1-1-2011

Focusing Professional Development by Differentiating for Teachers

Amy Weber-Salgo
Walden University

Walden University

COLLEGE OF EDUCATION

This is to certify that the doctoral study by

Amy Weber-Salgo

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Gary Schnellert, Committee Chairperson, Education Faculty
Dr. Douglas McBroom, Committee Member, Education Faculty
Dr. Tiffany DePriter, University Reviewer, Education Faculty

Chief Academic Officer

Eric Riedel, Ph.D.

Walden University
2012

Abstract

Focusing Professional Development by Differentiating for Teachers

by

Amy Weber-Salgo

MA, Walden University, 2005

BA, University of Nevada, Reno, 1990

Proposal Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Administrative Leadership for Teaching and Learning

Walden University

September 2012

Abstract

This study addressed the problem of low student achievement in elementary school mathematics and investigated the level of knowledge held by the teachers. Previous studies have shown that students who succeed in mathematics are more successful during their school years, including college, and earn a higher income level as adults. A theoretical framework of andragogy framed three research questions for investigation. The first question focused on the current professional development needs of the teachers. The other two questions investigated whether the mathematical knowledge relating to teaching (MKT) correlates with the socioeconomic level of the school or correlates with annual yearly progress (AYP) status. Randomly selected elementary teachers from 12 schools participated by completing a survey and taking an online assessment to determine their MKT level. There was no significant correlation between the teachers' MKT scores and the socioeconomic level of their school or the AYP status of the school. Results indicated the need for professional development in mathematical progressions and instructional techniques. Data also suggested that this professional development be adapted to meet the individual needs of the participating teachers. These data informed the creation of 45 professional development training modules for teachers. This study, with the recommended training modules, can initiate social change by providing teachers with individualized training and new instructional strategies to implement in their classrooms with their students, thereby promoting higher levels of student achievement in mathematics.

Focusing Professional Development by Differentiating for Teachers

by

Amy Weber-Salgo

MA, Walden University, 2005

BA, University of Nevada, Reno, 1990

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Administrative Leadership for Teaching and Learning

Walden University

September 2012

Dedication

"Challenge is a *dragon* with a gift in its mouth. *Tame the dragon* and the gift is yours." - Noela Evans, 1994.

I found this quotation when I started this doctoral journey. I would like to dedicate this work to all of those who helped me to tame this difficult, demanding, enlightening, beautiful dragon.

Dragon Tamer Co-Captain is, and will always be, my wonderful husband, Richard. Thank you for helping me to discover my strengths. Thank you for assisting me in confronting this dragon and for supporting me every single semester, even when I swore I could not do this. Thank you for holding me through my tears and my frustration. Thank you for celebrating each success, no matter how small. Thank you for all of the extra work you did so that I could sit in front of the computer, again. Thank you for allowing me to cover every inch of our home with my work. I treasure you. You are the gift.

To my amazing daughters, Lauren and Danielle: Thank you for supporting and loving me through everything. I am so incredibly proud of you both. How surreal it was to share my studying woes with my two college girls. Now it is my job to support you as you continue your educational journeys. I am only the first Dr. Salgo. Soon there will be Dr. Lauren Salgo and Dr. Danielle Salgo. The world is a better place because of your talents, your kindness, your passion, and your brilliance.

To my mom and dad, Jake and Valerie Weber: Thank you for always making me believe that I could do it. Thank you for valuing education in such a way that

contributing to the educational system has become my life's work. Knowing that you are proud of my accomplishments means the world to me.

To Rich, Karin, Peggy, Tom, and Corinne: Thank you for supporting me. Thank you for listening to me while I passionately discussed elementary school mathematics. Thank you for always asking me how things were going, even when I am sure I made you regret asking last time. I am lucky to have all of you in my life. My dear Corinne, as you begin your own college journey, I hope you find a path that sparks your passion and serves your talents. The world will be a better place no matter what you choose. Do what you love and love what you do!

Finally, to two people who always gave me strength and inspiration, Nanny and Papa. Thank you for always believing in me. Thank you for encouraging me to grow and to give. Papa, when I am teaching teachers about mathematics, I am so grateful that you made math fun and easy for me. Nanny, when I walk across that stage I will be wearing your wedding ring, so that you will both be with me. I miss you both more than words can say.

This beautiful, strong, courageous dragon has been tamed.

Acknowledgements

I am so grateful to those who supported me on this doctoral journey. First, I would like to thank Walden University. By making the choice to study with Walden, I was been challenged beyond measure. Along with this challenge, I have received enormous support from so many places along the way. The support I have received from Dr. Gary Schnellert, Dr. Douglas McBroom and Dr. Tiffany DePriter has allowed me to successfully complete this journey, even though I was not sure that I could. Dr. Heather Miller offered me the advice that kept me focused and encouraged. She said that the "best doctoral study is the one that is finished." Well, now it is finally finished and I am ready to think about my next research project. At Walden, I have been able to learn from my talented classmates about school systems across the country and around the world. I have learned that social change can happen, one person at a time.

I would also like to thank the wonderful teachers in my school district. They encourage me to be a better professional, even when they do not necessarily match my enthusiasm for elementary mathematics. They are hardworking, positive, amazing professionals, and I am honored to work with them every day.

Most importantly, I would like to thank all of my former and future students. It is for you that this work is important. It is for you that I strive to improve. It is for you that I go to work each day wondering how I can make your education better.

Table of Contents

List of Tables

List of Figures

Section 1: The Problem

Introduction

The National Mathematics Advisory Panel (2008) began its final report with the following statement: “The eminence, safety, and well-being of nations have been entwined for centuries with the ability of their people to deal with sophisticated quantitative ideas” (p. xi). Yet, on an international scale less, than one-third of our students are able to reach a proficient level in mathematics (Fleischman, Hopstock, Pelczar, & Shelley, 2010). In Nevada, only about one-quarter of eighth grade students reach the proficiency level on quantitative assessments (United States Department of Education, 2009).

One way to address this problem is to increase the instructional skills of the teaching force in the district (U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010). Teachers have an essential role in ensuring the success of our students. In order to assist teachers in this vital endeavor, professional development (PD) providers must deliver high quality training focused on their specific needs. While many training opportunities are offered, according to Wiliam (2007), “if we are serious about improving student achievement, we have to invest in the right professional development for teachers” (p. 187). The difficulty is in determining what the *right* PD is.

This project study took take place in a large district in Nevada, focusing on elementary school mathematics and the PD needs of the teachers and administrators. The problem under investigation for this study was the high number of students who are not able to make the minimal standards in mathematics achievement each year. This problem is apparent as early as third grade, which is the youngest grade to participate in the Nevada state assessment system, and it continues into the state university system where many students need remediation in mathematics.

This project study addressed this problem using elementary teachers as participants. The goal of the data collection was to determine the mathematical knowledge for teaching levels at four groups of schools. Using these data, I created a PD program differentiated according to the specific to the needs of those schools. To ensure confidentially, I refer to the school district by the pseudonym, XYZ School District.

In 2009 in the XYZ School District, there were 63 elementary schools, a special education school, 16 middle schools, and 12 high schools (XYZ School District, 2009). During the 2009-2010 school year, there were 62,431 students, 46.2% of whom were racial minority students. There were 7,418 employees, including 4,177 certified teachers.

In 2010, the XYZ School District published a document outlining a strategic plan, called Envision, with the intent of embarking on a "revolution of educational reform where the status quo is challenged and a bold call to action is issued to all our employees and our community" (XYZ School District, 2010, p. 1). Teachers, administrators, classified employees, parents, students, university stakeholders, and business and community leaders created this plan. Along with five goals, this plan outlined four areas of commitment: alignment, accessibility, accountability, and achievement. The commitment to alignment requires that the systems and policies of the district focus on the essential purpose of student achievement. Accessibility refers to the commitment to ensure that all students have access to a high quality education. A commitment to accountability requires that every single employee be held accountable for the continuous improvement in our schools. The commitment to achievement focuses on data systems that can be used to analyze current practices and results to determine the next steps to take. These four areas were used to develop five specific goals for the XYZ School District.

The goals are as follows:

Goal 1. Provide continuous academic success for every student, which includes differentiating instruction using a rigorous curriculum and using valid assessment data as a guide.

Goal 2. Recruit and support highly effective personnel, provide them with high quality training and PD, motivate them to perform at the highest levels, and develop a new evaluation system to determine their effectiveness.

Goal 3. Engage families and community partners, a goal set to improve communications, encourage meaningful involvement, and strengthen community partnerships.

Goal 4. Value and strengthen a positive, self-renewing culture. This goal focuses on safe, orderly schools, where collaboration is the norm and continuous improvement and innovation are expected within the diverse and inclusive culture.

Goal 5. Align performance management systems, a goal that coordinates the organizational structures, improves communication within multiple departments, and focuses on improving the support systems that schools use when they need support from outside of their building.

This doctoral project focused on objectives within Goals 2 and 4, providing high quality training within a culture of collaboration and innovation. Within these goals are multiple objectives that include timelines and specify the departments that are responsible for completing that portion of the goal. This project concentrated on the content area of elementary school mathematics working within the framework of the objectives outlined in the XYZ School District Envision strategic plan.

The state of Nevada joined 42 other states in adopting the Common Core State Standards (CCSS); an initiative led by the National Governors Association and the Council of Chief State School Officers (Center on Educational Policy, 2011). As the state of Nevada moves forward with the CCSS adoption, there is a need to focus PD in the content areas in order to ensure that teachers fully understand what standards they are expected to teach and the best instructional practices to use when teaching those standards.

Definition of the Problem

Using the degree of elementary mathematics achievement of the students in the XYZ School District and the PD of their teachers as a guide, this project focused on identifying the current level of the elementary mathematics teachers' instructional knowledge and whether that level differs from school to school. One of the charges from the Strategic Plan is to use valid assessment data as a tool for targeting instructional support (XYZ School District, 2010). Another is to use student achievement data in order to differentiate instruction based on the students' readiness needs and learning styles. This project combined these two charges with a focus on teachers, not on students, using teacher assessment data regarding their knowledge level for teaching mathematics to differentiate the PD program for the teachers. Future studies can be conducted to determine if the PD program effects change in student achievement, but that goal was not a focus for this study.

The National Staff Development Council (2011) defined PD as having a "comprehensive, sustained, and intensive approach to improving teachers' and principals' effectiveness in raising student achievement" (para. 3). PD should include a review of data regarding teacher performance and have learning goals for the teacher that have been determined after analyzing data (Easton, 2008). This study provided data to assist in setting these goals.

Suggestions for more research on the PD needs of teachers are prevalent in the literature. The National Mathematics Advisory Panel (2008) listed seven suggestions within the category of Teachers and Teacher Education, with six of the seven suggesting more research in this area, including research on the effects of professional training on instructional practices and on student achievement. Research on "teacher expertise" is needed, and this research will help to change the current instructional practices in our schools (Wiliam, 2007, p. 201). More research is needed in order to understand the "complex interactions that make professional learning possible" (Bell, Wilson, Higgins, & McCoach, 2010, p. 481).

Many authors have made suggestions for PD, including the specific content that should be covered, the length of time required for real change to occur, and specific strategies and techniques that should be implemented (Bailey, 2010; Bell et al., 2010; Hill, Rowen, & Ball, 2005; National Staff Development Council, 2011; National Mathematics Advisory Panel, 2008). None of these authors offered suggestions regarding how to adapt the PD program to meet the needs of the specific teachers attending. Once the needs of our teachers are determined, at least at the school level, PD providers can adjust training schedules and content to meet those needs and training resources can be effectively allocated.

Rationale

Evidence of the Problem at the Local Level

The concerns regarding the PD needs of teachers stem from the issues surrounding the elementary mathematics achievement in the XYZ School District on the Nevada State Criterion Referenced Test (NV CRT). Given that the effectiveness of PD increases according to the content presented and the length of the program, there is a need to determine the exact content necessary and the methods required for delivering the content (Bailey, 2010; Ball, Hill, & Bass, 2005).

The NV CRT is one of the items used to determine whether a school or a district attained annual yearly progress (AYP) as expected by the education department's accountability model. The XYZ School District did not attain AYP goals in mathematics in middle school or high school for the 2009-2010 school year. The district did attain AYP in elementary school mathematics; however, the status in five categories was, "warning: status level below baseline" (Nevada Department of Education, 2010).

Students in Grades 3-8 take the NV CRT annually, and the questions on the NV CRT align with Nevada's content standards in reading and mathematics (Nevada Department of Education, 2011). Each district and school receives a rating using the results of the NV CRT. These results include ratings for five distinct racial/ethnic subgroups and three special populations. The special populations include students needing an individualized educational plan, students with limited English proficiency, and students who are economically disadvantaged. Determining if a school or district attained AYP is a complex process, which includes 37 different comparisons. Within the individual schools, only 45% of the 108 schools in the XYZ School District were classified as "high achieving" or "adequate" for the 2009-2010 school year. The expectation for the 2011-2012 school year was for 78.1% of students to score at the "proficient" or above category.

In addition to the determination of whether a school attained AYP, the Nevada Department of Education uses NV CRTs to categorize the students' achievement levels. The four achievement categories on the NV CRT are *emergent/developing*, *approaches standard*, *meets standard*, and *exceeds standard*.

1. Emergent/developing is used to describe a student who requires extensive remediation and does not apply the appropriate skills and strategies or may apply them occasionally,

2. Approaches standard, which describes a student who is inconsistent in use of the skills and strategies and requires a targeted intervention,
3. Meets standard, showing that the student uses the skills and strategies reliably and does not need remediation, and
4. Exceeds standard, which is used to identify students who are able to apply and generalize the skills and strategies to a range of conditions.

During the 2009-2010 school year, 4,984 third grade students participated in this assessment, and 28% of the third grade students fell into the two lowest achievement categories (Nevada Department of Education, n.d.). This percentage amounts to nearly 1,400 students who were not able to meet the minimum tested standards.

The results in other grade levels for the 2009-2010 school year were similar. In fourth, fifth, and sixth grades, 28.8%, 28.5%, and 25.3%, respectively, did not reach a level of meeting standards (Nevada Department of Education, n.d.). As students enter middle school, the results are even worse. In seventh grade, 30.3% of students do not meet standards, and in eighth grade, 42.8% are in the bottom two categories. In eighth grade, that percentage amounts to over 2,000 students who are not meeting the minimum standards in mathematics for their grade level, as determined by the NV CRT.

When looking at the NV CRT data from another perspective, there is yet another problem. In third grade, on the 2009-2010 NV CRT tests, 36% of the students scored in the highest category: exceeds standard. However, by eighth grade only 3.5% of XYZ School District's students are able to score in the category of exceeds standards. Also in eighth grade, only 26% of the student population chose to enroll in eighth grade Algebra and, of those, only 64% of the students were able to pass a credit-by-exam test, which allows them to earn high school credit during middle school (XYZ School District, 2010).

The XYZ School District has set a goal for the year 2015 of increasing the rate of participation in eighth grade algebra classes to 50%, with a secondary goal of increasing the pass rate on the credit-by-exam test to 85% (XYZ School District, 2010). The importance of increasing the eighth grade algebra participation and achievement rate cannot be underestimated. Students who complete Algebra II courses are more likely to go to college, more likely to graduate from college, and more likely to earn income in the top quartile (National Mathematics Advisory Panel, 2008). This fact is one of the reasons for the XYZ School District's goal of increasing the participation rate in eighth grade algebra. Another reason is to determine the intervention needs of the participating students so that teachers can provide interventions early on in order to ensure future success (The Education Alliance of XYZ, 2010).

The importance of this goal is reinforced in a district publication entitled *XYZ K-16 Data Profile: XYZ School District Graduates Attending UNR and TMCC* (University of Nevada, Reno and Truckee Meadows Community College), which includes the XYZ School District's 2010 Graduates (2010). This publication by the Education Alliance of XYZ addresses the results from two studies. The Education Alliance of XYZ is comprised of school district personnel, university researchers, and school board members. One study was conducted by a collaboration of the XYZ School District and two local postsecondary schools: the UNR and TMCC. This study focused on the transition between the K-12 XYZ School District system and collegiate level entry and the future success of the students. Seventy percent of the XYZ School District graduates attend the University of Nevada, Reno or Truckee Meadows Community College. The second study was a collaborative effort by the XYZ School District and WestEd. The school district used this study to inform the strategic planning efforts.

One of the connections made in the document published from these two studies, is the connection between eighth grade algebra and the remediation rate in mathematics at the collegiate level. The need to take remedial courses, at UNR and TMCC, is determined by the student's score on a college entrance exam, either the ACT or SAT. On the ACT, the student must have a score of at least 22 in order to opt out of remedial courses. Students who take algebra in eighth grade may raise their score on the ACT exam by four points as compared to students who take Algebra I in ninth grade (The Education Alliance of XYZ, 2010). These authors also state that students who take eighth grade algebra are more likely to take calculus in high school, and if a student takes calculus in high school, his or her chances of needing remediation in college is reduced 15 times. Nationally the remediation rate in college mathematics is 25.8% (Chen, Wu, & Tasoff, 2010). The local colleges have a much higher rate. At UNR, the rate is 46%, and at TMCC, the rate is 89% (The Education Alliance of XYZ County, 2010).

Another connection made in these two studies is the rate of college momentum. This rate of momentum is calculated using the following formula [(credits quintile * 10) + (grade point average * 12.5)], with a 100 point maximum. Students with greater academic momentum, those taking more credits and achieving higher grades, were found to have taken higher-level mathematics courses in high school. The differences between a student who only took lower level mathematics courses and a student who took calculus, is a 25-point jump in the academic momentum percentile score. The impact on the momentum scale of completing advanced mathematics courses in high school was found to be the greater in mathematics than in science, arts and humanities, and English. Students who took algebra in eighth grade were also more likely to return to UNR for their second year.

Evidence of the Problem at the National and International Level

After looking closely at the XYZ School District data, the data from across the nation and around the world shed even more light on the mathematics achievement concerns. These data come from the National Assessment of Educational Progress (NAEP), the Program for International Student Assessment (PISA), and the Trends in International Mathematics and Science Study (TIMSS). The NAEP, often called the Nation's Report Card, is an ongoing assessment given to a representative sample of students in the United States in fourth, eighth, and twelfth grade (United States Department of Education, 2010). NAEP chose these grade levels because they "represent critical junctures in academic achievement" (United States Department of Education, 2010, para. 3). Educators use this assessment to compare states and districts, as well as trends over time. On the NAEP 2009 fourth grade assessment, Nevada scored lower than 35 states, higher than eight states, and not significantly different from eight states (United States Department of Education, 2009). On the eighth grade NAEP 2009 assessment, Nevada scored lower than 39 states, higher than six states, and not significantly different from six states (United States Department of Education, 2009). In fourth grade, only 32% of the students in Nevada scored at the proficient or above level. In eighth grade, the results were even lower with only 25% of the students scoring proficient or above.

The international studies show the ranking of the United States on a global scale. The PISA assessment is given every 3 years and is focused on the achievement levels of 15-year-olds in reading, mathematics, and science (Fleischman et al., 2010). The Organization for Economic Cooperation and Development (OECD) is responsible for the administration and data analysis of the PISA. In 2009 the major focus of the PISA was reading, with a minor focus on mathematics and science. The 2009 PISA results in mathematics indicated that the United States ranked 17th out of 33 countries, with 11 countries having similar scores. On average 32% of students scored at or above a level of proficiency; however, in the United States, only 27% of students scored at this level. The average score in the United States was higher than on the 2006 PISA, but it was similar to the 2003 PISA. When looking at only the top performers on this assessment, the United States has only 7.7% of students reaching that level of achievement. This percentage is lower than the OECD average of 13% in the participating countries. The United States also has more students unable to reach a baseline mathematics level than the OECD average, 28% versus 21.3% (Fleischman et al., 2010).

Another international assessment, TIMSS, provides more of the picture of the mathematics achievements of our students. The TIMSS assessment has been given four times, in 1995, 1999, 2003, and 2007 (Gonzalez et al., 2008). Its focus is the mathematics and science knowledge level of fourth and eighth grade students in the participating countries. In fourth grade, the average U.S. student scored lower than students did in 8 of the 35 other countries. In eighth grade, there were five other countries with higher average scores. All of the countries with higher scores are in Europe or Asia.

