2012; Marzano, 2003; McRel, 2010; NMAP, 2008; NSDC, 2009) but not all professional development was found to be effective (Marzano, 2003; Reeves, 2010; Stronge, 2007). The results of the current study found similar results. All of the teachers received professional development but not all of the professional development was effective. In addition, some of the professional development in this study shared the following characteristics found in the research: collaborative (Darling-Hammond & Richardson, 2009; Kanold et al., 2012) and job-embedded (Darling-Hammond & Richardson, 2009; McRel, 2010; NSDC, 2009). Also, this study found professional development was focused on curriculum, standards, and instructional strategies which concurs with the research of Braun (2011), Darling-Hammond & Richardson (2009), Kanold et al. (2012), and Reeves (2010).

Another recommendation found in the literature was that professional development should happen in professional learning communities (PLCs) (Anderson & Herr, 2011; Darling-Hammond & Richardson, 2009). Although none of this study’s participants used the term PLC, their descriptions of work while collaborating with colleagues was similar to that of PLCs. Finally, 30 to 100 hours of professional development offered over six to 12 months showed the largest gain in student achievement (Yoon et al., 2007). This study found that only two of the 14 survey participants indicated that they received over 30 hours of professional development in preparation for implementing Pennsylvania Core Mathematics Standards.

**Recommendations for Further Research**

This study investigated elementary teachers’ perceptions of the changes to mathematics instruction due to implementation of Pennsylvania Core Mathematics...
Standards and the professional development needed to effectively implement Pennsylvania Core Mathematics Standards. This study has prompted recommendations for further research in several areas. This study found elementary teachers varied greatly in their perceived beliefs of their preparation to implement Pennsylvania Core Mathematics. A study comparing the teachers’ perceived levels of preparation and student achievement could further understanding of a potential link between the two. Although this study collected demographic information, no comparison was made among grade level assignments. A second study could compare teachers’ perceived levels of preparation and further needed support with PSSA and non-PSSA assessed grades. Since this study focused on elementary teachers, another qualitative study could focus on secondary mathematics teachers’ perceptions related to PSSA and Keystone Algebra. Finally, since the participants of this study were from suburban and rural school districts, another study could focus on participants from urban settings.

Conclusion

This study examined elementary teachers’ perceptions regarding changes in mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and professional development needed to effectively implement Pennsylvania Core Mathematics Standards. Specifically, elementary teachers’ perceptions were gathered on (a) the changes, (b) the effectiveness of these changes, (c) how the changes benefitted students, and (d) further needed changes. Also, elementary teachers’ perceptions of professional development including (a) types, (b) level of support, and (c) additional needed professional development and support were collected. Teachers also reported their perceptions of levels of preparation for implementing the standards.
Conclusions were made based on analysis of data collected through the use of an online survey, comprised of open-ended questions and Likert scale statements, and in-person interviews.

The results of the study revealed that elementary teachers changed mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards. The perceived amount of change varied from very little to drastic. Mathematics textbooks were changed in all of the classrooms and most teachers described this change as effective. Although there were many changes, teachers perceived further changes were needed. Districts should consider providing additional resources for instruction including standards-aligned problems and materials to bridge students’ content knowledge gaps. Since lessons are taking longer than expected, consideration should be given to increasing mathematics instructional time. Finally, study findings indicate the need for parents to understand the standards. It is advised that districts hold parent meetings to explain the standards, explain grade level content, and model instructional strategies.

Study results also revealed that elementary teachers received professional development prior to implementation of Pennsylvania Core Mathematics Standards. Even with professional development on the standards, some teachers did not feel fully prepared. Furthermore, teachers perceived that neither their undergraduate nor graduate work prepared them for implementing the standards. It is recommended that pre-service teacher training include information on Pennsylvania Core Mathematics Standards and on instructional strategies to support implementation of the standards. Moreover, district provided professional development is vital for the effective implementation of standards. Elementary teachers would benefit from additional professional development on:
Pennsylvania Content and Practice Mathematics Standards, grade level content information, instructional strategies, and technology. Finally, findings suggest that teachers benefit from collaboration with peers. Consideration should be given to providing additional time for collaboration.

The results of this study uncovered elementary teachers’ perceptions of the changes to mathematics instruction due to implementation of Pennsylvania Core Mathematics Standards and the professional development needed to effectively implement these standards. There was an array of perceived effective changes and professional development supported implementation of standards; however, more changes, professional development, and support are needed. Understanding how teachers perceive changes to mathematics instruction and professional development should assist educators in their work of improving the mathematics achievement of all students.
References


instructional design principles. Learning Disability Quarterly, 35(4), 200-211.
doi:10.1177/0731948712438557

Doabler, C., Nelson, N., Kosty, D., Fien, H., Baker, S., Smolkowski, K., & Clarke, B.
(2014). Examining teachers' use of evidence-based practices during core
teachers' use of evidence-based practices during core
teachers' use of evidence-based practices during core mathematics instruction. Assessment for Effective Intervention, 39(2), 99-111.
doi:10.1177/1534508413511848

Easley, J., II. (2011). What do students know anyway? High school graduates'
examination of standards and the responses of expert educators for educational
equity. Improving Schools, 14(3), 223-238. doi:10.1177/1365480211422285


Week, 30(1), 1, 20-21.