Evidence of the Problem from the Professional Literature

In 2010, the U.S. Department of Education outlined five priorities for improving education in this country. The published document is *A Blueprint for Reform: The Reauthorization of the Elementary and Secondary Education Act*. In this next section, I frame the evidence of the need for higher quality mathematical instruction from the professional literature within these five priorities.

The first priority in the *Blueprint* (U.S. Department of Education, 2010) is to ensure that students leave school ready for college and career, regardless of their "income, race, ethnic or language background, or disability status" (p. 3). Included in this priority is the need to develop assessments, which better serve the needs of our educational system along with the assurance of a "well-rounded" educational system that enables our citizens to participate and prosper in our national and global economy (U.S. Department of Education, 2010 p. 25). The achievement level of our students in mathematics is a matter of "national concern" (Gersten et al., 2009, p. 4). According to the National Mathematics Advisory Panel, (NMAP; 2008) the United States is not currently achieving as an "international leader" (p. 3).

In order for citizens to be prepared for the future, they must now attain a higher level of mathematics achievement. In the past, higher level mathematics was limited to engineers and scientists, creating a situation where many citizens are unable to perform simple calculations. Currently, 78% of adults are unable to calculate the interest on a loan, 71% cannot calculate the miles-per-gallon for their car, and 58% are incapable of figuring out a 10% tip in a restaurant (National Mathematics Advisory Panel, 2008). This higher level mathematics is now considered to be basic. All of our citizens should be able to process quantitative information that they encounter in their daily lives.

Another focus area is the need to have effective teachers and principals in schools, to have the best educators in places where they are needed most, and to improve the current system for recruiting and preparing teachers (U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010). Schools must provide appropriate instruction that meets the needs of all learners, and teachers will need focused training in order to make that happen (U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010). Teachers will need training in order to understand their curriculum, and their responsibility to combine effectively the Nevada State Standards with the CCSS. They will also need help choosing, and effectively using, appropriate instructional resources. These resources will improve the quality of their teaching in a mathematics classroom, which is dependent upon how the teacher uses the curriculum and resources (Hill et al., 2008). Teachers will also need training in accurately identifying students with mathematical difficulties and in methods to prevent or mitigate those difficulties. The PD plans for the XYZ School District need to reflect these needs.

In addition to training teachers effectively, there is a need to find out what teachers know and how they use that knowledge. This study collected data on the mathematical knowledge for teaching (MKT) of the teachers who participated. According to the NMAP (2008), directly assessing the content and pedagogical knowledge of teachers can indicate a relationship to student achievement. Researchers have shown that increasing a teacher's MKT score improves the teacher's ability to provide high quality mathematical explanations, to locate and correct student errors, and to choose appropriate tasks (Ball, Thames, & Phelps, 2008).

The third priority set by the *Blueprint* is to ensure that all students have access to a curriculum that is rigorous and inclusive of all students. This curriculum must address the specific needs of all students, including those with language concerns, poverty issues, or disabilities. This curriculum must also maintain a high level of achievement throughout the years in school. Currently the achievement level of students in mathematics progressively worsens as the students get older. The level is lower in 12th grade than in eighth grade, and it is lower in eighth grade than in fourth grade, according to international assessments (National Mathematics Advisory Panel, 2008). This statistic is indicative of a gap in the various mathematical curricula used in the United States.

The fourth priority focuses on encouraging and rewarding excellence. One way to increase the chances that a student graduates with a bachelor's degree is to ensure that the student has had access to a high quality elementary and secondary curriculum. This approach has more of an effect on students' rate of success in college than their test scores, their class rank, and their grades (U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010). One way to increase the rigor of a mathematical lesson is to include cognitively challenging tasks. On the 1999 TIMSS video study, less than 1% of mathematics lessons included a high level of intellectual challenges, which can help the students to make connections (Charalambous, 2010). Another example of the low level of rigor in the mathematical instruction in the United States is the level of difficulty of the problems in the textbooks. In Singapore, one of the highest performing countries in mathematics, the textbook includes a higher quantity of difficult problems. A difficult problem requires that the student fluently use standard algorithms with automatic recall of basic computational facts. In addition, the student must have a deep conceptual understanding of the mathematical operations in order to choose procedures effectively. In the United States, the simple problems outnumber the challenging ones (National Mathematics Advisory Panel, 2008).

The final area of priority focuses on promoting improvement and innovation in schools. For example, in many of the higher achieving countries, the students are able to reach a level of fluency with addition, subtraction, multiplication, and division much sooner than children in the United States are. This area needs innovation in order to make changes in the frequency and the methods of practice and to adjust amount of emphasis required to ensure fluency (National Mathematics Advisory Panel, 2008).

Another area where innovation is needed is in changing the perception and definition of algebra. Many parents and teachers believe that algebra is two classes taken in middle and high school. In an effort to increase mathematical achievement, the teaching of algebra should begin in kindergarten and continue throughout the grade levels (Arbaugh et al., 2010). This approach was one of the areas of focus for this project.

Definitions and Acronyms

Annual Yearly Progress (AYP): The process for determining whether a school or district is making adequate progress towards ensuring that their students are achieving at an acceptable rate (Nevada Department of Education, 2011).

Common Core State Standards (CCSS): A set of standards for instruction adopted by the state of Nevada. The National Governors Association Center for Best Practices and the Council of Chief State School Officers developed these standards to “provide a clear and consistent framework to prepare our children for college and the workforce” (Common Core State Standards Initiative, 2010).

Item Response Theory (IRT): Used to present scale scores with equal intervals (Schilling, 2007).

Mathematical Knowledge for Teaching (MKT): A combination of subject matter knowledge and pedagogical content knowledge (Ball et al., 2008).

Mathematical Quality of Instruction (MQI): Includes the teachers’ ability to respond to students, to develop rich mathematics, to use mathematical language appropriately and frequently, to make connections, to teach without mathematical errors, and to teach students in an equitable manner (Learning Mathematics for Teaching Project, 2011).

Professional Development (PD): training which increases the effectiveness of teachers and administrators.

Significance

This study, which focused on increasing teachers' effectiveness in mathematics through PD, was significant because of the relationship of elementary mathematics to the future success of the students. A high quality mathematics education in elementary school increases the chances that students will be prepared to take algebra in eighth grade. This preparation, in turn, increases the likelihood that students will take higher-level mathematics in high school and the likelihood that they will go to college, and it also decreases the likelihood that students will need remediation upon entering college (Arbaugh et al., 2010; Gersten et al., 2009; National Mathematics Advisory Panel, 2008; The Education Alliance of XYZ, 2010). Part of the preparation for ensuring that students are able to enter eighth grade algebra is to ensure that their algebraic instruction begins in kindergarten and continues throughout their elementary school years. Given that the "primary determinant" for the rate of student success is the quality of the instruction, it is imperative that teachers are prepared to meet this need (U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010, p. 13).

In addition, Ball, Hill, and Bass (2005) found that the teachers of higher risk students scored lower on MKT tests. If this situation is the case in XYZ School District, then the PD providers can adjust the PD plan to address that need. This state will contribute to the need for a comprehensive PD plan as suggested by the National Staff

Development Council (2011). Zambo and Zambo (2008) found that individual teachers improve their teaching skills through PD opportunities.

Guiding and Research Questions

The research questions for this study addressed the PD needs of the teachers in the XYZ School District. In order to increase the level of mathematics achievement in middle school and high school, there is a need to improve the foundational skills that the students gain in elementary school. One way to improve skills is to provide focused, effective PD for the teachers in the elementary schools. The National Staff Development Council describes effective PD as that which ultimately increases student achievement (National Staff Development Council, 2011).

The research questions for this study were as follows:

1. What are the current PD needs of elementary mathematics teachers in the XYZ School District?
2. What is the relationship between the mathematical knowledge for teaching (MKT) and the socioeconomic level of the school in which the teacher is currently working?
3. What is the relationship between the mean MKT score of the teachers of a particular school and whether or not the school makes AYP?

I developed the second question because of the size of the school district. There are 63 elementary schools that all may have different PD needs. These 63 schools have been sorted into four categories according to their socioeconomic level in an effort to allocate resources appropriately. Much of the PD in which the teachers are involved in happens at the school level after being planned at the district or state level. Each school, or category of school, may have individual needs in order to ensure that effective instruction in mathematics is occurring daily.

Within the AYP data of these 63 schools, an equity issue arises. The XYZ School District did make AYP in mathematics overall (Nevada Department of Education, 2010). However, five categories were listed as *Warning: Status Below Baseline*. These categories are Hispanic/Latino, Black/African American, students on individualized education plans, limited English proficiency, and free/reduced lunch students. The students in these categories, who are not able to reach a proficient level, were the reason for using the equity categories in the second research question. This project attempted to address the poor and minority achievement gap as suggested by Heck (2007), while also addressing what Wagner (2008) calls the “global achievement gap.” Addressing this gap will increase the district’s standing on the international assessments and in the global economy.

Review of the Literature

In reviewing the available literature, several themes emerged about the topic of improving elementary mathematics instruction, the relationship of high quality instruction to student achievement, and the PD of teachers, including the theory of adult learning. I reached a saturation of studies in the literature review using the following key words: *education reform*, *elementary mathematics*, *teaching quality*, *teaching effectiveness*, *student achievement*, *instruction*, *effectiveness*, *content knowledge*, *pedagogy*, *andragogy*, *teacher training*, *policy*, *teacher qualifications*, *mathematics equity*, *PD*, and *social reform*. I discuss four themes in this section. The first theme is the theoretical framework of adult learning theory. The second theme is educational reform in mathematics, which contains a discussion of the CCSS initiative, equity, and social justice. The third theme focuses on teacher preparation, employment, and retention. Quality instruction in mathematics and teacher content knowledge encompass the last theme.

Theoretical Framework

The theoretical framework for this study is adult learning theory. There are many different formats in education where teachers are the focus of the learning. PD as defined by the National Staff Development Council (2011) is "a comprehensive, sustained, and intensive approach to improving teachers' and principals' effectiveness in raising student achievement" (para. 3). Using this definition, PD can take many forms: stand-and-deliver, coaching, mentoring, professional learning communities, and staff development. Each format of PD is focused on raising student achievement by increasing the knowledge base of the adults in the school.

Researchers have developed adult learning theory over many decades as attempts to define the ways that teaching adults differs from teaching children. Knowles et al. (2005) traced the term andragogy back to 1833 when it was used to describe Plato's work. Knowles began using this term in 1967 and spent several decades furthering the theory of andragogy. Current adult learning theory is based on the foundation put down by Lindeman in 1926, which focused on a set of assumptions including the way that learning for adults is centered in their experiences and the need for adults to be self-directing (Aderinto, 2005; Knowles, Holton, & Swanson, 2005). Adults use their experiences to guide their learning; they are not able simply to study a subject without knowing how it will be useful in their lives.

There is a recent change in the work of pedagogical and andragogical theory. There is an overlap between the two, and no longer is one assigned to children and the other to adults (Brown, 2006). Knowles, Holton, and Swanson (2005) suggested that pedagogy involves teaching and andragogy involves helping others to learn. Using this definition allows some flexibility between the two. Knowles et al. (2005) unidentified six principles that make up the andragogical theory, each of which can apply to children or adults. They are as follows:

- need to know,
- learner self-concept (self-directed),
- learner's experience,
- readiness to learn (life tasks),
- orientation to learning (problem centered), and
- motivation to learn (internal).

An andragogical perspective coincides with Thames and Ball's (2010) suggestion that PD should focus on actual mathematical situations that come up in a classroom. This approach helps teachers to explore a subject that has a connection their lives. Professional knowledge improves according to the length of the PD and the focus of the PD curricula. PD in mathematics that emphasizes explanation, communication, and representations has had a greater impact on teacher learning (Ball et al., 2005; Hill & Ball, 2009). Bailey (2010) studied the use of a standards-based PD program. Effective

PD is most important for the teachers who score in the bottom third on an MKT test (Hill et al., 2005). Unfortunately these teachers are the least likely to choose to attend PD in mathematics. This problem suggests a need to provide teacher incentives for attending PD as a motivation strategy. These incentives may include payment for their time, classroom books and materials, or release time from their teaching assignment.

A report written by the National Council of Teachers of Mathematics (2010) suggested that there is a great need to link the research base with teachers and school administrators. This report outlined 25 questions for researchers to study that would help to inform the day-to-day decisions made by practitioners. Several of the 25 questions apply directly to this study, and one question focuses its attention specifically on professional learning in teachers: "What should be the goals of professional learning, and how will we measure attainment of these goals in terms of teacher growth?" (Arbaugh et al., 2010, p. 52).

If researchers are able to answer this question, professional developers would know what to emphasize in their trainings. There would also be a greater understanding of what it means to be an effective teacher of mathematics and the required level of mathematical content knowledge for teaching. Teacher trainers, teacher leaders, mentors, and coaches would have a more focused agenda that address the day-to-day tasks teachers face (Hill, 2010).

In June 2010, a joint task force was formed to respond to the release of the CCSS (Joint Task Force on CCSS, 2010). This task force included members of the National Council of Teachers of Mathematics, the National Council of Supervisors of

Mathematics, the Association of Mathematics Teacher Educators, and the Association of State Supervisors of Mathematics. This task force offered recommendations and areas in which they could support the implementation of the CCSS. One of the goals presented calls for raising the capacity of teachers by planning PD that includes the effective use of the mathematical practices. The intended outcome of this goal is to raise the MKT of teachers. While there is a need to improve preservice teacher education programs, this study focused on inservice PD only.

The Joint Task Force also suggested differentiating PD for teachers according to their experiences and their knowledge levels. Using Sousa and Tomlinson's (2011) definition, differentiation requires the careful selection of content and the understanding that learners need to be educated as individuals with individual learning styles, levels of readiness, and interests. Using a differentiation framework and andragogical theory, when trainers are planning and conducting PD, the "nature of each individual adult" can be considered (Aderinto, 2005, p. 141).

Mathematics Reform

The NMAP (2008) report described the background for the current mathematics reform efforts. The ability of the nation to compete globally is, in part, dependent upon its capacity to "deal with sophisticated quantitative ideas" (p. 1). This report maintained that the responsibility to ensure our mathematical success lies with all of us, including researchers, teachers, community members, curriculum developers, textbook publishers, politicians, assessment developers, teacher trainers, and school administrators.

Among the concerns described in the NMAP (2008) report are the inequalities in student achievement in mathematics related to the students' race and economic level. One of the priorities is to ensure that all students graduate from high school ready for college and a career regardless of their income level, race, ethnicity, or first language.

More than half of the 63 schools in the XYZ district are considered high risk according to their socioeconomic level. Children from lower socioeconomic families tend to enter school at a disadvantage, and then they "fall further and further behind" (Ball et al., 2005, p. 44). One way to address this issue is to ensure that our teachers are prepared with the mathematical content knowledge that they need (Hill et al., 2005). Ball et al. (2005) found that the teachers of higher poverty students tended to have lower mathematical knowledge. In their study of over 600 teachers, the higher knowledge level teachers tended to teach at schools where there are fewer disadvantaged students. According to the U.S. Department of Education (2009), the best teachers should be teaching the most at-risk students. In order to address issues with mathematical equity, educators need to ensure that all of their students have access to high quality teachers (Hill, 2010). Raising the MKT of all of teachers would be another way to address equity issues (Hill & Lubienski, 2007). This approach could ensure that every student receives a high quality education.

Gutierrez (2010) offers an additional idea to this dilemma. If only an "achievement gap" lens is used, specific needs of our at-risk students are not recognized by educators (Gutierrez, 2010). Supporting these students requires attention to the uniqueness of each student and understanding about the diverse issues that many face.

Educating teachers and administrators in diversity would help schools meet the needs of disadvantaged students (National Council of Teachers of Mathematics, 2003).

Along with addressing equity needs, another suggestion from NMAP is the development of a “focused, coherent progression of mathematics learning” (National Mathematics Advisory Panel, 2008, p. xvi). One response to this suggestion is the development of the CCSS initiative (Beckmann, 2011). Schmidt, Houang, and Cogan (2002) suggested an implementation of a common standards initiative as a method for improving the standing of the United States on international assessments.

Although some argue that the CCSS is unnecessary and will not guarantee that our international standing will improve, 42 states have adopted them (CCSS, 2011; Usiskin, 2007). These standards are not simply a reduction in the number of standards but a “more focused” attempt to improve the mathematical abilities of our citizens (Common Core State Standards Initiative, 2010).

The CCSS documents list the specific skills, knowledge, and habits of mind that students should gain as they travel through the K-12 educational system (Common Core State Standards Initiative, 2010). The standards are rigorous and require the use of higher order thinking skills to master them. They were developed using research based mathematical learning trajectories, evidence from previous standards in a variety of states, and evidence from top performing countries around the world.

Within the CCSS are the eight “Standards for Mathematical Practice” that combine the process standards written by the National Council of Teachers of Mathematics and the strands of proficiency written by the National Research Council

(Common Core State Standards Initiative, 2010). These practices inform mathematical instruction at all levels in order to reach a higher level of expertise. They include the following:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

These eight mathematical practices are intended to help the students engage with the mathematical content on a deeper level (Common Core State Standards Initiative, 2010). If students are able to connect their lives to the mathematics they are learning, their achievement levels tend to be higher (House, 2004). Students need a reason to learn mathematics (Hopkins, 2007). Learning mathematics for the sake of doing mathematics in school is simply not enough to motivate students to learn. Once students learn a concept or skill, they can make connections from that skill to other problem solving situations (Wu, 2009). For example, once students understand that the standard algorithms for whole numbers are simply a "sequence of single-digit computations" put together, they will be better prepared to learn algebra and higher-level mathematics (Wu, 2009, p. 5).

Teacher Preparation and Certification

As the United States moves forward with an educational reform agenda, there is a need to determine the best way to prepare teachers, to evaluate teachers, and to retain the most effective teachers. One of the policy changes recommended by NMAP (2008) is to find methods for effectively preparing the teaching force and to evaluate and retain the most effective teachers. The research base for empirical studies of effective teacher preparation programs is very limited (National Mathematics Advisory Panel, 2008).

In a study that compared teacher preparation programs in 16 different countries, the researchers concluded that teachers in the United States are "getting weak training mathematically" (The Center for Research in Math and Science Education Michigan State University, 2010, p. 1). In order to compete on an international scale, there needs to be improvement in teacher preparation programs to include more courses in formal mathematics and fewer courses in overall pedagogy that is not mathematically focused.

This study also emphasized the need to "break the cycle" of low mathematical achievement (The Center for Research in Math and Science Education Michigan State University, 2010, p. 3). Schools are not fully preparing students to compete mathematically on an international scale. These same schools, which have a less demanding curriculum, are preparing future teachers to teach mathematics. Internationally the top performing countries expect 90% of their teachers to take courses in linear algebra and calculus (The Center for Research in Math and Science Education Michigan State University, 2010). In the United States, only 66% of teachers take these courses, which then provide them with the opportunity to take even more advanced mathematics courses. Future elementary school teachers start out behind mathematically and end up behind in their mathematical pedagogy, yet they are still certified to teach upon completing their program of study and passing the required state tests.

In the past, districts faced with a shortage of certified teachers recruited and hired noncertified teachers (Kane, Rockoff, & Staiger, 2007). This practice is not common now because of the requirements of No Child Left Behind and the state laws that followed (Kane et al., 2008). Teachers in the United States gain certification to teach using one of two paths. Some follow a traditional path to certification by completing university programs intended for future teachers. Others are certified to teach in an alternative manner. These teachers generally hold a bachelor's degree, pass the required state tests, and then take classes in education during their first few years of teaching (Kane et al., 2007). Student achievement in the classroom has not been empirically linked to the certification path taken by the teacher (Kane et al., 2008). If certification alone does not determine teaching effectiveness and teacher preparation programs are in need of major improvements, the aspects of teaching that are directly related to student achievement and how educators can influence those aspects should be investigated in order to better serve the needs of students.

Teaching Quality

Although many school districts collect data at the time of hire, often this is simply a method for ensuring that they follow state laws and that they can find a starting place for the teacher's salary (Rockoff, Jacob, Kane, & Staiger, 2008). The quality of the instructional capabilities of the teacher is difficult to determine. In addition to teacher characteristics such as preparation and licensing, Heck (2007) included classroom effectiveness and its impact on student learning in the definition of teacher quality. Heck (2007) found that high quality teachers effect an increase in student achievement in mathematics, and they are better able to reduce the achievement gap between students of differing backgrounds.