case study of a professional learning community. Research in Middle Level

patterns, and content knowledge for teaching mathematics. Teacher Education
and Special Education, 32(4), 319-336. doi:10.1177/0888406409343540

Griffin, G., League, M., Griffin, V., & Bae, J. (2013). Discourse practices in inclusive
doi:10.1177/0731948712465188


from Common Core State Standards Initiative Preparing America's Students for College & Career: http://www.corestandards.org/


NCLB's Highly Qualified Teacher Requirements. (n.d.). Retrieved from Pennsylvania Department of Education: http://www.portal.state.pa.us/portal/server.pt/community/highly Qualified_teacher_requirements/8631


http://paschoolperformance.org/

doi:10.1177/0895904811417580


doi:10.1177/0013161X11436273


doi:10.3102/0034654308317473


doi:10.1177/1098300708326597


Appendix A

Survey Questions

1. How many years of experience do you have teaching mathematics?
   
   1 – 5
   6 – 10
   11 – 20
   21 – 30
   30+

2. What is your current teaching assignment?
   
   K – 2
   3 – 6

3. What is your area(s) of certification? Mark all that apply.

<table>
<thead>
<tr>
<th>Elementary</th>
<th>Special Education</th>
<th>Mathematics</th>
</tr>
</thead>
</table>

   For each statement, please indicate which of the following best describes your perspective.

4. I have changed classroom instruction due to the implementation of PA Core Mathematics Content Standards.

   Strongly Agree    Agree    Disagree    Strongly Disagree

5. I have changed classroom instruction due to the implementation of PA Core Mathematics Practice Standards.

   Strongly Agree    Agree    Disagree    Strongly Disagree

6. The mathematics curriculum in my classroom has changed due to the implementation of PA Core Mathematics Standards.

   Strongly Agree    Agree    Disagree    Strongly Disagree
7. I have changed instructional strategies due to the implementation of PA Core Mathematics Standards.

   Strongly Agree   Agree   Disagree   Strongly Disagree

8. I have changed lesson planning due to the implementation of PA Core Mathematics Standards.

   Strongly Agree   Agree   Disagree   Strongly Disagree

9. I have changed assessments due to the implementation of PA Core Mathematics Standards.

   Strongly Agree   Agree   Disagree   Strongly Disagree

10. I am fully prepared to teach the PA Core Mathematics Standards.

    Strongly Agree   Agree   Disagree   Strongly Disagree

11. My mathematics undergraduate or graduate work fully prepared me for teaching the PA Core Mathematics Standards.

    Strongly Agree   Agree   Disagree   Strongly Disagree

Consider the changes in your mathematics classroom due to the implementation of PA Core Mathematics Standards. Please mark the degree of effectiveness of these changes, if any, to your mathematics classroom instruction.

<table>
<thead>
<tr>
<th></th>
<th>Very Effective</th>
<th>Effective</th>
<th>Not Effective</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. Change in Mathematics Instructional Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Change in Mathematics Textbooks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Change in Mathematics Resources (other than textbooks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Consider the professional development you may have received. Please mark the degree, if any, the professional development supported your implementation of PA Core Mathematics Standards.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Supported</th>
<th>Supported</th>
<th>Did Not Support</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. District Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Intermediate Unit (IU) Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Self-Directed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. How many hours of professional development have you received in preparation for implementing PA Core Mathematics Standards?

1-10 hours
11-20 hours
21-30 hours
31 or more hours

Please use the text boxes to answer the following questions.

19. Describe the professional development you believe you need to implement the PA Core Mathematics Standards.

20. What has been the most helpful in preparing you for implementing PA Core Mathematics Standards?

21. What additional supports would help you in implementing PA Core Mathematics Standards?
22. How has the implementation of PA Core Mathematics Standards benefitted students?

23. What has changed the most due to the implementation of PA Core Mathematics Standards?

24. What do you believe still should be changed for the effective implementation of PA Core Mathematics Standards?
Appendix B

Interview Questions

1. What is your certification?

2. What grade level do you teach?

3. How many years have you taught mathematics?

4. How have you changed classroom instruction based on the implementation of PA Core Mathematics Standards? How effective were these changes?

5. What further changes should be made to effectively implement PA Core Mathematics Standards in your classroom?

6. How has the implementation of PA Core Mathematics Standards benefitted students?

7. Do you feel fully prepared to implement PA Core Mathematics Standards? Please explain.

8. What professional development have you had due to implementation of PA Core Mathematics Standards? How effective was the professional development?

9. What additional supports would help you in implementing PA Core Mathematics Standards in your classroom?
Appendix C

IMMACULATA UNIVERSITY RESEARCH ETHICS REVIEW BOARD
REQUEST FOR PROTOCOL REVIEW--REVIEWER'S COMMENTS FORM
(R1297)

Name of Researcher: Carol Kelsall

Project Title: Implementation of Pennsylvania Core Mathematics Standards: Elementary Teachers’ Perceptions

Reviewer's Comments

Your proposal is Approved. You may begin your research or collect your data.

PLEASE NOTE THAT THIS APPROVAL IS VALID FOR ONE YEAR (365 days) FROM DATE OF SIGNING.

Reviewer's Recommendations:

- Exempt
- Expedited
- Full Review

Approved
Conditionally Approve
Do Not Approve

______________________________
Thomas F. O’Brien, Ph.D., Ed.D.
Chair, Research Ethics Review Board

August 26, 2014
DATE