Teachers in the United States vary greatly in their mathematical skills needed for teaching, and teachers with deficient skills are more likely to make mistakes and present lessons in a way that is confusing for students (Hill, 2010). The NMAP report (2008) recommended that research be conducted in order to determine the specific "skills and practices" that teachers need in order to improve student achievement (p. xxi). Although many studies have tested the general mathematical knowledge of teachers, a growing body of research is focusing on the mathematical knowledge needed by teachers in order to be effective in the classroom (Ball et al., 2005; Charalambous, 2010; Hill, 2010; Hill, Dean, & Goffney, 2007).

The importance of this research cannot be underestimated. The level of achievement reached by students with high quality teachers is considerable when compared to those students who have lower functioning teachers (National Mathematics Advisory Panel, 2008). Student scores may differ by as much as 12 to 14% during one year in elementary school. There may be as much as 10-percentile points gained in the achievement level of a student with a high quality teacher. There is consensus among many researchers that the relationship between the teachers' MKT and the level of student achievement acquired is strong (Ball et al., 2008; Charalambous, 2010; Hill, 2010; Hill et al., 2005; National Mathematics Advisory Panel, 2008; Thames & Ball, 2010).

In the late 1980s, Shulman (1986) and colleagues investigated the notion of a specialized knowledge that is necessary for teaching. This knowledge is broader than the knowledge held by the public; it is unique to the teaching profession (Ball et al., 2008). For example, a first grade teacher may know that half of a dozen eggs is six, but she may not know how to best represent this fraction using an area, line, or set model, or she may not understand the common misconceptions that students have about fractions. NMAP (2008) suggested replacing the tests that are simply a proxy for mathematical knowledge with a test specific to the knowledge needed to teach mathematics. In a yearlong study in Germany, Baumert et al. (2010) found that general content knowledge, knowing the math, is not as effective as pedagogical content knowledge in predicting student achievement. There is a distinct difference between knowing mathematics and knowing how to teach mathematics.

Pedagogical content knowledge in mathematics is difficult to define; however, there are several aspects that are prevalent in the literature (Ball et al., 2008). Teachers need to be able to identify, understand, and correct student misconceptions. They must be able to do this during their lesson in order to help the student move forward. Teachers must know why procedures work, how to explain the concepts, and how to use mathematical vocabulary appropriately. Teachers use this special knowledge when choosing tasks for students to complete, when facilitating classroom discourse, and when grading and commenting on student work. It is especially important that teachers are able to make connections to the previous mathematics learning of the students and to the future learning requirements they will face (Ball et al., 2005; Ball et al., 2008).

In an effort to develop an instrument to assess this knowledge in teachers, the Learning Mathematics for Teaching Project at the University of Michigan, began writing multiple-choice questions to test the MKT construct. This assessment includes questions on choosing appropriate representations, on understanding mathematical misconceptions, and on understanding unconventional solutions made by students (Hill & Ball, 2009).

The MKT assessment has been used in many research studies. In a large study using a sample of 625 teachers, Hill (2010) found a weak connection between the background of the teacher and the MKT scores. There was a modest relationship between the MKT score and the number of years the teacher had been teaching. Hill found a stronger relationship between the MKT scores and the achievement level of their students. Hill et al. (2005) found that the MKT level of the teacher could be used to predict gains in student achievement in first and third grades. These authors suggested that even in the very early mathematics instructional stages, the knowledge base of the teacher can have an important effect. In this study, one standard deviation in MKT score translated to a one-tenth standard deviation in the achievement level of the students. This number is equivalent to 2 to 3 weeks of extra instructional time.

In another study, Hill et. al. (2008) were able to show an association between the MKT scores of the teachers and the mathematical quality of their instruction based on observational data. The focus of this study was to observe the influence of MKT on several aspects of instruction. The quality of the instruction was assessed using a detailed rubric to score the instruction on the use of mathematics vocabulary, errors present, the quality of the responses to students, the use of representations, and the connections made during the lesson. The level of knowledge for teaching in mathematics "affects what is taught and how it is taught (Zodik & Zaslavsky, 2008, p. 167). In a study of novice teachers, Rowland (2008) examined how the teachers used their mathematical knowledge in their lesson plans and instruction. One construct that was prevalent in this study was the choice and use of examples. Another researcher found that studying the creation of examples in mathematics can help teachers to increase their own MKT (Zodik & Zaslavsky, 2008). Finding a way to increase the MKT is of the utmost importance.

Implications

There are many implications for this study. After collecting and analyzing the data, XYZ School District could design and implement a focused PD plan. This plan would focus on the PD needs of the teachers as determined by the outcomes on the MKT evaluations. These evaluations help to determine what teachers already know and how they are able to use what they know.

The goal of any PD is to increase the knowledge level of the teachers in order to improve student achievement (National Staff Development Council, 2011). The goal of PD in mathematics is to increase the teachers' knowledge of content, student learning, effective instruction, and assessment (National Council of Teachers of Mathematics, 2003). This PD should include examples of high quality teaching, time for reflection on practice, collaboration, and time to build a long-term plan. Sustained PD, which focuses on standards along with communication and representations, improves student achievement (Bailey, 2010; Hill & Ball, 2009). Bailey (2010) found that the MKT scores of teachers can be increased with careful attention to PD program features, including content, and effective facilitators

The PD plan needs to be specific to types of schools if the results show that there is a relationship in the MKT scores and the type of school, in the XYZ School District. For example, Ball et al. (2005) found an inequality in the MKT scores of teachers in high poverty schools. If this situation is the case in the XYZ School District, the PD plan may need to focus on those schools with more intensity. By increasing the MKT of the teaching force, student achievement will increase positively (Hill et al., 2005).

The results may also suggest a need for PD for the administrators of the schools. They may need more training in how to support their teachers as their teachers work to improve their MKT. Another possible focus for the administrators may be a plan for determining the specific needs for the school. This plan may include training in the use of observation tools for observing mathematics lessons.

Summary

This study took place in the XYZ School District in Nevada. This district has 63 elementary schools and has recently developed a strategic plan outlining the vision as the district moves forward for the next few years (XYZ School District, 2010). This study focused on several objectives within this plan: student academic success, highly effective personnel, and a culture of collaboration within and across departments.

The problem of focus in this study was the need to improve the student achievement levels in elementary mathematics (Nevada Department of Education, n.d.). In third grade, almost 1400 Nevada students are not achieving the minimal standards in mathematics. By eighth grade, this increases to almost 2000 students. Currently only 26% of XYZ School District eighth grade students enroll in algebra courses. There is a solid research base showing that completing algebra in eighth grade improves the chances of going to and succeeding in college (National Mathematics Advisory Panel, 2008; The Education Alliance of XYZ, 2010). Taking algebra in eighth grade also reduces the need for remediation upon entering college and increases the momentum of staying in college.

One method for addressing this problem is to increase the MKT in the teaching force (Hill et al., 2005). Determining the knowledge that teachers have and how they use it will allow understanding if there are equity issues in schools as was found in Hill et al. (2005). The quality of instruction that students receive is an important factor in the rate of success for students (U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010).

In the next section, I describe the exact method used for obtaining the necessary data. This section includes information on the methodology, the study sample, the process for reviewing the data, the results, and suggestions for future study. This section is followed by the project I developed after analyzing the results along with my final conclusions and reflections.

Section 2: The Methodology

Introduction

The positive link between MKT and student achievement warrants more research on the MKT level in the teaching force and the way that MKT level is used in classrooms (Hill et al., 2008; National Mathematics Advisory Panel, 2008). Alonzo (2007) explained that teaching requires a “definable body of knowledge for teaching which goes beyond simple understanding of the content to be taught” (p. 136). Teachers have many tasks to complete when teaching mathematics, even at the elementary level. In addition to interpreting student work and analyzing discourse, they must be able to choose appropriate examples, representations, and models (Ball, 2003). In order for teachers to plan their lessons, they must be able to assess their students’ knowledge levels and identify, often in advance, the misconceptions the students may have.

This study utilized a pragmatic approach, a format often used by researchers to solve a problem in education (Lodico, Spaulding, & Voegtle, 2010). In order to determine the PD needs in elementary mathematics in XYZ School District and the equitable distribution of those needs, I collected two types of data in this quantitative correlational study. The first was an online check of the MKT among the participants. The second was a simple survey to collect information about the professional history of the participants, including the number of hours of training they have attended. These data provided a clearer picture of the MKT level without using proxy sources, such as the number of mathematics courses taken or the path to certification utilized. In this section, I present the methodology, sample, and data collection procedures.

Research Design

This study focused on a deductive quantitative methodology using two instruments that provide numerical data, which I then statistically analyzed. The instruments included a short survey and an online assessment of MKT. The specific design for this study was nonexperimental, descriptive correlational methodology. No discussion of causality is included. This type of study was appropriate given that I used the data to describe a statistical relationship between the variables, and, where a relationship was found, determined the strength of that relationship (Lodico et al., 2010). Following an explanatory correlational design, I collected the data at a single point in time and analyzed the scores from the participants as a single group. As suggested by Lodico, Spaulding, and Voegtle (2010), I collected information about the variables, but I did not manipulate or control them.

Using the research questions as a guide, I developed the following hypotheses:

H_0: There is no relationship between the mathematical knowledge for teaching and the socioeconomic level of the school in which the teacher is currently working.

H_1: There is a relationship between the mathematical knowledge for teaching and the socioeconomic level of the school in which the teacher is currently working.

Setting and Participant Selection

The setting for this study was the XYZ School District. The sample population included all of the current elementary school teachers in the district, whose job description included teaching mathematics. Using four categories of elementary schools, as defined by the district, I chose 12 schools using a cluster random selection process. The four categories of schools were determined using data on the number of students who qualify for the free/reduced lunch program, the number of students who are English language learners, and the Title I status of the school. The categories are:

- Low risk (15 schools)
- Moderate risk (12 schools)
- Challenge (14 schools)
- Title I (22 schools)

Although the number of schools in each category is not equal, randomly choosing three schools from each category ensured that the four categories had equal representation. I did not include schools with fewer than 300 students in order to ensure a larger sample size in the participating schools. There was one school from each category with fewer than 300 students, and I excluded these four schools from this study.

Out of the 12 randomly selected schools, four refused participation. I replaced these four by four other randomly selected schools so that the total number of schools did not decrease. Of those four schools, two refused participation and were also replaced. Teachers from the 12 participating schools attended a short presentation of approximately 15-30 minutes. This presentation included information about the study and offered the teachers the opportunity to take part in the online MKT portion of the study and in the survey. Only regular education teachers currently teaching Grades 1 through 5 were included. Descriptions of the MKT instrument and the survey are in the next section.

Instrumentation

This project utilized two instruments. The first was a short survey of the professional history of the participants. The second was an online assessment of the MKT level of the participating teachers. The Learning Mathematics for Teaching Project at the University of Michigan developed this instrument. I attended required training on this instrument in October 2010 at Harvard University. Although the MKT assessment included several mathematical topics, for this study I used assessments from two topic areas:

- number concepts and operations (MKT NCO) and
- patterns, functions, and algebra (MKT PFA).

I chose these areas in order to represent the most common topics in elementary mathematics education and to represent the focus areas of the CCSS (Common Core State Standards Initiative, 2010; Hill et al., 2005; Schilling & Hill, 2007). Teachers used an online assessment system to complete the MKT assessment. I gave each consenting teacher an access code for the system after getting informed consent. The assessment took approximately 30-60 minutes to complete.

Former teachers, professors of mathematics, professional developers, and mathematicians all assisted in the writing of the MKT instrument (Hill et al., 2005). The focus of the writing was to use scenarios that teachers face in real classrooms, including common mathematical knowledge and the knowledge specifically needed for teaching mathematics, which the authors call "specialized content knowledge" (Hill et al., 2005, p.

387). The intention was to develop questions that test the unique knowledge that teachers of mathematics should have. This focus differs from the mathematical knowledge that teachers may gain in college mathematics classes or their overall mathematical skill. For example, one of the released items displayed three samples of student work on a multidigit multiplication problem. Each of the samples arrived at the same answer, but the algorithm used was different for each. The question for the teacher was, "Which of these students would you judge to be using a method that could be used to multiply any two whole numbers?" (Hill et al., 2005, p. 402). One of the terms of using this instrument is to refrain from sharing the actual items in any publication. Therefore, the instrument is not included in this document. However, many of the released items that are no longer included in the test are presented in Appendix D.

The authors of the MKT assessment found it reliable and valid. To determine reliability, they developed multiple forms, which is consistent with the recommendations from educational research experts (Creswell, 2008; Lodico et al., 2010). The MKT instrument has an estimated person-reliability of 0.91 (Hill, 2010). The authors also used many procedures to validate their instrument. The questions were reviewed by internal and external sources, each of which included mathematicians. They also conducted interviews with participants in order to understand why they made the answer selection that they did to determine if the answer chosen was consistent with the reasoning the participant used. The researchers then developed another instrument, the MQI rubric, to correlate the MKT scores with actual instructional practices that occur in the classrooms of the participants (Hill et al., 2008). Content validity checks have also been conducted on the MKT instruments to ensure that the items measure what they are intended to measure. The MKT instrument uses Item Response Theory (IRT) to produce scores with equal intervals and to determine the reliability of .88 for this measure.

Data Collection and Ethical Considerations

There were two phases of data collection for this study. After selecting the 12 participating schools, I conducted a short presentation to the teaching staff at each school. This presentation included information about the purpose of the study, some background information about MKT, and the procedures for this project. The specific procedures addressed were the informed consent process, the confidentiality coding process, the MKT online assessment and survey, and the methods for reporting the results.

In February of 2011, I completed a National Institutes of Health course on protecting human research participants. The informed consent form and the procedures used in this study follow the guidelines set forth in this course. The informed consent form for this study included a statement of anonymity, some background information on the topic of MKT, and the specific procedures for data collection. This form also included the Institutional Review Board approval number 01-31-12-0024532 from Walden University. I informed the participants of the voluntary nature of this study, the low level of risk involved, and the possible benefits for the participant and the researcher. I gave participants my personal contact information should they have questions or change their minds about participating. In addition to these topics, the developers of the MKT instrument provided a statement of the use of their instruments. This statement ensures that these instruments are not to be used "to evaluate individual teachers for tenure, pay, hiring, or any other purpose with high stakes consequence" (Learning Mathematics for Teaching [LMT] Project, 2010, p. 2).

After this presentation, I asked the teachers to fill out a short questionnaire regarding their use of the XYZ School District elementary mathematics program, their recent PD participation in elementary mathematics, and the number of years they have taught at their current school. I also gave each participant a website address, a project code, and an individual code for logging on to the website to take the MKT assessment. This individual code ensured that their personal information was not included in any reports from the website. The teachers used the Teacher Knowledge Assessment System (TKAS), which is an online assessment system for the MKT. This approach not only sped up the scoring process but also allowed the teachers to take the assessment at a time convenient for them and standardized the administration of the test.

Table 1 shows the participation rate of each of the twelve schools. There were 203 possible participants, 134 surveys returned, 44 completed MKT PFA, and 42 completed MKT NCO.

Table 1
Participation by School

School Code	Code	Possible Participants	Surveys Returned	TKAS sign in	MKT PFA Completed	MKT NCO Completed
Low Risk 1	LR1	16	4	2	2	2
Low Risk 2	LR2	19	15	2	2	2
Low Risk 3	LR3	20	8	5	2	2
Moderate Risk 1	MR1	18	6	7	7	7
Moderate Risk 2	MR2	20	14	5	5	4
Moderate Risk 3	MR3	18	16	4	3	3
Challenge 1	C1	10	8	1	1	1
Challenge 2	C2	18	15	6	6	6
Challenge 3	C3	18	14	4	4	3
Title I 1	T1	19	17	3	3	3
Title I 2	T2	10	5	2	1	1
Title I 3	T3	17	12	8	7	7
Unknown School				3	1	1
Totals		203	134	49	44	42

Note. TKAS = Teaching Knowledge Assessment System; MKT PFA = Mathematical Knowledge for Teaching Patterns, Functions and Algebra; MKT NCO = Mathematical Knowledge for Teaching Number Concepts and Operations. Unknown School = participants entered a code that was not recognized.

Table 2 shows the participation rate of each school category. Schools in the Challenge category had the highest participation rate on the survey (80%). Schools in the Moderate category had the highest participation rate on the MKT PFA and on the MKT NCO (29% and 27% respectively). Schools in the Low Risk category had the lowest overall participation rate (Survey = 49%, MKT PFA = 11%, MKT NCO = 11%).

Table 2

Participation by School Category

School Category	Possible Participants	Surveys Returned	Survey Participation %	MKT PFA Completed	MKT PFA Participation %	MKT NCO Completed	MKT NCO Participation %
Low Risk	55	27	49%	6	11%	6	11%
Mod. Risk	56	36	64%	15	29%	14	27%
Challenge	46	37	80%	11	24%	10	22%
Title I	46	34	74%	11	24%	11	24%
Unknown Category				1		1	
Total	203	134	66%	44	22%	42	21%

Note. TKAS = Teaching Knowledge Assessment System; MKT PFA = Mathematical Knowledge for Teaching Patterns, Functions and Algebra; MKT NCO = Mathematical Knowledge for Teaching Number Concepts and Operations. Unknown School Category = participant entered a code that was not recognized.

Data Analysis

The purpose of this correlational study was to determine if a relationship existed between the MKT score of the teacher and the current teaching assignment of the teacher. The data collection resulted in nominal data for the type of school and interval data for the MKT. There were also separate variables included in this study, simply because of the setup of the TKAS program. The TKAS program uses the data collected from other research projects as part of a larger, meta-analysis study. In addition to providing an IRT equivalent score for each of the participants, the system provided details from the survey about the past mathematical training of the teachers, their confidence level about teaching math, the instructional focuses in mathematics in their classroom and various demographic information. I transferred all of these results into SPSS software in order to conduct further statistical tests.

Descriptive Statistics

In reporting descriptives, it is important to note that the sample size for the main data set and the subset were quite different, with certain variables not available for both sets. For the main data set, the short survey ($N = 134$), I established the following variables:

- percentage of time the Everyday Math series is used during math instruction,
- the number of hours of training the teachers have participated in during the past five years,
- the number of years they have been working at their current school,
- their school's AYP status, their school's category, and
- whether or not they chose to take the MKT online assessment.

For the subset of teachers who competed the MKT online assessment as well as the survey ($n = 44$), the following variables were available in addition to those previously listed:

- gender ($n = 44$, female = 35, male = 5, unknown = 4),

- race/ethnicity (*n* = 44, White, not of Hispanic origin = 40, missing data = 4),
- the years they have been teaching mathematics,
- the grades levels taught in the past year (See Table 3),
- the focus of mathematics instruction in their classroom,
- their thoughts about the MKT assessment,
- their confidence level in teaching mathematics, and
- their scores on the MKT PFA (*n* = 44) and the MKT NCO (*n* = 42).

Table 3 shows the grade levels the participants have taught in the past year. Only one teacher taught above the fifth grade level. Those teaching K-2 and 3-5 were almost evenly split.

Table 3
Grade Levels Taught in the Past Year

		Frequency	Percent
	K-2	19	39.5%
	3-5	18	37.5%
	6-8	1	2.0%
	9-12	0	0.0%
Missing		10	20.8%
Total		48	100.0%

Note. More than one selection was possible.

Figure 1 shows a comparison of the four school categories between the entire sample (*N* = 134) and the subset of teachers who completed the survey and the MKT online assessment (*n* = 44).

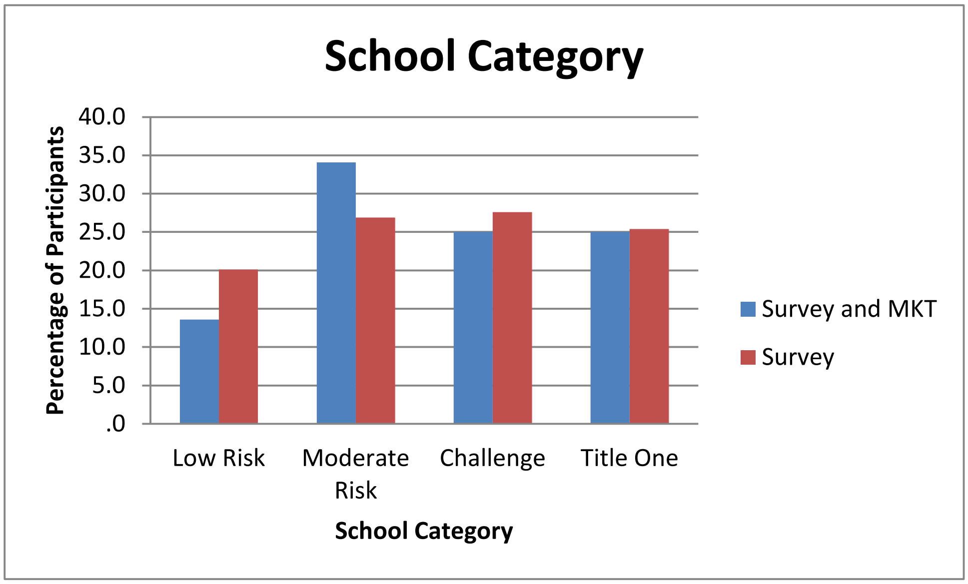


Figure 1. Bar graph showing the school category by the entire sample and the subset.

Figure 2 shows a comparison of the AYP status between the entire sample (N = 134) and the subset of teachers who completed the survey and the MKT online assessment (n = 44).

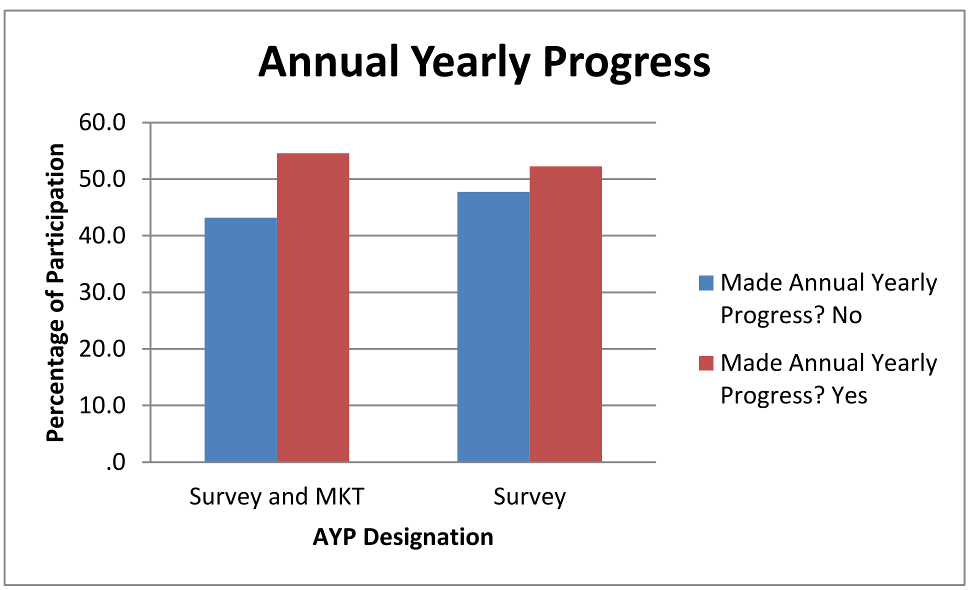


Figure 2. Bar graph showing the entire sample and the subset by the annual yearly progress status.

Figure 3 shows the entire sample (N = 134) and the subset of teachers who completed the survey and the MKT online assessment (n = 44) categorized by the number of years they have taught at their current school. Most of the teacher participants had taught at their current school for five or more years.

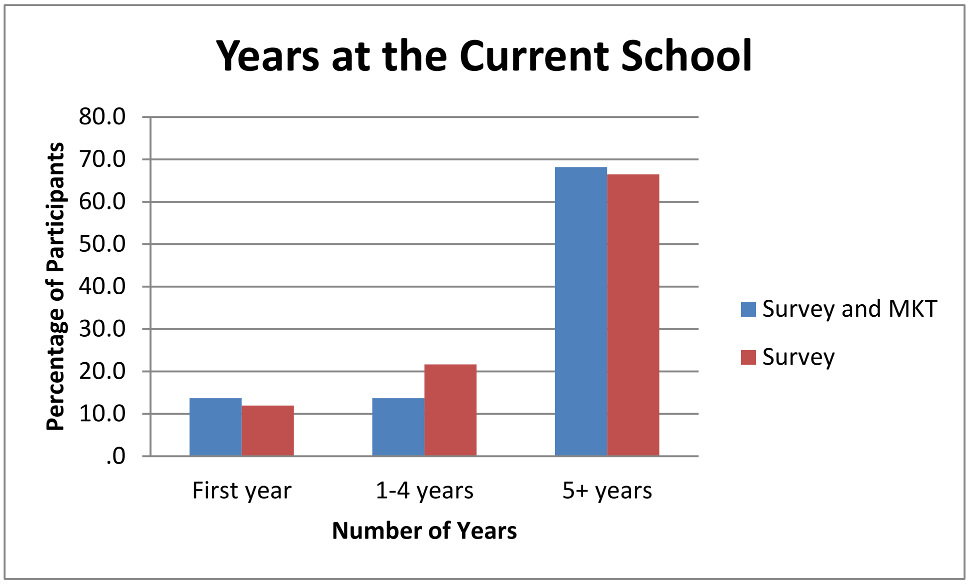


Figure 3. Bar graph showing the number of years the teacher has worked at the current school by the entire sample and the subset.

Figure 4 shows the number of hours of training the participants have had in the past 5 years comparing the entire sample (N = 134) and the subset (n = 44). The majority of teachers have had less than 20 hours of training in mathematics.

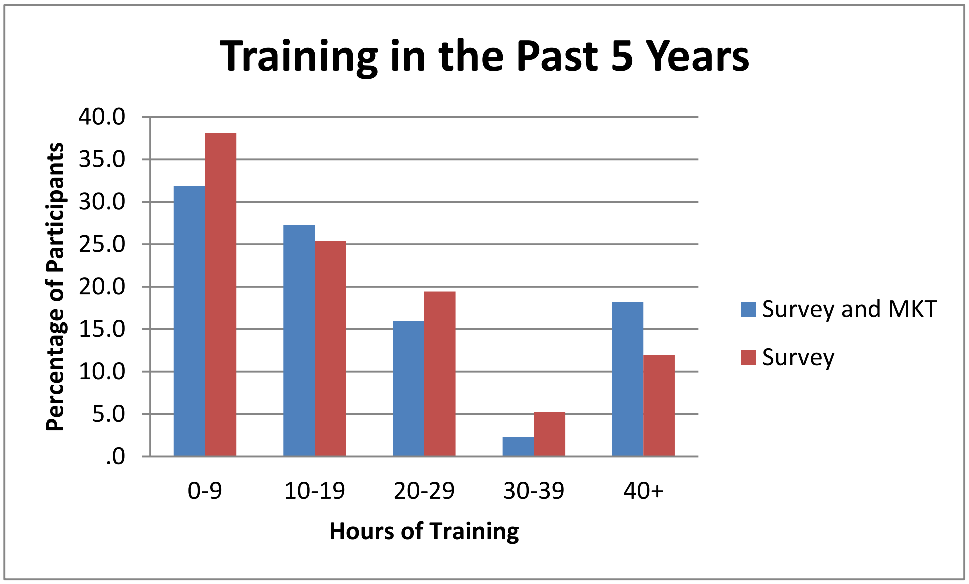


Figure 4. Bar graph showing the hours of training in the past 5 years by the entire sample and the subset.

Figure 5 shows a comparison between the entire sample (N = 134) and the subset (n = 44) according to the percentage of time the teachers use the district adopted text.

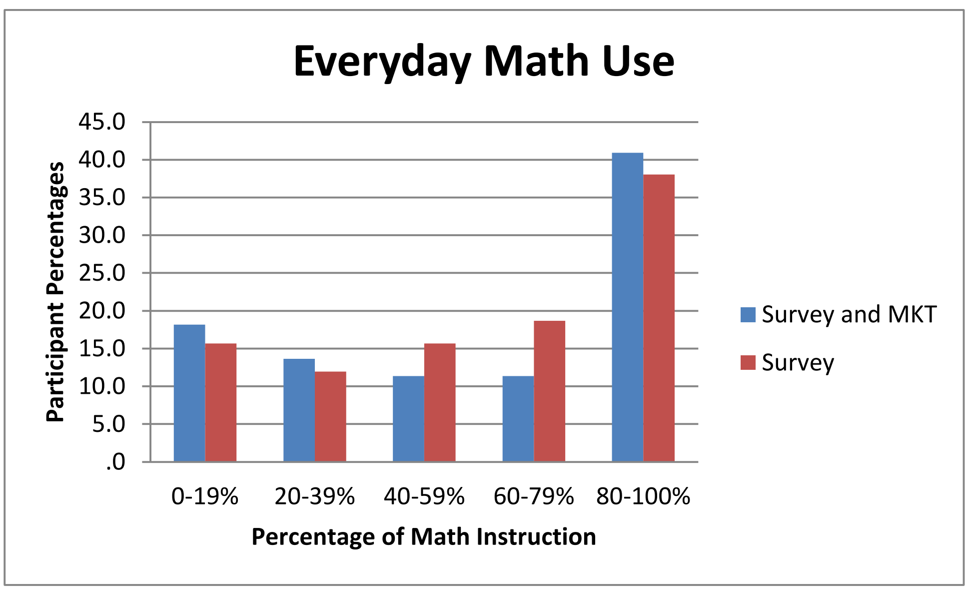


Figure 5. Bar graph showing the percentage of time the teacher uses Everyday math by the entire sample and the subset.

After determining that the assumption of homogeneity of variance had not been violated using a Levene's test, I used an ANOVA to determine the significance of the difference between the groups. I did not find a statistical significance between the entire sample and the subset (see Tables 4 and 5). The entire sample and the subset yielded similar results in each of the five categories: Everyday Math use, training in the past five years, years at the current school, AYP, and school category. This finding contributes to a higher level of confidence, $p < .05$, when generalizing the results.

Table 4
Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Everyday Math Use	2.296	1	132	.132
Training in the past 5 years	.898	1	132	.345
Years at the current school	.012	1	132	.914
Annual Yearly Progress	.582	1	132	.447
School Category	.325	1	132	.569

Table 5
ANOVA of Sample and Subset

		Sum of Squares	df	Mean Square	F	Sig.
Everyday Math Use	Between Groups	.734	1	.734	.331	.566
	Within Groups	292.736	132	2.218		
	Total	293.470	133			
Training in the past 5 years	Between Groups	2.086	1	2.086	1.163	.283
	Within Groups	236.698	132	1.793		
	Total	238.784	133			
Years at the current school	Between Groups	.036	1	.036	.073	.788
	Within Groups	65.195	132	.494		
	Total	65.231	133			
Annual Yearly Progress	Between Groups	.035	1	.035	.138	.711
	Within Groups	33.398	132	.253		
	Total	33.433	133			
School Category	Between Groups	.982	1	.982	.844	.360
	Within Groups	153.615	132	1.164		
	Total	154.597	133			

The MKT instrument was designed so that the average teacher, answering items covering a wide range of difficulty, would get 50% correct (Hill, 2010). The scores are reported as an IRT score, which accounts for individual items on the test that may vary in the level of difficulty (Schilling, 2007). The mean score is zero, the standard deviation is one, and a normal distribution is between -2 and +2 (Hill, 2010). If the raw scores were used, the percentage correct would not represent a linear relationship, because they would not account for the variation in the individual test items. For this reason, the results in the following tables are presented as IRT scores.

Table 6 shows the results of the MKT PFA and the MKT NCO online assessments. Means for the MKT PFA and MKT NCO were -.269 (SD 1.003) and -.085 (SD .909) respectively. The mean scores for both assessments showed no significant difference between the school categories.

Table 6
Descriptive Statistics of MKT Assessments

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
MKT Patterns, Functions and Algebra	44	-2.6979	1.5893	-.2690	1.0029	-.297	.357	-.091	.702
MKT Number Concepts and Operations	42	-2.2597	1.9391	-.0847	.9092	-.121	.365	-.108	.717
Valid N (listwise)	42								

Figure 6 shows the noteworthy difference between the mean MKT scores of each assessment and the grade level the teachers have taught in the past year. The K-2 teachers had a lower mean MKT score on both assessments when compared to the 3-5 teachers.

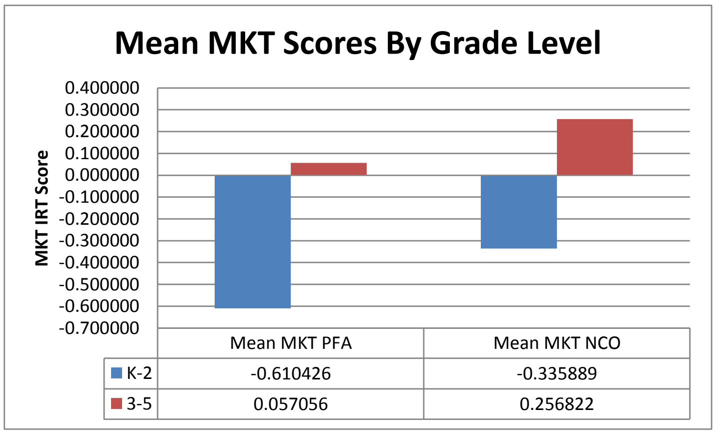


Figure 6. Bar graph showing the mean MKT scores by the grade levels taught in the past year.

After completing both the MKT PFA and the MKT NCO, the participants were asked questions regarding their thoughts about the MKT assessment. Table 7 shows that only 4.2 % of the participants indicated that they knew most of the answers on the assessment. The sample size varies throughout this portion beginning with *n* = 44 and ending with *n*= 34. Ten participants completed the MKT assessments but did not complete this TKAS survey.

Table 7

Thoughts about the MKT assessment

		I knew the correct answers to most of the questions		The questions focused on mathematics teachers need to know		The questions included mathematics that I frequently use in my teaching		I enjoyed Answering the Questions	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
	Participant Skip	0	0.0	1	2.3	0	0.0	0	0.0
	Strongly disagree (1st option on Likert Scale)	2	4.5	1	2.3	13	29.5	7	15.9
	2nd Option on Likert Scale	9	20.5	6	13.6	9	20.5	9	20.5
	3rd Option on Likert Scale	16	36.4	8	18.2	11	25.0	9	20.5
	4th Option on Likert Scale	6	13.6	7	15.9	5	11.4	9	20.5
	5th Option on Likert Scale	6	13.6	10	22.7	3	6.8	4	9.1
	Strongly agree (6th option on Likert Scale)	2	4.5	8	18.2	0	0.0	3	6.8
	Total	41	93.2	41	93.2	41	93.2	41	93.2
Missing	System	3	6.8	3	6.8	3	6.8	3	6.8
Total		44	100.0	44	100.0	44	100.0	44	100.0

The participants answered questions about the focus of mathematics in their classroom. I split this information between Tables 8 and 9 for readability. Only 9.1 % of the participants indicated that developing nonconventional algorithms and examining different representations was a major focus. Only 11.4% indicated that estimation was a major focus in their classroom.

Table 8

Classroom Focus on Specific Topics Part 1

		Learning how to carry out the steps of a conventional computation procedure		Practicing methods or strategies for finding answers to basic facts		Developing transitional, alternative, or nonconventional methods for doing computation		Applying basic facts or computation to solve word problems	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
	Participant Skip	1	2.3	1	2.3	1	2.3	1	2.3
	Not a focus (1st option on a Likert scale)					3	6.8		
	2nd option on Likert scale	2	4.5	1	2.3	6	13.6		
	3rd option on Likert scale	6	13.6	5	11.4	4	9.1	3	6.8
	4th option on Likert scale	7	15.9	6	13.6	9	20.5	7	15.9
	5th option on Likert scale	9	20.5	10	22.7	7	15.9	15	34.1
	Major Focus (6th option on Likert scale)	9	20.5	11	25.0	4	9.1	8	18.2
	Total	34	77.3	34	77.3	34	77.3	34	77.3
Missing		10	22.7	10	22.7	10	22.7	10	22.7
Total		44	100.0	44	100.0	44	100.0	44	100.0

Table 9

Classroom Focus on Specific Topics Part 2

		Estimating the answer to a computation problem		Comparing and examining different representations of a mathematical concept or procedure		Explaining the thinking or procedures used to solve a problem	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
	Participant Skip	1	2.3	1	2.3	1	2.3
	Not a focus (1st option on a Likert scale)	1	2.3	3	6.8		
	2nd option on Likert scale	5	11.4	2	4.5	1	2.3
	3rd option on Likert scale	6	13.6	6	13.6	2	4.5
	4th option on Likert scale	9	20.5	10	22.7	5	11.4
	5th option on Likert scale	7	15.9	8	18.2	13	29.5
	Major Focus (6th option on Likert scale)	5	11.4	4	9.1	12	27.3
	Total	34	77.3	34	77.3	34	77.3
Missing	System	10	22.7	10	22.7	10	22.7
Total		44	100.0	44	100.0	44	100.0

Table 10 shows the confidence level of the teachers. While 20.5 % of the participants indicated a high confidence level in teaching the curriculum, the results were much lower for their confidence in explaining complex problems and for helping all students master difficult concepts (11.4 and 2.3 respectively).

Table 10

Confidence in Teaching Mathematics

		Confidence in explaining to students how to do complex mathematics problems		Confidence in skillfully teaching all the concepts covered in the mathematics curriculum		Confidence in helping all of your students master difficult concepts in mathematics	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
	Participant Skip	1	2.3	1	2.3	1	2.3
	Not at all confident (1st option on a Likert scale)	1	2.3	0	0.0	1	2.3
	2nd option on Likert scale	3	6.8	0	0.0	1	2.3
	3rd option on Likert scale	6	13.6	2	4.5	5	11.4
	4th option on Likert scale	6	13.6	11	25.0	13	29.5
	5th option on Likert scale	12	27.3	11	25.0	12	27.3
	Extremely confident (6th option on Likert scale)	5	11.4	9	20.5	1	2.3
	Total	34	77.3	34	77.3	34	77.3
Missing		10	22.7	10	22.7	10	22.7
Total		44	100.0	44	100.0	44	100.0

Research Questions

This section addresses the data specific to each of the three research questions. The research questions for this study are as follows:

1. What are the current PD needs of elementary mathematics teachers in the XYZ School District?
2. What is the relationship between the mathematical knowledge for teaching (MKT) and the socioeconomic level of the school in which the teacher is currently working?
3. What is the relationship between the mean MKT score of the teachers of a particular school and whether or not the school makes AYP?

Research Question One: What are the current PD needs of elementary mathematics teachers in the XYZ School District?

When conducting statistical tests for this question I utilized ten variables. A Spearman's rho test was used to determine if any of these variables had a statistically significant relationship to at least one other variable. I also include a discussion of the nonsignificant relationships that demonstrate the PD needs of the school district.

Teachers whose schools did not make AYP during the 2010-2011 school year reported more hours of training than the teachers at schools that did make AYP. The relationship between the number of hours a teacher has attended training in the past five years was found to have a small, negative correlation to AYP in the larger sample, $r_s = -.178$, $N = 134$, $p < .05$. A medium, negative correlation was also found between the number of years a teacher has taught math to the number of hours of training attended, r_s

= -.347, $n = 33$, $p < .05$. The relationship between the number of years a teacher has taught math and the classroom focus on explanation showed a medium, positive correlation, $r_s = .423$, $n = 34$, $p < .05$.

The results from a Spearman's rho conducted between all seven of the classroom focus questions are in Table 11.

Table 11

Correlations of Classroom Focus Questions

			1	2	3	4	5	6	7
Spearman's rho	1. Classroom focus on conventional computation	Correlation Coefficient	1.000	.588**	.202	.585**	.047	.050	.293
		Sig. (2-tailed)	.	.000	.251	.000	.793	.778	.093
		N	34	34	34	34	34	34	34
	2. Classroom focus on methods/ strategies for basic facts	Correlation Coefficient	.588**	1.000	.290	.727**	.336	.254	.371*
		Sig. (2-tailed)	.000	.	.096	.000	.052	.148	.031
		N	34	34	34	34	34	34	34
	3. Classroom focus on developing transitional, alternative, or nonconventional algorithms	Correlation Coefficient	.202	.290	1.000	.312	.278	.742**	.364*
		Sig. (2-tailed)	.251	.096	.	.072	.111	.000	.034
		N	34	34	34	34	34	34	34
	4. Classroom focus on applying basic facts or computation to solve word problems	Correlation Coefficient	.585**	.727**	.312	1.000	.473**	.381*	.459**
		Sig. (2-tailed)	.000	.000	.072	.	.005	.026	.006
		N	34	34	34	34	34	34	34
	5. Classroom focus on estimating the answer to a computation problem	Correlation Coefficient	.047	.336	.278	.473**	1.000	.668**	.371*
		Sig. (2-tailed)	.793	.052	.111	.005	.	.000	.031
		N	34	34	34	34	34	34	34
	6. Classroom focus on comparing or examining different representations of a mathematical concept	Correlation Coefficient	.050	.254	.742**	.381*	.668**	1.000	.370*
		Sig. (2-tailed)	.778	.148	.000	.026	.000	.	.031
		N	34	34	34	34	34	34	34
	7. Classroom focus on explaining the thinking or procedures used to solve a problem	Correlation Coefficient	.293	.371*	.364*	.459**	.371*	.370*	1.000
		Sig. (2-tailed)	.093	.031	.034	.006	.031	.031	.
		N	34	34	34	34	34	34	34

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The teachers in the Title I and Challenge schools were more likely to indicate their classroom focused on conventional computation, than the teachers in the Low Risk and Moderate Risk categories. This question was shown to have a medium, negative correlation to the category of school, r_s = -438, n = 43, $p < .05$. A one-way between-groups analysis of variance was conducted on these variables. There was a statistically significant difference at the $p < .05$ level between the Low Risk and the Title I schools on the "Classroom focus on conventional computation" focus question. The effect size, calculated using eta squared, was .32, a large effect size. This effect size shows a high strength of association between the school category and the participants' use of conventional computation.

Teachers who reported a higher percentage of time using the district adopted math program, Everyday Math, were also more likely to have a classroom focus on developing transitional, alternative, or nonconventional algorithms, $r_s = .376$, $n = 33$, $p < .05$. Classrooms that focus on estimating the answer to a computation problem had a large, positive correlation to the number of years a teacher has been teaching at their current school $r_s = .526$, $n = 33$, $p < .01$. As shown in Figure 7, the years a teacher has been teaching at their current school was higher for the teachers in the Low Risk category than it was for the teachers in the Title I schools, $r_s = .277$, $n = 134$, $p < .01$.

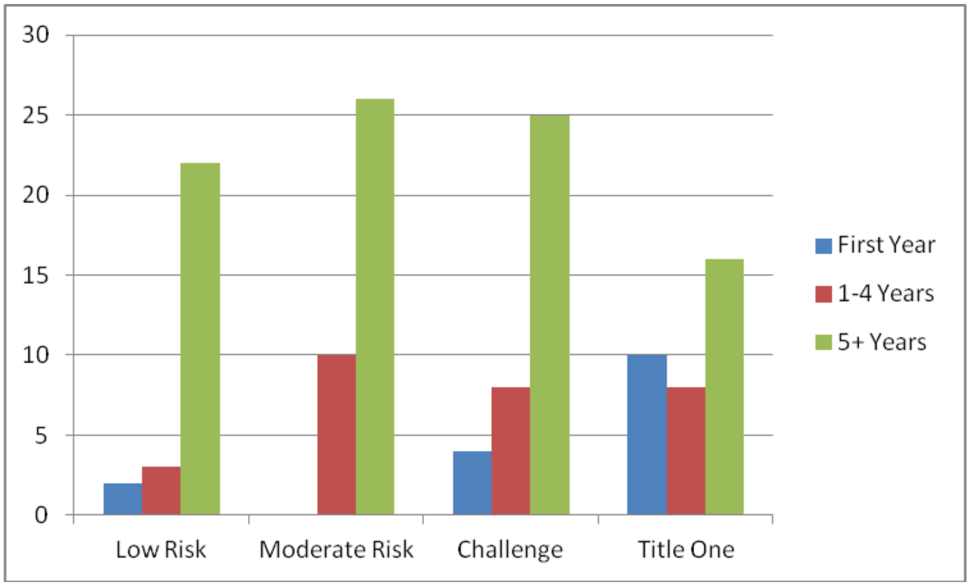


Figure 7. Bar graph showing the number of years teachers have been teaching at their current school sorted by school category (n=134).

Using Cohen (1988) as a guide for determining the strength of the relationship, a medium, positive correlation was found between the use of the Everyday Math program and the school category, $r_s = .235$, $N = 134$, $p < .01$, $r_s = .345$, $n = 42$, $p < .05$. A one-way between-groups analysis of variance was conducted on these variables. There was a statistically significant difference at the $p < .05$ level between the Low Risk/Moderate Schools and the Challenge schools on their use of the Everyday Math program. The effect size, calculated using eta squared, was .25, a large effect size showing the strength of the difference between the groups.

A medium, negative correlation was found between the MKT PFA scores of the teachers and the increase in the use of the Everyday Math series $r_s = -.344$, $n = 42$, $p < .05$. A medium, positive correlation was found for both the MKT PFA and the MKT NCO with the selection of “Grades 3-5” as grades taught in the past year, $r_s = .352$, $n = 34$, $p < .05$, $r_s = .421$, $n = 34$, $p < .05$ respectively.

Table 12 shows the correlations between the MKT scores and the participants' thoughts about the MKT assessment. Using a Spearman's rho, I found a positive correlation between each of the four questions and the two MKT assessments. High MKT scores were associated with the participants' selection of "I knew the answers," "Teachers need to know," "Math I frequently use," and "Enjoyed answering the questions." The two MKT assessments had a large, positive correlation as well, indicating that a high MKT PFA score is associated with a high MKT NCO score.

Table 12

MKT and Participants Thoughts about the Assessment

			MKT Patterns, Functions and Algebra	MKT Number Concepts and Operations	I knew the answers	Teachers need to know	Math I Frequently Use	Enjoyed Answering the Questions
Spearman's rho	MKT Patterns, Functions and Algebra	Correlation Coefficient	1.000	.634**	.695**	.460**	.467**	.633**
		Sig. (2-tailed)	.	.000	.000	.002	.002	.000
		N	44	42	41	41	41	41
	MKT Number Concepts and Operations	Correlation Coefficient	.634**	1.000	.518**	.331*	.209	.641**
		Sig. (2-tailed)	.000	.	.001	.035	.189	.000
		N	42	42	41	41	41	41
	I knew the answers	Correlation Coefficient	.695**	.518**	1.000	.365*	.522**	.636**
		Sig. (2-tailed)	.000	.001	.	.019	.000	.000
		N	41	41	41	41	41	41
	Teachers need to know	Correlation Coefficient	.460**	.331*	.365*	1.000	.521**	.544**
		Sig. (2-tailed)	.002	.035	.019	.	.000	.000
		N	41	41	41	41	41	41
	Math I Frequently Use	Correlation Coefficient	.467**	.209	.522**	.521**	1.000	.540**
		Sig. (2-tailed)	.002	.189	.000	.000	.	.000
		N	41	41	41	41	41	41
	Enjoyed Answering the Questions	Correlation Coefficient	.633**	.641**	.636**	.544**	.540**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.
		N	41	41	41	41	41	41

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 13 shows the mean, range, minimum, and maximum in the MKT scores for each category of school. The highest mean scores for both assessments were in the Title I school category. The Title I schools also had the highest and the lowest scores on the MKT PFA. The Low Risk schools had the highest and the lowest scores on the MKT NCO. The minimum and maximum scores for the MKT PFA and the MKT NCO were -2.6979 to 1.5893, range = 4.2872, SD 1.0130016 and -2.2597 to 1.9391, range = 4.1988, SD .9201267, respectively. Hill et al. (2005) found that even one standard deviation in MKT score can be equivalent to 2 to 3 weeks of extra instructional time.

Table 13

MKT by School Category

School Category		MKT Patterns, Functions and Algebra	MKT Number Concepts and Operations
1 Title I	Mean	-.095145	.248891
	N	11	11
	Std. Deviation	1.4351436	.8255632
	Range	4.2872	2.6292
	Minimum	-2.6979	-.9521
	Maximum	1.5893	1.6771
2 Challenge	Mean	-.369464	-.439440
	N	11	10
	Std. Deviation	.9598194	.9035404
	Range	3.2285	2.7693
	Minimum	-2.2952	-1.5839
	Maximum	.9333	1.1854
3 Moderate Risk	Mean	-.273613	-.162286
	N	15	14
	Std. Deviation	.7485294	.7442310
	Range	2.8712	2.3221
	Minimum	-1.9379	-1.3696
	Maximum	.9333	.9525
4 Low Risk	Mean	-.327600	.048450
	N	6	6
	Std. Deviation	.9985217	1.4020969
	Range	2.6615	4.1988
	Minimum	-1.0722	-2.2597
	Maximum	1.5893	1.9391
Total	Mean	-.260012	-.088729
	N	43	41
	Std. Deviation	1.0130016	.9201267
	Range	4.2872	4.1988
	Minimum	-2.6979	-2.2597
	Maximum	1.5893	1.9391

Research Question 2: What is the relationship between the mathematical knowledge for teaching (MKT) and the socioeconomic level of the school in which the teacher is currently working?

This question examined the scores on both of the MKT assessments to see if there was a correlation with the MKT scores and the category of school the teacher was currently working in. No significant correlation was found between these variables. An ANOVA also found no significant difference between the means of the groups of schools. Figure 8 shows the boxplot of the MKT PFA scores arranged by school category. The median scores, as shown by the dark line within the box, are very similar for each category. The range of scores, as shown by the lines extending from the box, is larger within the Title I category of schools. The boxplots for the Moderate Risk and Low Risk schools also show several outliers in the data.

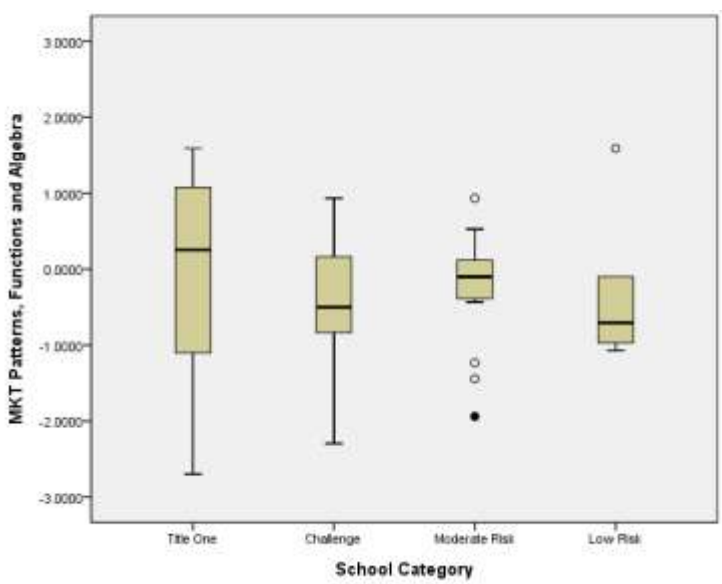


Figure 8. Boxplot showing the MKT PFA scores by school category.

Figure 9 is a boxplot of the MKT NCO scores sorted by school category. This chart also shows the similarity in the median scores and the range of scores within each school category.

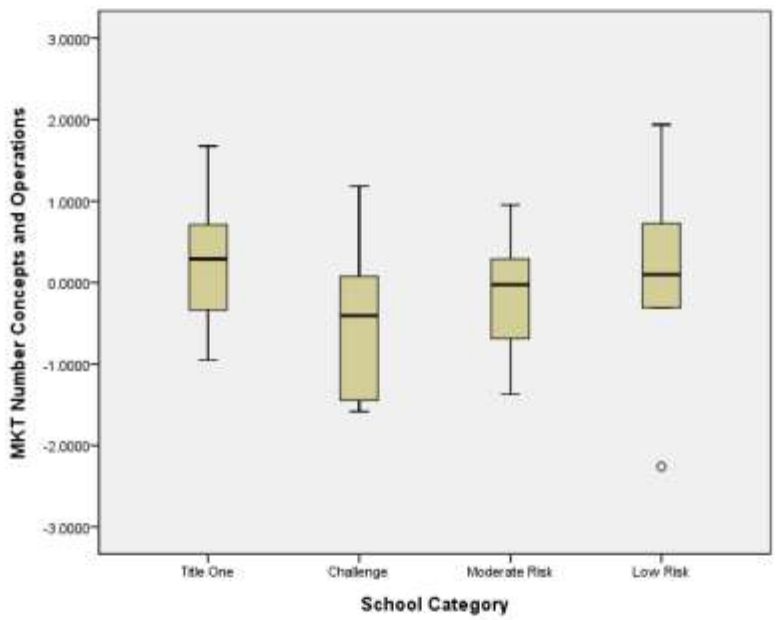


Figure 9. Boxplot showing the MKT NCO scores by school category.

Research Question 3: What is the relationship between the mean MKT score of the teachers of a particular school and whether or not the school makes AYP?

No correlation was found between the school's AYP designation and the MKT scores for both of the MKT assessments. Figure 10 shows the MKT PFA scores by the schools' AYP status. The median scores are similar and the range in the "Yes" designation is larger.

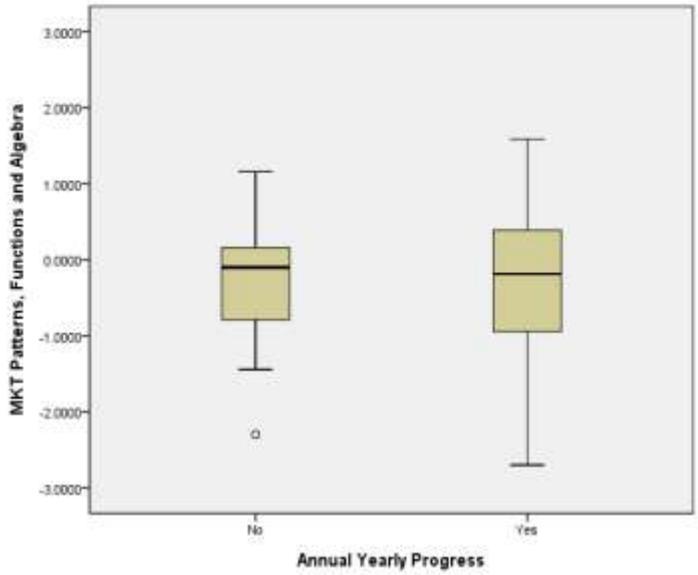


Figure 10. Boxplot showing the MKT PFA scores by AYP designation.

Figure 11 is a boxplot showing the MKT NCO scores by AYP status. Even though the medians are similar, the range is larger within the schools who made AYP.

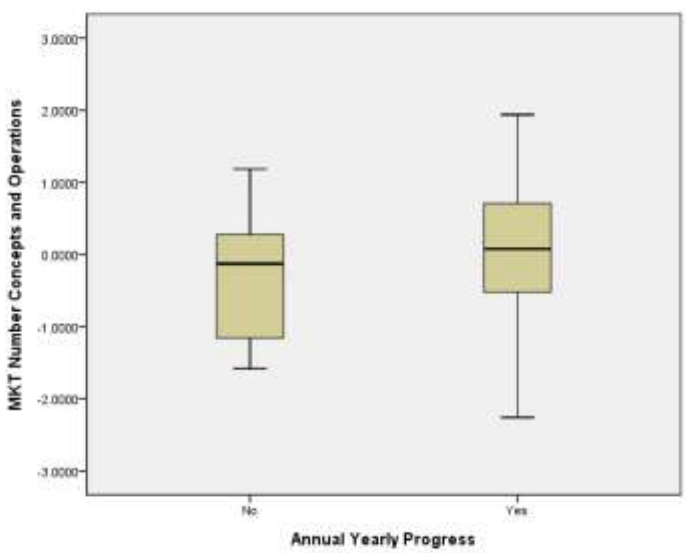


Figure 11. Boxplot showing the MKT NCO scores by AYP designation.

Assumptions, Limitations, Scope, Delimitations

There are several assumptions and limitations for this study within each aspect of the methodology. There was a risk in randomly choosing schools as participants. Although I believe the burden placed on a school for participating was very small, one assumption was that, with the support of the district office, the administrator of the school would consent to participating. The teachers in each school participated without any compensation, and this may have impacted their participation selection. They may also have had fears regarding their own mathematical abilities that prevented them from consenting. These limitations affect the sample size and therefore the generalizability of the results.

There are several limitations within the implementation of the instruments in this study. One is the use of the TKAS system for assessing the MKT levels of the teacher. The teachers took this assessment at their leisure. I collected and analyzed the data under the assumption that teachers did not consult other sources to help them answer the questions. For in-service teachers, taking an online assessment of this type is very unusual and may be of some concern to the participating teachers (Schilling & Hill, 2007). Including released items in the presentation to the teachers may have helped to alleviate some of their concerns.

This study was delimited to first through fifth grade teachers in the XYZ school district. Using a random selective procedure ensured that there was adequate representation within the four categories of schools under study. The MKT level of the teacher leaders, instructional coaches, and administrators could have also been examined, but that was beyond the delimitations of the current study.

The scope of this study focused on the MKT level of the teachers as one possible explanation for the low student achievement results that this district was facing experiencing. It was beyond the scope of this study to include many other factors that could attribute to the student achievement levels within this district. Although MKT was offered as one possible explanation for the low student achievement, general pedagogy could also have been considered, as could the teachers' access to support and to materials.

Among the limitations are the time and financial restrictions that inhibit the possibility of collecting data on the current students of the teachers or on including the entire population of teachers within the 63 schools in this study. Each of these areas is a consideration for future research.

Conclusion

This study utilized a nonexperimental, descriptive correlational methodology. I used two instruments to gather data in order to determine the PD needs and the MKT equity among school categories. I randomly chose twelve schools to participate, three from each of four school categories. I asked the first through fifth grade teachers to give their informed consent to participate in the MKT assessment, which included its own survey, and the survey I created. The informed consent process explained the purpose for the study, the confidentiality procedures, the data collection methods, and the method for reporting the results.

The MKT portion of the study focused on number concepts and operations as well as on patterns, functions, and algebra. I statistically analyzed the MKT portion of the study to determine if a correlation existed between MKT and the school category. I used statistics, including frequency distributions, measures of central tendency, and measures of variability, to determine the direction and strength of that correlation, if it existed.

The participants included 134 teachers from twelve schools. Of those who took the MKT assessment (n=44), all of them were white and most of them were female. Most of these teachers had been teaching at their current school for more than five years, although this number was smaller at the Title I and Challenge schools. The K-2 teachers had a lower mean MKT score than the 3-5 teachers on both assessments. Only 4.2 % of the teachers indicated that they knew most of the answers on the test.

When asked about their classroom focus in mathematics, only 9.1% indicated that nonconventional algorithms and differing representations were a major focus in their classrooms. Only 11.4% indicated that estimation was a major focus. Only five teachers selected “Extremely Confident” when rating their confidence level for explaining complex problems and only one teacher selected “Extremely Confident” for helping all of their students to master complex concepts.

Teachers in schools currently not making AYP reported many more hours spent in training than teachers in schools making AYP did, although their MKT scores were not significantly different. This may be the result of NCLB requirements for schools not making AYP or it may be the result of the financial status of the schools making AYP. Teachers in the Title I and Challenge schools were more likely to focus on conventional algorithms and less likely to use Everyday Math. A medium, negative correlation was found between the teachers' use of Everyday Math and their MKT PFA scores. Teachers with lower MKT PFA scores were more likely to use Everyday Math for a larger percentage of their instructional time in mathematics.

Teachers who knew the answers and enjoyed answering the questions had higher MKT scores on both assessments. Teachers who use this type of math frequently and agreed that it was math teachers need to know, had higher scores on both assessments.

Each category of school showed a large range in MKT scores for both assessments, indicating the need for differentiated PD in order to meet the needs of teachers at both ends of the range.

I used many of the identified correlations and descriptive statistics to develop the associated project study. The details of this project are in Section 3. The MKT theory is still under development and although this study will not solidify that theory, it is my hope that this study will contribute to the development of the theory.

Section 3: The Project

Introduction

Even before the CCSS were developed, there was a call for training "corps of teachers" to have the skills to prepare our children mathematically (Wu, 2009, p. 14). This project, called "Focus on Mathematically Proficient Students", will provide multiple, differentiated trainings for administrators, instructional coaches, PLCs, or individual teachers to use. It encompasses a combination of theory and practice as suggested by Anderson (2008) as a way to encourage PD participation in mathematics for elementary teachers. This project does not simply provide more training. It allows for training that is targeted to the specific needs of the teachers and their schools. As noted in the results from this study, many of the schools not making AYP had been receiving more training than the schools making AYP. While this study did not investigate the details about these trainings, by definition effective PD increases student achievement (Bailey, 2010; Baumert et al., 2010; Hill, 2007; National Council of Supervisors of Mathematics, 2008; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007).

I designed the 45 training modules in this project to address several instructional issues suggested in the literature and suggested by the results from the data collection of this study. These modules address multiple PD concerns including equitable access to high quality mathematics, teaching and learning strategies and techniques, curriculum development, and assessment driven instruction.

I chose to use a training module format for two reasons. First, the format for PD in most of the elementary schools in the XYZ School District is a 75-minute block on

Wednesday afternoons. These modules will fit into the time frame of this block. The second reason I chose this format was to differentiate the PD for the individual needs of the teachers or of the schools. PD providers can combine these modules as indicated to address the specific needs of the schools. While some modules require an organized progression, teachers can complete most of the modules in any order as part of an ongoing, embedded PD program.

Goals

The initial data analysis helped to identify several areas of need for elementary mathematics. The goal of this project was to develop a PD plan that:

1. was specific to the needs of the XYZ School District,
2. was based on professional development research,
3. will help teachers transition from the Nevada State Standards to the CCSS Mathematics,
4. can be individualized for specific teachers, groups, or schools, and
5. used the Prime Leadership Framework as an organizational base (National Council of Supervisors of Mathematics, 2008).

The National Council of Supervisors of Mathematics (NCSM) developed the Prime Leadership Framework to help meet a specific goal: "Mathematics education leaders must be able to ensure a better future for every student through initiating adult actions focused on improved student achievement" (National Council of Supervisors of Mathematics, 2008, p. 4). As shown in Figure 8 the Prime Leadership Framework includes four principles with three indicators in each principle. NCSM developed these indicators to help mathematics leaders determine a course of action.

The Prime Leadership Framework

Principle	Indicator 1	Indicator 2	Indicator 3
Equity Leadership	Every teacher addresses gaps in mathematics achievement expectations for all student populations.	Every teacher provides each student access to relevant and meaningful mathematics experiences.	Every teacher works interdependently in a collaborative learning community to erase inequities in student learning.
Teaching and Learning Leadership	Every teacher pursues the successful learning of mathematics for every student.	Every teacher implements research informed best practices and uses effective instructional planning and teaching strategies.	Every teacher participates in continuous and meaningful mathematics professional development and learning in order to improve his or her practice.
Curriculum Leadership	Every teacher implements the local curriculum and uses instructional resources that are coherent and reflect state standards and national curriculum recommendations.	Every teacher implements a curriculum that is focused on relevant and meaningful mathematics.	Every teacher implements the intended curriculum with needed intervention and makes certain it is attained by every student.
Assessment Leadership	Every teacher uses student assessments that are congruent and aligned by grade level or course content.	Every teacher uses formative assessment processes to inform teacher practice and student learning.	Every teacher uses summative assessment data to evaluate mathematics grade-level, course, and program effectiveness.

Figure 12. Chart showing the PRIME Leadership Framework. Reprint with permission.

I used the Prime Leadership Framework to create and organize 45 training modules (see appendix A) each of which addresses a specific indicator, most indicators having more than one module. Included with each module are recommendations for differentiation. I created these recommendations using the results of my data collection and analysis.

Rationale

In Nevada, teachers are required to attend six semester hours or 120 PD hours in order to renew their teaching license every six years. Georges, Borman, and Lee (2010) considered this to be a moderate amount, with some other states requiring as many as 200 PD hours. While those hours are required to be associated with the applicant's current teaching assignment, the hours can be in any subject area for elementary teachers. Teachers in elementary school, who are typically generalists, may take 120 hours in English, Language Arts and no hours in mathematics if they choose.

This project will offer teachers PD in mathematics designed to fit their specific needs. If the expectation is for teachers to respond to the needs of each individual student in their classroom, then it follows that PD providers must respond their individual needs (Strickland, 2009). Teachers or their administrators or coaches will be able to choose modules that they are interested in or modules indicated by student achievement in their school. PD providers will be able to adjust to the needs of their participants. For example, PD providers need to consider the current grade levels of their audience members. In this study, K-2 teachers had lower MKT levels than 3-5 teachers did. The K-2 teachers may need more intensive work on the mathematics of future grade levels to see the connection to what they are teaching. The results of this study also indicated that teachers who use the district adopted mathematics program spend more classroom time focused on alternative algorithms. Teachers who do not indicate this particular classroom focus may need more training on the methodology of this practice and the research behind its effectiveness.

I developed several modules around specific CCSS mathematical domains Either these domains are new to the grade level in our state or they require significant change from current practice. The CCSS Mathematical Practices modules are specific to the study of the practice and the teacher's responsibility to encourage its use. Each content domain also includes work with the CCSS Mathematical Practices. While the CCSS Mathematical Practices are not intended to be separated from the content domain, a close examination of each is necessary.

Review of the Literature

This literature review was necessary to develop an effective PD program that encompasses best practices, differentiates for teachers, and addresses our CCSS Mathematics needs. This section includes literature review of four topics. The first section is PD specific to mathematics. The second topic, differentiation, includes an overview of differentiation as well as a discussion of differentiating for adults. The third theme warrants its own section: the CCSS mathematics. These standards are a vastly different form of standards than teachers have worked with in Nevada. They are standards intended to help students develop deep, conceptual understanding of the mathematics at their grade level. The fourth topic is instructional design, which includes lesson planning, and topics specific to mathematics such as modeling, representations, and the use of examples. I chose these four categories and reached saturation in the literature after using the following Boolean terms: PD, elementary mathematics, teacher, training, standards, differentiation, instruction, lesson planning, model, representation, and examples.

Professional Development in Mathematics

While there are many attributes to effective PD, several researchers have identified four content areas of critical importance: coherence, content-focused, realistic to the classroom, and collaboration with student data (Hill, Schilling, & Ball, 2004; Leko & Brownell, 2009; Yoon et al., 2007). In addition to these four attributes, PD should involve multiple sessions and be sustained over time (Bailey, 2010; Hill, 2007). Substantial PD, averaging 49 hours, can raise student achievement by as much as 21 percentile points (Yoon et al., 2007). Student achievement improves after as little as 14 hours of PD. PD with duration of less than 14 hours showed no significant effect on student achievement.

Teachers may have very different expectations for the outcome of a PD program (Kise, 2006). They may expect activities they can immediately use in their classrooms. They may want only the big idea so they can develop the details themselves. They may want the details for implementing the initiatives. They may insist on proof that this new initiative is worth the effort it will take to implement. One way to address these varied expectations is to know the PD audience well (Kise, 2006). What are their beliefs? What are their strengths? What are their concerns about teaching mathematics? Do they have a system in their school for collaboration?

Teaching is a very isolated profession (Beckmann, 2011). It is not common to have collaboration time within a school building and even rarer to collaborate between buildings. One of the many reasons teachers give for leaving the profession is a "debilitating sense of isolation" (Carroll, 2009, p. 11). PD should include giving teachers time to collaborate. This allows teachers to use each other as resources, to hear the perspectives of their colleagues, and to solidify their own knowledge (Carter, 2010; Fullan, 2009; Kise, 2006). In order to examine and possibly change teaching practices and beliefs, teachers need the support and "intellectual space" of fellow teachers (Bray, 2011). PD should focus on communities of teachers, not individual teachers (Breyfogle & Spotts, 2011). Zambo and Zambo (2008) found that collaboration helps to overcome some of the stigma associated with working in an underperforming school. In order for PD to be effective, the content taught must make its way from the PD program through the teams of teachers and into the classroom.

The format and content of a PD program can vary widely. Some programs include a wide selection of content topics and others are focused on one topic. The PD in a school district can take place in a grade level group as they study a topic together, it can be implemented by trainers within the district or by contracting with an outside source. One type of outside source is a publishing company. This type of training generally takes place following district adoption of materials. This type of PD is not sufficient to increase student achievement (Hill, 2007). If content knowledge, pedagogy, and MKT are also included in a structured learning environment, student achievement can be positively affected (Baumert, et al., 2010). Any PD offering should be aligned with the standards, the materials, and any summative assessments. Formal PD is one way of filling in the gaps in the knowledge and skills of our teachers.

Differentiation

Differentiation provides a format for balancing the specific needs of a student with the learning content (Strickland, 2009; Tomlinson & Imbeau, 2010; Tomlinson & McTighe, 2006). Teachers of children or adults can differentiate their instruction based on the students' readiness, interest, or learning profile. In this definition, *instruction* can be content, process, product, or affect. Tomlinson and Imbeau (2010) suggest that teachers "continually ask, 'What does *this* student need at *this* moment in order to be able to progress with *this* key content, and what do I need to do to make that happen?'" (p. 14).

Differentiating for student readiness. When addressing the readiness needs of a student, it is important to note that readiness and ability are not one in the same. Ability includes the current knowledge and skill set of the learner, while readiness is determined by whether or not they are ready to learn this particular content. The students' "proximity" to mastering the content must be considered when differentiating by readiness (Tomlinson & Imbeau, 2010, p. 16). Readiness can be determined through formative or summative assessment and can be addressed with flexible grouping of students. Differentiating is not as simple as giving some students less work than others (Sousa & Tomlinson, 2011).

Teachers can differentiate the content by readiness in two ways. They can identify the learning continuum of the content and present material to the students based on their point on the continuum. Teachers can also change the methods for accessing the content. For example, they may have students listen to a recording of the textbook instead of reading it, but they will still participate in the mathematical exercises.

Differentiating by process begins when the students are actively working with the content. They can process the content alone or with partners. The teacher can offer more scaffolding for some students in order to secure access to the content. Process is generally associated with the activities of the classroom. Using the term sense-making activities helps the teacher understand the true purpose of the activity (Sousa & Tomlinson, 2011; Tomlinson & Imbeau, 2010; Tomlinson & McTighe, 2006).

Teachers can differentiate the product that students produce as a summative assessment of the content. This utilizes authentic performance tasks that allow the student to show their understanding of the content and their ability to transfer that knowledge (Wiggins & McTighe, 2011; Sousa & Tomlinson, 2011). The teacher may provide check-in support to students who need help organizing their time. The student's product may be their native language first and then translated into English.

Differentiating for student interest. There are several ways to differentiate instruction based on student interest. If teachers are very familiar with their content and with their students they are better able to make connections between the two (Sousa & Tomlinson, 2011). Teachers can point out something familiar to the students before introducing new content to help them connect. They can also point out real world application of the content. For example, the teacher can explain using fraction addition to calculate changes necessary when altering a recipe or sharing a sandwich.

Teachers can differentiate content by interest by using examples specific to the students' culture or by providing mathematical problems from local engineers. The process can be differentiated by allowing them to use their knowledge in an area of their choice. Some students can work with fraction problems in a recipe context, some in a furniture-building example, and others in an equal sharing context. Each of these contexts can then be used for an authentic performance tasks thereby differentiating by product.

Differentiating for student learning profile. Students' learning profile may determine how their needs are met in the classroom. Whether they prefer noisy or quiet classrooms, group or individual work, learning about the big picture or the details can all influence their ability to learn the content (Tomlinson & Imbeau, 2010). The profile of a student may be determined by their learning style, their intelligence preferences, their culture, or their gender. The learning style can determine how they learn, how they explore, or how they interact with the content. It is important that regardless of his or her learning profile, that each student has a specific content related target to reach.

Differentiating the content by learning profile asks the teacher to present material using multiple formats and to include the topic overview as well as the details. By using a variety of materials the teacher can check the resources against cultural or gender bias. When differentiating the process teachers may include individual and group work. They may include competition and collaboration in their choices of activities. Using tasks with concrete outcome can be used along with tasks that are more abstract. In order for the summative assessment, the product, to be differentiated the teacher may offer analytical, practical and creative methods of expression.

Differentiating for elementary mathematics teachers. Much in the same way school administrators ask teachers to differentiate for their students, PD providers must also differentiate for teachers. We must ask ourselves the same question: "What does *this* student need at *this* moment in order to be able to progress with *this* key content, and what do I need to do to make that happen?" (Tomlinson & Imbeau, 2010, p. 14). There are "substantive differences" in our teaching force (Goldschmidt & Phelps, 2010, p. 437). Teachers differ in their use and handling of errors and misconceptions, in their ability to lead mathematical discussions, and in their own mathematical knowledge (Bray, 2011). To lessen this gap, PD needs to meet the needs of individual teachers and to align their specific feedback to their evaluation results (Kane & Staiger, 2012; U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010).

Teachers need respectful and differentiated tasks based on an assessment of their needs (Strickland, 2009). They also need to be a part of flexible grouping opportunities. Differentiating for teachers should be a systematic and consistent part of any PD plan. Professionals can differentiate for teachers in many ways including their readiness level, their diverse interests, and their unique learning preferences.

Content presented to learners needs to be "a little too difficult" and there should be a support system in place to help with any difficulties (Tomlinson & McTighe, 2006). When differentiating for teachers the content may change based on their readiness level, such as their MKT, their interests, or their learning profile. Teachers with lower MKT need to spend more time working with conceptual knowledge and matching their procedural knowledge to it (Bray, 2011; Wu, 2009). These teachers tend to use student errors to point out procedural mistakes instead of applying conceptual knowledge to the error. These teachers also need more training in multiple responses. They often judge a student's problem solving method based on whether it follows the traditional algorithm and they are often uncomfortable with alternative algorithms (Gutierrez, 2010; Hill & Ball, 2009). Novice teachers may also need the content differentiated. They are more likely to struggle with creating helpful examples than experienced teachers (Zodik & Zaslavsky, 2008). They need help understanding some of the more common mistakes teachers make in creating examples to use with students.

When differentiating PD content by interest, the provider may way to show video exemplars of good teaching (Kise, 2006). This will help connect the PD to their classroom. Teachers may also want to visit classrooms to observe the expected teaching practice. They may need a clearer picture of how this practice will increase student achievement. Teachers with many years of experience may need to see proof of how the new practice is better than the way they have been teaching.

The process of PD for teachers can also be differentiated by readiness, interest, and learning profile. It can vary from individual learning, to group or individual coaching, to PLC work, to large group staff training (Kise, 2006; Kose, 2007). Kise (2006) suggests asking participants to describe their ideal staff development day. This helps the provider to identify learning profiles and interests.

The products from teacher PD are the actual classroom practices of the participants. Differentiating this area according to readiness, interest, or learning profile requires adapting the assessment method. One possibility is to create an assessment portfolio. This portfolio may include multiple observations, videos of instruction, samples of student work, lesson plans, or individual feedback sessions (Kane & Staiger, 2012; Tomlinson & McTighe, 2006).

Differentiation allows teachers to meet individual needs whether the teacher is teaching children or adults. In order to meet the demands of the CCSS Mathematics our teachers will need PD that is specific to their needs, their knowledge and skill level, and their experiences. This project will address those specific differentiation needs within an effective PD program.

Common Core State Standards Mathematics

Schmidt, Houang, and Cogan (2002) determined that American students "were greatly disadvantaged" by the fact that we do not have a coherent, common curriculum. Despite rare concerns that the CCSS will cause "irreversible damage," forty six states have adopted these standards (Zhao, 2009, p. 46).

These standards were written to contribute to a focused and coherent curriculum. The CCSS Mathematics addresses the need for deep conceptual understanding of the mathematics along with the necessary procedural fluencies (Common Core State Standards Initiative, 2010).

The CCSS Mathematics includes two sets of standards. The Standards for Mathematical Practice include the habits of mind, processes, and proficiencies that is required of our students. These practices also provide a connection for students to interact with the Standards for Mathematical Content.

According to Wu (2011), these standards address topic of critical importance in mathematics education: clarity and precision, continuity, and reasoning.
Teaching mathematics with a constant focus will give students and teachers the necessary time to understand the content deeply (Wu, 2011). Burns (2007) suggested that the focus stay on the mathematical content not on the class assignments. The CCSS Mathematics helps to focus instructional time on an explicit, specific set of goals.

The coherence of the CCSS Mathematics demonstrates how topics flow along a learning progression and throughout a grade level. For example, students in first grade focus mostly on number even when they are studying geometry or measurement. In second grade the students add to their understanding of number and learn more about our place value system. While each topic in mathematics is interwoven into a "whole tapestry," these standards show the movement and flow in and between topics (Wu, 2009).

The CCSS Mathematics was developed to meet the needs of our society. These standards will help to ensure that our students graduate from high school career and college ready. Our teachers will need assistance teaching to these, more rigorous, standards. These teachers happen to be graduates of the "very system that we seek to improve" (Ball, Hill, et al., 2005). Wu (2011) asserts that the most important goal of PD is to replace the misinformation these teachers received during their years in school. Teachers are the key to the success of the CCSS Mathematics (Wu, 2011). Teachers will need to know how to teach the mathematical content effectively which requires that they see a connection between school math and real math (Wu, 2011). This will help to make the mathematics worthy of instructional time. Teachers will need to understand fully the learning progression of the content they are teaching so that they can find the content entry point for their students (National Council of Teachers of Mathematics, National Council of Supervisors of Mathematics, Association of State Supervisors of Mathematics, and the Association of Mathematics Teacher Educators, 2010).

Instructional Design

One method of instructional design is Understanding By Design (UbD). This is a framework for curriculum planning (Wiggins & McTighe, 2011). This type of design helps teachers set goals, assesses those goals, and plan learning tasks related to meeting the learning goals. Teachers should be focusing on student learning rather than on delivering content. Preparing to teach mathematics to children requires “far more work” than expected (Beckmann, 2011). Planning in mathematics requires that the teacher help the students to see the topics as an interwoven whole, not as a set of disconnected skills (Burns, 2007).

Excellence in mathematics does not always translate into excellence in teaching mathematics (Beckmann, 2011). Teachers who are confident in their mathematical abilities and in their MKT “tend to spend more time planning, designing, and organizing” their instruction (Zambo & Zambo, 2008, p. 159). Teachers confident only in their mathematics, but not in their ability to help their students learn mathematics often fall back on procedural techniques instead of conceptual knowledge.

Setting the goals. Integral to the UbD process is determining what it will look like when the student is able to transfer the learning to new situations. Teachers teach the content, but they must also ensure that students are able to use the content in a meaningful way. This requires that the teacher set clear goals and make plans to assess each of those goals (Tomlinson & McTighe, 2006). In order to determine exactly what students should know, understand and be able to do, teachers must closely examine the standards themselves. The progression of the CCSS Mathematics domains needs to be fully understood by the teacher in order to set appropriate goals. Using a term coined by Ma (1999), teachers need to have “Profound Understanding of Fundamental Mathematics” (p. 124). As teachers learn more about the mathematical domain they are teaching, their competence increases (Zambo & Zambo, 2008).

Setting goals using the UbD model includes determining three types of goals: transfer, meaning, and acquisition. The transfer goal is the “long-term aim of all education” (Wiggins & McTighe, 2011, p. 14). This goal helps the learner to see that the mathematics they are learning transfers to their life outside of school and to their future as an adult. We want our students to see the need to think mathematically for other purposes besides simply learning mathematics (Hopkins, 2007). The meaning goal is reliant upon understanding the content. This is where the student interacts with the content is able to draw inferences, make connections, and apply their learning to new situations (Wiggins & McTighe, 2011). The third type of goal is the acquisition goal. These goals include the specific knowledge and skills necessary to learn the content at a deeper level. The next step is to plan the assessments that assess each of these goals.

Planning for assessment. When planning for assessment, teachers consider the evidence they need to determine if the goals have been met. Students should be able to apply and explain the content (Wiggins & McTighe, 2011). Assessment in this case may range from a short quiz on a specific skill to a performance task involving using the abstract knowledge in a practical way given a new situation. When considering assessment validity Wiggin and McTighe (2011) suggest asking two questions: "Could the student do the performance but not understand? And vice versa: Could the student do poorly at the specific test but still be said to understand based on other evidence?"(p. 90). Burns (2007) reminds us that a student answering a problem correction is not sufficient evidence of their learning. A true assessment requires that they provide an explanation of their thinking. The CCSS Mathematics provides this view of assessment:

> These Standards define what students should understand and be able to do in their study of mathematics. Asking a student to understand something means asking a teacher to assess whether the student has understood it. But what does mathematical understanding look like? One hallmark of mathematical understanding is the ability to justify, in a way appropriate to the student's mathematical maturity, why a particular mathematical statement is true or where a mathematical rule comes from. There is a world of difference between a student who can summon a mnemonic device to expand a product such as $(a + b)(x + y)$ and a student who can explain where the mnemonic comes from. The student who can explain the rule understands the mathematics, and may have a better chance to succeed at a less familiar task such as expanding $(a + b + c)(x + y)$. Mathematical

understanding and procedural skill are equally important, and both are assessable using mathematical tasks of sufficient richness (Common Core State Standards Initiative, 2010, p. 4).

Designing the learning tasks. Good pedagogical practices and mathematical instruction are based on the teachers' ability to appropriately choose a task, problem, or activity for the students to engage in (Corey, Peterson, Lewis, & Bukarau, 2010). Teachers should provide students with tasks that are intellectually stimulating as this "appears to be the most important feature of a high-quality mathematics lesson" (Corey, et al., 2010, p. 450). Umland (2012) has defined a mathematical task as "a problem or set of problems that focuses students' attention on a particular mathematical idea and/or provides an opportunity to develop or use a particular mathematical habit of mind."

Tasks can include concepts and procedures. While a task can also be used as an assessment, learning tasks should be designed only after the goals and the assessments are clear. The lessons are a reflection of those goals and assessments (Breyfogle & Spotts, 2011). When planning mathematical tasks, teachers should take the time to plan for linking the visual representations with the symbolic representation (Gersten, et al., 2009). These connections are best made explicitly during instruction (Burns, 2007).

Summary of Literature Review

When planning this project I considered the four topics in the literature review: PD in mathematics, differentiation, CCSS Mathematics, and Instructional Design. I chose these topics after analyzing my data. Each topic provides a critical piece of the design of the final project.

When planning or providing PD for teachers, it is important to remember that PD should be content focused, it should have a coherent plan, it should be realistic to the needs of a classroom, and it should include a student data component. PD should take place over multiple sessions, and last for a substantial number of hours, a minimum of 14 hours has been shown to improve student achievement (Yoon, et al., 2007). Effective PD allows the teachers the time to collaborate with their colleagues and helps them to see the link between the standards, the materials, and the summative assessments in their district. Teachers may insist on proof that this new information is worth changing their practices. An effective PD provider will ensure that this takes place. The module design for this project provides a framework for an ongoing, embedded PD implementation. PD providers can choose between 12 and 45 hours to complete over the course of two years. These hours can be differentiated as needed.

Differentiating for teachers requires that the PD provider discover what each teacher needs to interact with this content, and what they, the PD provider, can do to help that happen. Differentiation during PD can take multiple forms. Teachers should have access to flexible grouping opportunities according to their needs. This may include their readiness level in learning or in teaching mathematics. It may also vary according to their unique interest or learning preferences. PD can have many formats including individual learning, coaching, PLC work, or large group trainings. It is important to find out the preference of the teachers involved. One method of differentiating the product of a PD is to help the teachers create an assessment portfolio of their learning. This can include videos, student work samples, or observations. I addressed each of these differentiation aspects in the Focus on Mathematically Proficient Students training module project.

The CCSS Mathematics was created in response to a particular need: to ensure that our students graduate career and college ready. These standards include the Standards for Mathematical Practices and the Standards for Mathematical Content. These standards address the mathematical habits of mind and a coherent, focused progression of mathematical learning in the domains. These standards require that the student understands a topic and that the teacher is able to assess that understanding. Several of the modules in this project are specific to the CCSS Mathematics. Many of the other modules address that same issues that the CCSS Mathematics was intended to address, such as instructional focus and coherence.

Instructional design includes three components: goal setting, assessment design, and design of instructional tasks. This helps the teacher and the students see the topics as an interwoven whole instead of a set of isolated skills. Planning well takes a great deal of time, but being clear about the goals is necessary to ensure that each learning activity has a purpose. Two of the modules in this project focused on learning the UbD structure to enhance instruction. I formatted all of the modules according to the UbD structure in order to emphasize the value in using this format for planning.

Implementation

Using the four main goals of the PRIME Leadership Framework and the 16 sub goals, I created 45 modules for PD. Each module takes approximately 75 minutes and includes PD provider notes with goals, links to materials, and videos. Some of the modules include PLC discussion questions and some include specific book sections to read and discuss. I created these modules following the UbD format of creating goals, assessments, and lessons. Each module session should begin with time for reflection about the last session. During this time, teachers share their experiences with the content from the previous session and reflect on the essential questions.

PD providers, instructional coaches, or administrators can use these modules with their teachers as needed. Each participating teacher will have access to an online folder and will be given a binder in which to store each handout or resource. I will revise these modules as needed and eventually put into an online format for our rural teachers to use. PD providers will be asked to commit to a minimum of 12 modules for each group of teachers over the course of two years.

Resources and Existing Supports

There are several systems available to support this project. In the XYZ School District, there is a team of instructional coaches called Implementation Specialists. There are approximately 30 teacher coaches on this team, each of whom is responsible for 3-5 schools. Part of my assigned duties is to train this group in elementary mathematics. This team will be crucial to getting the modules out to the teachers. Another support that is already in place includes releasing students 45 minutes early every Wednesday in every school. This allows for 75 minutes of training time or PLC work every week. Some schools may be able to provide funding for substitute teachers to cover classes while the classroom teachers work on a module.

Barriers

If the trainings took place during the school day, each school would have to use their budget to cover the expense of the substitutes, making this not an ideal option. Some of our schools have Title I money or available PTA funds. Other schools do not have this as an option. These schools may need help from the grant department to write grants specific to this project.

Another potential barrier may be whether the district approves of this proposed project. I will need time to present the overview with the Implementation Specialists and building coaches, which will require approval from their supervisory team. I will also need permission for them to attend the twice-monthly training sessions.

Another barrier may be the administrator of the schools with whom the Implementation Specialists are working. School administrators will decide independently whether to participate in these module trainings. The administrator may decide to include only certain modules instead of following the suggested guidelines.

Timetable

I will present a project overview to the Implementation Specialists group along with the lists of modules and suggestions for their use. Our district also has instructional coaches assigned to only one school who are welcome to attend this overview training. I will also present this overview to the administrators at either their summer institute or at their quarterly meetings.

After the overview training is complete, I will offer train-the-trainer days on the modules, beginning with the Equity goals. I will combine 4-6 modules into a day of training. This will take approximately ten days to complete all of the modules with the trainers. By scheduling two training days a month for the first half of the 2012-2013 school year, all of the modules will be available to the participating Implementation Specialists, coaches, and administrators for use by December 2012. They can then schedule their own trainings dependent upon the needs of their schools. Concurrent with these trainings, I will begin to use the modules in a few schools that I work with closely. My expectation is that it would take at least 2 years to complete all of the modules if a school chose to work on all of them.

Roles and Responsibilities

I will have several roles in this project. I will be training the PD providers while also presenting the modules to teachers. I will be coordinating the module access and revising the modules as needed. I will meet with the instructional coaches, Implementation Specialists, or building administrators to devise a plan specific to the needs of their school and coordinating the schedules to implement that plan. I will also be putting the modules in an online format to allow for further access.

The PD providers will have a few responsibilities after they have attended a module training session. I will ask that each PD provider commit to completing a minimum of 12 training modules with each group of teachers over the course of two years. The PD provider must report names of all participants with whom they use the module, and they must collect feedback after completing each module. I will use these data as part of the project evaluation.

Project Evaluation

This project will be evaluated using multiple formats including data collection on module use, module feedback, and formative and summative assessments of teaching practices. Hill (2007) suggests that local PD and its effect on student learning is "rarely evaluated" (p. 111). Teachers may be required to attend PD, but there is rarely an assessment of their learning after the PD. Occasionally teachers may be asked if they think they have learned anything from the PD, but this self-reporting does not show if instructional changes were made.

Formative Assessment

I will collect feedback at three different levels throughout the module use, including all stakeholders in the evaluation process. First, I will ask each PD provider to supply every module participant with a feedback form. These forms will include evaluation of the module itself and of the module delivery by the PD provider. I will also ask the PD provider to use the same evaluation form to evaluate the module and of the ease of delivery. I will ask that these evaluation forms be turned in within 10 days of the module completion. I will use the collected module feedback to revise each module as necessary.

Another evaluation will take place after the completion of 12 training modules. This will be an overall evaluation of the modules as a group, the PD providers, and of the program itself. In this evaluation, I will include the participants themselves, the PD providers, and the building administrators of the participants even if they were not participants in the modules themselves.

The third evaluation involves instructional observations. The PD providers will observe the teachers as they teach mathematics, unless the provider is responsible for their evaluation. In that case, another Implementation Specialist or coach will do the observation. The PD provider will then meet with the teacher to discuss areas of strength and suggestions for improvement as suggested by Gersten et al. (2009). The PD provider will individualize this feedback and ensure that it is not used for formal evaluation purposes.

The tool used for these observations will be the Mathematical Quality of Instruction Lite (MQI Lite), developed by Hill. This instrument has been found to be reliable and valid (Kane & Staiger, 2012). It has been positively associated with student achievement when combining multiple observations. It includes a three-point scale of low, medium, and high, checking for six elements during instruction.

Summative Assessment

I will use three different summative assessments: the MKT, the observations, and student achievement data. All participants will take the MKT assessment online using the TKAS system before and after the module trainings, unless they did not complete at least 12 trainings. This will require careful records of module participation. I will compare the participant scores on the initial MQI Lite to the score on the final MQI Lite.

The Implementation Specialist and Coaches will not have MQI scores because they do not have regular classes to teach.

I will consider student achievement data with caution. I will not use these data to determine if there has been a change in the effectiveness of the teacher, but I will use it to compare schools that did participate with schools that did not participate. Since adopting the CCSS Mathematics, Nevada is currently transitioning to a new assessment format. This prevents me from using student data as a pre- and post- test as the test will change dramatically.

Implications for Social Change

Just as this project is differentiating PD for teachers, it is my hope that this will also encourage teachers to differentiate their instruction in response to the children in their classrooms. Differentiation requires that the goals remain the same for all students, but that the instructional techniques vary according to their needs (Tomlinson & McTighe, 2006). All teachers and all students should be required to participate in educational experiences that require high-level thinking. Teachers and PD providers should plan these experiences in response to the students' needs and to the learning goals. Teachers and students should be working on authentic tasks that help them to understand the big ideas and challenge them to interact with the material in a meaningful way. Teachers should be providing appropriate instruction and a challenging curriculum in order to meet the needs of their diverse learners (U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010). This project will do the same for the teachers in their learning.

Improving a teacher's MKT and their quality of instruction may help to alleviate some of the achievement gaps between our students. As Ball et al. (2005) explains, "one important contribution we can make toward social justice is to ensure that every student has a teacher who comes to the classroom equipped with the mathematical knowledge needed for teaching" (p. 44). Improving mathematical instruction by relating that instruction to individual students and to their lives will help to ensure that social justice exists in our school system (Gutierrez, 2010; Root, 2009). One way to address the social justice issue is to empower individual students and teachers by raising their mathematical competency (Wager & Stinson, 2012). By allowing students and teachers to take the time to acknowledge their strengths and their weaknesses, the true learning process can begin for everyone.

Section 4: Reflections and Conclusions

Introduction

This section contains many reflections and conclusions about this doctoral study. It begins with a discussion of the strengths of this project, which includes many aspects of the project design and the resulting PD modules. While there are several limitations in this project, there is a section which includes several suggestions for remediating them. This is followed by an explanation of how my definition of scholarship has changed throughout this doctoral journey. My view of scholarship is clearer now.

Also in this section is a discussion of the development of the project and its evaluation and my thoughts about leadership and change. Educational leadership requires balancing of multiple items and deep reflection of practice. The next three sections are an analysis of self as a scholar, as a practitioner, and as a project developer. While I consider myself a high-level scholar, practitioner, and project developer, I humbly acknowledge that I still have so much to learn.

The last two sections are arguably the most important in my work: social change and future research. This project is of little worth unless it enacts social change. If it does not help to close the achievement gap in our students and in our teachers, it should not continue. While this project has answered many questions for me, much more research is needed in this area.

Project Strengths

There were several strengths in this project beginning with the design of the research and ending with the format of the final project. I collected the research data anonymously from a variety of participants working within a variety of randomly selected schools. The participants included beginning teachers and experienced teachers. There were teachers who reported having no mathematical training in the last five years, teachers who reported 40+ hours, and all categories in between. At the time of the study, the teachers were working in schools from each category of socioeconomic level.

After analyzing the data, I developed a project based on the results and the current research. The data indicated a need for differentiating PD to meet the variety of needs within our local teaching force. One school can have a teacher at the lowest end of the MKT range and a teacher next door at the highest end. Another teacher in the building may report a strong classroom focus on estimation and a teacher in the same grade level may report a weak focus. Down the hall a teacher may report a high level of confidence in preparing their students, while another teacher does not feel as confident. Our incredibly busy teachers deserve training that fits their personal needs, while addressing the needs of the district.

PD providers should not consider this project a list of “one-shot” trainings. I designed this project to provide ongoing training using multiple formats and differentiated content. I incorporated the current PD system of the district, with some suggestions for other possible formats. Time to implement and reflect on the content from each module were included as part of the basic format.

One particular strength of this project was the inclusion of all stakeholders. While I collected the data from teachers and schools, the resulting project included teachers, instructional coaches, Implementation Specialists, and building administrators. My current position requires that I provide training for all of these stakeholders, so including each group in the project increased my effectiveness at my job.

Recommendations for Remediation of Limitations

This project has a number of limitations. Within the data collection there was a great difference between the number of participants in the survey and the number of participants in the MKT assessments (N=134 and n=44, respectively). I did not foresee this and therefore I did not make provisions for it within the design of the study. One change I would make to address this issue is to include a few survey items asking about the participants' decision-making process in deciding whether to take the online assessment.

I would also be more careful in the timing of my data collection. IRB approved my data collection at the beginning of February. It took until the end of March to collect all of the data. I think if I would have been able to collect data earlier in the year, even a month or two earlier, I would have had more teachers choose to take the MKT assessment. Asking teachers to commit to even one hour of extra work especially right before the district spring break, without an immediate benefit was difficult. Scheduling the initial presentations with schools also proved to be very complicated. Schools are very busy places and some administrators were difficult to contact for scheduling.

Another limitation of the project was the XYZ School District's focus on textbook training. While this focus was necessary in order for teachers to implement the adopted materials effectively, these trainings take time away from the module trainings. One way to address this issue would be to institute a more collaborative format between the PD providers in the district. This would allow the module-training providers to incorporate effective textbook use in the modules and vice versa.

I could have studied the problem studied in a very different way. While I chose to focus on the teachers' MKT, I could have chosen to focus more on the quality of their day-to-day instruction. Using a qualitative format, I could have done more teacher interviews or more student and teacher observations. I also could have researched the current level of student achievement in the teachers' classrooms. These are all areas for possible future study.

One very concerning limitation is the control of the module use. While building administrators have the final say on which modules are used with their staff, this may sometimes defeat the differentiation format of the modules. A principal, instructional coach or Implementation Specialist may choose to use only one or two of the modules instead of the recommended minimum of 12. This issue will require a balance of module use control and respect of the professionalism of the PD providers.

As is the case with many educational issues, the cost of module trainings may be prohibitive. If the school is not able to use these modules within the early release format, they will have to find another time to use them. This will require that they find money for substitutes to release teachers from the classroom for training or money for stipends to pay teachers to participate outside of their contract time. Fortunately, the school district has an entire grant department, which schools can utilize to procure funding. The district has several community partners who may choose to underwrite this training.

Scholarship

My definition of scholarship has changed throughout my years in this program. Previously, I associated scholarship with knowing. Now I associate it with questioning. I thought scholarship required a certain level of education; now I think it requires a level of understanding that is continuously developing. I separated "real" scholars from popular scholars, not looking closely enough to see that real scholars could also be popular.

Throughout this journey, I have developed a great respect for professionals who are able to implement current research findings into their daily teaching practices. This requires a level of time and commitment that is especially challenging for classroom teachers.

Scholarship requires willingness to listen to feedback and criticism, which is one of the requirements for calling an article or paper scholarly. The term "peer-reviewed" has taken on a completely new meaning for me. Once it was simply a possible checkmark in a database search. Now I understand the depth of the peer-reviewed requirements. As a result of this doctoral process, I began peer-reviewing articles for a National Council of Teachers of Mathematics journal called "Teaching Children Mathematics." I have also read many peer reviewed articles that I did not think were scholarly, which made me question the integrity of the particular journal.

Project Development and Evaluation

The most important thing I learned in the development of this project was that my expectations of the data results were getting in the way of what the project really needed to be. Before collecting the data, I thought the project would be a training that teachers could attend. I thought this would be a weeklong training and would incorporate the necessary content. The final format for the project was developed because I knew our teachers did not need just another training. They did not have time to sit through even a small portion of a training that did not fit their needs. I also quickly realized that my format needed to utilize the existing system of support in order to make it cost effective for schools to implement. If I was really going to find a way to differentiate according to their needs, I needed to find out exactly what those needs were. My data revealed many needs, but I still have many questions about their other needs. While many, many hours went in to the details of creating this project, I will not know the real strengths and weaknesses until it is implemented. The bottom line is whether or not the training modules change teaching practices and affect student achievement. Time will tell.

Leadership and Change

Change is the name of the game in leadership. Leadership requires a change in thinking, a change in learning, and a change in reflective practice. It requires balancing professional respect with insisting on the best use of instructional time. It requires balancing scholarly research with individual needs. It requires balancing the needs of the teachers while insisting that student achievement stay at the forefront of every decision.

Educational leadership requires acknowledgement that sometimes the most difficult task is to balance the egos of the adults. Every stakeholder has an agenda determined by what he or she truly thinks is best. In my district, we talk about the importance of teachers collaborating, yet we have at least five departments providing trainings for teachers and administrators who work independently of each other. Collaboration is not the norm. However, even though it is rare, when it does happen, the results are remarkable.

One big change in my personal leadership came through the data collection process. I was essentially trying to push my agenda on schools whose administrator may or may not have believed in the value of my agenda. I was asking teachers to help me without an immediate payoff. I have worked with almost forty schools in the past two years, many of which were included in the study. Because of this, I believe many teachers participated simply out of loyalty to me. I also believe that many teachers decided not to participate out of fear that the data collection was not truly anonymous. I saw a fear in the eyes of some teachers when they understood what I was asking them to do. I saw a defensive wall go up many times during my presentations. Many teachers were afraid. They were afraid that other people would see their scores, they were afraid that their own mathematical skills would not measure up in some way. I have a much greater respect now for this fear. This realization has made me a better leader and a much better trainer.

Analysis of Self as Scholar

I learned many things about myself as a scholar throughout my time in this program. Scholarship requires a skill for saturating the literature before making claims. While I am not sure I ever completely saturated the literature, my skills certainly improved to the point of the available literature becoming redundant. Scholarship requires a high level of library skills, which I have acquired, thanks to this journey. I am actually worried about the time when I will not have full access to Walden's wonderful library. After several semesters, I started to recognize when my research was relying too much on a certain author or group. I began seeing how the limitations section of a research document heavily influenced my belief in the integrity of the author(s). Scholarship requires a conceptual understanding of statistics that I certainly did not have when I started. When writing the results, I wrote paragraphs with ease that I would not have understood three years ago. I certainly still question my statistical abilities, but I am much more confident in reading the results sections and not simply moving on to the discussion of the research.

As a scholar, I appreciated some of the best advice given to me over the course of my journey. I created a numbering system and a spreadsheet to organize my references. I used a to-do list so that every moment I was able to work on something if I had time. My study improved when I followed the advice from IRB to make my data collection anonymous instead of confidential. I think that this step improved my participation rate. I followed the advice to "just start writing" that came from my committee chair, Dr. Gary Schnellert. I looked closely at the suggestions and comments from Dr. Douglas McBroom that improved my writing greatly and helped me to embrace feedback. A colleague suggested that I choose a topic about which I was completely passionate. My passion for elementary mathematics instruction never wavered. Perhaps the most important advice came from Dr. Heather Miller who suggested that the best doctoral studies are the ones that get finished. Because every article I read lead to many more fascinating articles, I had to learn that not all of them were necessary for my study. I had to start a list of articles to read after I graduate.

Analysis of Self as Practitioner

My effectiveness as an educational practitioner has greatly increased throughout this doctoral journey. When I begin this program, I was a classroom teacher also working as an assessment manager for my elementary school. I was able to implement the research that I was reading into my classroom and into my school. Then I became an Implementation Specialist working in multiple schools. This position was at the forefront of my thinking throughout this project. I believe that this group of around 30 talented individuals is the key to effective PD reaching our 63 elementary schools. I am currently a mathematics trainer working with multiple school sites in multiple counties. This project has made me more cognizant of the fears teachers have about their own mathematical abilities. I am able to calm some of those fears by acknowledge them and by suggesting that the implementation of the CCSS Mathematics provides an excellent learning opportunity for all of us.

I have been able to challenge some of the thinking that occurs in my district. I no longer simply accept metanalysis of research. I insist on primary sources for research. When my thinking contradicts the thinking of my colleagues, I am able to back up my position with research. Or I can respectfully and humbly back up their position with research!

Analysis of Self as Project Developer

Once I chose the skeletal format for the project, I was able to envision the rest of the project quickly. While the project is complete for my doctoral degree, it will need many modifications and revisions before I will call it complete. Only when I am sure the trainings are effective will it be finished. Only when I am confident it is meeting the needs of the teachers, improving instruction in the classrooms, and improving student achievement will I feel completely ready to turn it over to widespread use.

The Project's Potential Impact on Social Change

Without a doubt, this work was the most important, fulfilling, frustrating and demanding work that I have done in my 20 years in the educational system. I realized years ago that I needed to expand the help that I provided to teachers. I was a teacher leader in my building, but I was not affecting the change I sought after. This project has given me the confidence and the drive to move beyond my school to work at the district level. This project is important for the many stakeholders that I work with on a daily basis.

The first group of stakeholders impacted is the administrators and PD providers. They are all trying to increase student achievement by providing high quality PD for their teachers. This module format will help guide them to use resources worthy of the task. It allows them to differentiate the content as needed to meet the specific needs of their teachers.

The second group impacted is the teachers themselves. PD providers will offer trainings that fit their needs, their interests, and their preferred learning styles. I created this project to meet the needs of teachers who may not have received the math instruction that they needed as children. I intended not only to provide them with instructional strategies, but also to increase their competence and confidence in their own mathematical abilities. By empowering teachers, I believe we can initiate social change.

After implementing this project within my district's 63 elementary schools, I can expand its use to the other five counties with which my department works. The Nevada state education department can also use this project after the online format is completed. This can be an addition to the state website, increasing the possibility of its use by our rural teaching force.

Of course, the most important stakeholders impacted by this project are the students in the classrooms. This is where the real social change occurs. We have an obligation to provide all of our students with instruction that meets their needs, helps them to learn the content, and begins to close the gaps created by social inequities. I believe this project will address social justice by helping our teachers meet the demands set before them.

Implications, Applications, and Directions for Future Research

Educating a child changes the trajectory of their lives. Children who excel at mathematics have a world of opportunities open to them. When discussing my research with other educators I have often heard their enthusiasm for research in elementary mathematics. The implications of this project are far reaching. Administrators can improve their PD plans for teachers. Teachers can use each module as a learning tool to improve their instruction. Students in each classroom can benefit from this improved instruction.

The data collected in this project showed a wide-ranging skill level in our teaching force. We cannot expect to meet the needs of every teacher in the building without acknowledging this diversity. As PD providers and planners, we are responsible to ensure that our PD increases the achievement level of all teachers and all students.

Future research can take many forms. First, a study with a larger sample size would help to solidify or contradict these findings. Second, I would suggest that researchers question the reasoning behind the choice to participate. I wonder if the teachers who did not participate were fearful of taking a math assessment or if they simply did not have the extra time to participate.

Future research should also be conducted on all of the current PD in which the teachers are involved. With at least five departments offering PD in this district, it is possible that some of this PD is contradictory. It is also possible that teachers are not making the connection between each separate PD offering.

Conclusion

This project had many strengths from its data collection to the development of the PD modules. I collected data anonymously from a random selection of schools. These schools represented a balance of socioeconomic levels and second language learner populations. The teachers included in the sample represented a variety of classroom experiences and a variety of skill levels in mathematics instruction.

I created the resulting PD modules in order to address the widely diverse needs of our teachers and schools. These modules include many content areas and can be used in multiple formats in order to differentiate the PD for the participating teachers. It includes many different stakeholders from administrators to coaches to teachers.

While there were several limitations to this project, this section included several suggestions for remediating those limitations. There was a great difference between the number of participants in the sample and in the subset. This could have been prevented by insisting that participation requires both the survey and the MKT assessment. It also could have changed if the timing of the initial presentations was different. Another limitation is the lack of collaboration between departments in providing PD to our teaching force. This could be rectified by developing a collaboration plan to ensure that our teachers are receiving coherent training.

Throughout my years in this program, my definition of scholarship has advanced. Scholarship once meant knowing and now I associate it more with questioning. I have increased my respect for scholars and I have developed enthusiasm toward feedback and criticism.

Through the development of the project, I learned to keep my expectations from getting in the way of the actual data results. I learned to focus on exactly what the data was telling me. I decided to utilize existing systems of support in my district in order to cut the costs. I analyzed my data more carefully than I originally thought was necessary in order to determine the exact needs of our teachers.

The balancing act of leadership requires careful planning and foresight. For me it requires that I look at the agenda of others with the assumption that they are proposing what they truly think is best. The collaborative process is a difficult one, but the results from collaboration positively affect all of the stakeholders. For years, I have called myself a "math person." I am very careful now not to say these words. If I truly believe that all of our students can learn mathematics at a high level, then I should also believe that my math skills were the result of good instruction. It follows then that teachers who are not confident in their math abilities were not taught the way they needed to be taught. It is part of my mission now to help them to learn what they missed in school and to increase their confidence in their abilities by helping them to learn.

I have grown as a scholar, practitioner, and project developer throughout this process. I back up my claims with research. I actually read the results sections of research now, I understand the statistics, and I focus more on the methodology. I have maintained a passion for elementary mathematics and the research about it. I have learned to "just write" and to remember that the best study is one that is finished.

Most importantly, I believe in my project's potential for enacting social change. Inequities abound throughout our educational system and this project offers one method for addressing those inequities. The module-training project allows PD providers to differentiate their PD to meet the specific needs of teachers, thereby helping those teachers to meet the needs of their students. Social change can occur in every classroom, one student and one teacher at a time.

References

Aderinto, J. A. (2005). An overview of selected theories of adult learning. *International Journal of Learning, 12*(12), 139-143.

Alonzo, A. C. (2007). Challenges of simultaneously defining and measuring knowledge for teaching. *Measurement, 5*(2-3), 131-137. doi:10.1080/15366360701487203

Arbaugh, F., Herbel-Eisenmann, B., Ramirez, N., Knuth, E., Kranendonk, H., & Quander, J. R. (2010). *Linking research & practice: The NCTM research agenda conference report.* Reston, VA: National Council of Teachers of Mathematics.

Bailey, L. B. (2010). The impact of sustained, standards-based professional learning on second and third grade teachers' content and pedagogical knowledge in integrated mathematics. *Early Childhood Education, 38*, 123-132. doi: 10.1007/s10643-010-0389-x

Ball, D. L. (2003). What mathematical knowledge is needed for teaching mathematics? *Secretary's Summit on Mathematics.* Washington D.C.: U.S. Department of Education.

Ball, D. L., Hill, H. C., & Bass, H. (2005). Knowing mathematics for Teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *American Educator, 29*(3), 14-17, 20-22, 43-46.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389-407. doi: 10.1177/0022487108324554

Bamberger, H. J., Oberdorf, C., & Schultz-Ferrell, K. (2010). *Math Misconceptions: From Misunderstanding to Deep Understanding.* Portsmouth, NH: Heinemann.

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., . . . Tsai, Y.-M. (2010). Teachers' mathematical knowledge, cognitive activation in the classroom, and student progress. *American Educational Research Journal, 47*, 133-180. doi: 10.3102/0002831209345157

Beckmann, S. (2011). From the Common Core to a Community of all mathematics teachers. *The Mathematics Educator, 20*(2), 3-9.

Bell, C. A., Wilson, S. M., Higgins, T., & McCoach, D. (2010). Measuring the effects of professional development on teacher knowledge: The case of developing mathematical ideas. *Journal for Research in Mathematics Education, 41*(5), 479-512.

Benjamin, A. (2011). *Math in Plain English.* Larchmont, NY: Eye on Education.

Bray, W. S. (2011). A collective case study of the influence of teachers' beliefs and knowledge on error-handling practices during class discussion of mathematics. *Journal for Research in Mathematics Education, 42*(1), 2-38.

Breyfogle, M., & Spotts, B. (2011, March). Professional development delivered right to your door. *Teaching Children Mathematics*, 420-426.

Brown, K. M. (2006). Leadership for social justice and equity: Evaluating a transformative Framework and andragogy. *Educational Administration Quarterly, 42*(5), 700-745. doi: 10.1177/0013161X06290650

Burke, K. (2010). *Balanced Assessment: From Formative to Summative.* Bloomington, IN: Solution Tree Press.

Burns, M. (2007, November). Nine ways to catch kids up. *Educational Leadership*, 16-21.

Carroll, T. (2009, October). The next generation of learning teams. *Kappan, 91*(2), 8-13.

Carter, M. (2010, July/August). Drive-through training. *Staff Training*, 61-63.

Celedon, S., & Ramirez, N. G. (Eds.). (2012). *Beyond Good Teaching: Advancing Mathematics Education for ELLs.* Reston, VA: National Council of Teachers of Mathematics.

Center on Educational Policy. (2011). *Common Core State Standards.* Retrieved May 5, 2011, from Center on Education Policy: www.cep-dc.org

Charalambous, C. Y. (2010). Mathematical knowledge for teaching and task unfolding: an exploratory study. *Elementary School Journal, 110*(3), 247-278.

Chen, X., Wu, J., & Tasoff, S. (2010). *Academic preparation for college in the high school senior class of 2003-2004.* Washington DC: National Center for Educational Statistics.

Cohen, J. W. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Common Core State Standards Initiative. (2010). *CCSSI Math Standards.* Retrieved June 5, 2011, from Common Core State Standards Initiative: Preparing America's Students for College and Career: http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

Common Core State Standards Initiative. (2011). *In the States.* Retrieved June 5, 2011, from Common Core State Standards Initiative: Preparing America's students for college and career: http://www.corestandards.org/in-the-states

Corey, D. L., Peterson, B. E., Lewis, B. M., & Bukarau, J. (2010). Are there any places that students use their heads? Principles of high-quality Japanese mathematics instruction. *Journal for Research in Mathematics education, 41*(5), 438-478.

Creswell, J. W. (2008). *Educational Research: Planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). Upper Saddle River, NJ: Pearson.

Creswell, J. W. (2009). *Research Design: Qualitative, quantitative, and mixed methods approaches (3rd edition).* Thousand Oaks, CA: Sage Publication.

Easton, L. B. (2008). *Powerful Designs for Professional Learning.* (L. B. Easton, Ed.) Oxford, OH: National Staff Development Council.

Fleischman, H. L., Hopstock, P. J., Pelczar, M. P., & Shelley, B. E. (2010). *Highlights from PISA 2009: Performance of U.S. 15-year-old students in reading, mathematics, and science literacy in an international context (NCES 2011-004).* U.S.Department of Education, National Center for Education Statistics. Washington, D.C.: U.S. Government Printing Office.

Fullan, M. (2009, October). Leadership development: the larger context. *Educational Leadership*, 45-49.

Georges, A., Borman, K. M., & Lee, R. S. (2010). Mathematics reform and teacher quality in elementary grades: Assessments, teacher licensure, and certification. *Educational Policy Analysis Archives, 18*(11), 1-36.

Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J., & Witzel, B. (2009). *Assisting students struggling with mathematics: Response to Intervention (RTI) for elementary and middle schools (NCEE 2009-4060).* Retrieved February 28, 2009, from National Center for Education Evaluation and Regional Assistances, Institute of Education Sciences, U.S. Department of Education: http://ies.ed.gov/ncee/wwc/publications/practiceguides/

Goldschmidt, P., & Phelps, G. (2010). Does teacher professional development affect content and pedagogical knowledge: How much and for how long? *Economics of Education Review, 29*, 432-439. doi: 10.1016/j.econedurev.2009.10.002

Gonzalez, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D., & Brenwald, S. (2008). *Highlights from TIMSS 2007: mathematics and science achievement of U.S. fourth-eighth-grade students in an international context (NCES 2009-001 revised).* Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Gutierrez, R. (2010). The Sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education, 41*(0), 1-32.

Heck, R. H. (2007). Examining the relationship between teacher quality as an organizational property of schools and students' achievement and growth rates. *Educational Administration Quarterly, 43*(4), 399-432. doi: 10.1177/0013161X07306452

Hill, H. C. (2007). Learning in the teaching workforce. *The Future of Children, 17*(1), 111-127.

Hill, H. C. (2010). The nature and predictors of elementary teachers' mathematical knowledge for teaching. *Journal for Research in Mathematics Education, 41*(5), 513-545.

Hill, H. C., & Ball, D. L. (2009, October). The curious-and crucial-case of mathematical knowledge for teaching. *Phi Delta Kappan, 91*(2), 68-71.

Hill, H. C., & Lubienski, S. T. (2007). Teachers' mathematics knowledge for teaching and school context. *Education Policy, 21*(5), 747-768. doi: 10.1177/0895904807307061

Hill, H. C., Blunk, M. L., Charalambous, C. Y., Lewis, J. M., Phelps, G. C., Sleep, L., & Ball, D. L. (2008). Mathematical knowledge for teaching and the mathematical quality of instruction: an exploratory study. *Cognition and Instruction, 26*, 430-511. Doi: 10.1080/07370000802177235

Hill, H. C., Dean, C., & Goffney, I. M. (2007, August). Assessing the elemental and structural validity: Data from teachers, non-teachers, and mathematicians. *Measurement, 5*(2/3), 81-92. doi: 10.1080/15366360701486999

Hill, H. C., Rowen, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406.

Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing measures of teachers' mathematics knowledge for teaching. *Elementary School Journal, 105*(1), 11-30.

Hill, H. C., Sleep, L., Lewis, J. M., & Ball, D. L. (2007). Assessing teachers' mathematical knowledge. In 2nd (Ed.), *Handbook for Research in Mathematics Education* (pp. 111-155). Charlotte, NC: Information Age Publishing.

Hopkins, M. (2007). Adapting a model for literacy learning to the learning of mathematics. *Reading & Writing Quarterly, 23*, 121-138. doi: 10.1080/10573560601158446

House, J. (2004). The effects of homework activities and teaching strategies for new mathematics topics on achievement of adolescent students from Japan: Results from the TIMSS 1999 assessment. *International Journal of Instructural Media, 31*(2), 199-210.

Jacobs, V. R., Lamb, L. L., & Philipp, R. A. (2010). Professional noticing of children's mathematical thinking. *Journal for Research in Mathematics Education, 41*(2), 169-202.

Joint Task Force on CCSS. (2010). *Report of Priorities Identified and Actions to be taken in response to the recommendations of the task force.* Brookhill Foundation.

Kane, T. J., & Staiger, D. O. (2012). *Gathering feedback for teaching.* Bill & Melinda Gates Foundation. Retrieved April 12, 2012

Kane, T. J., Rockoff, J. E., & Staiger, D. O. (2007). Photo finish: Certification doesn't guarentee a winner. *Education Next, Winter*, 61-67.

Kane, T. J., Rockoff, J. E., & Staiger, D. O. (2008). What does certification tell us about teacher effectiveness? Evidence from New York City. *Economics of Education Review, 27*, 615-631. doi: 10.1016/j.econedurev.2007.05.005

Kanold, T. D. (Ed.). (2012). *Common Core Mathematics in a PLC at Work: Grades 3-5.* Bloomington, IN: Solution Tree.

Kanold, T. D. (Ed.). (2012). *Common Core Mathematics in a PLC at Work: Grades K-2.* Bloomington, IN: Solution Tree Press.

Kise, J. A. (2006). *Differentiated coaching: a framework for helping teachers change.* Thousand Oaks, CA: Corwin Press.

Knowles, M. S., Holton III, E. F., & Swanson, R. A. (2005). *The Adult Learner.* London: Elsevier.

Kose, B. W. (2007, November). One principal's influence on sustained, systematic, and differentiated professional development for social justice. *Middle School Journal*, 34-42.

Lamberg, T. (2013). *Whole Class Mathematics Discussions: Improving In-Depth Mathematical Thinking and Learning.* Upper Saddle River, NJ: Pearson Education, Inc.

Learning Mathematics for Teaching (LMT) Project. (2010). *Obtaining our measures: Appropriateness to your project.* Retrieved September 24, 2010, from Learning Mathematics for Teaching (LMT) Project: http://sitemaker.umich.edu/lmt/appropriateness

Learning Mathematics for Teaching Project. (2011). Measuring the mathematical quality of instruction. *Journal of Mathematics Teacher Educaiton, 14*, 25-47. doi: 10.1007/s10857-010-9140-1

Leko, M. M., & Brownell, M. T. (2009). Crafting quality professional development for special educators: What school leaders should know. *Teaching Exceptional Children, 42*(1), 64-70.

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2010). *Methods in educational research: From theory to practice (Laureate Education, Inc., custom ed.).* San Francisco, CA: John Wiley & Sons.

Ma, L. (1999). *Knowing and Teaching Elementary Mathematics.* Mahwah, NJ: Lawrence Erlbaum Associates Inc.

McTighe, J., & Wiggins, G. (2004). *Understanding by design professional development workbook.* Alexandria, VA: ASCD.

Murray, S., Ma, X., & Mazur, J. (2009). Effects of peer coaching on teachers'collaborative interactions and students' mathematics achievement. *Journal of Educational Research, 102*(3), 203-212.

National Council of Supervisors of Mathematics. (2008). *The Prime Leadership Framework.* Denver, CO: Solution Tree Press.

National Council of Teachers of Mathematics. (2003). *Administrator's Guide: how to support and improve mathematics education in your school.* (A. J. Mirra, Ed.) Reston, VA: Association for Supervision and Curriculum Development.

National Council of Teachers of Mathematics, National Council of Supervisors of Mathematics, Association of State Supervisors of Mathematics, and the Association of Mathematics Teacher Educators. (2010). *Mathematics education organizations unite to support implementation of common core state standards.*

National Institute of Child Health and Human Development Early Child Care Research Network. (2005). A day in third grade: a large scale study of classroom quality and teacher and student behavior. *The Elementary School Journal, 105*(3), 305-323.

National Mathematics Advisory Panel. (2008). *Foundations for Success: The Final Report of the National Mathematics Advisory Panel.* Jessup, MD: U. S. Department of Education.

National Staff Development Council. (2011). *NSDC's Standards for Staff Development*. Retrieved from Learning Forward Standards: http://www.learningforward.org/standfor/definition.cfm

Nevada Department of Education. (2010). *Nevada Report Card District AYP.* Retrieved May 6, 2011, from Nevada Report Card: http://nevadareportcard.com/

Nevada Department of Education. (2011, February). *Adequate Yearly Progress Informational Material 2011 Technical Manual.* Retrieved May 5, 2011, from Nevada Department of Education: http://www.doe.nv.gov/AYPInfoMaterials.htm

Nevada Department of Education. (n.d.). *Assessment Details: CRT XYZ School District 09-10.* Retrieved October 3, 2010, from Nevada Report Card: www.nevadareportcard.com

Organisation for Economic Co-operation and Development. (2010). *PISA 2009 Results: Executive Summary.*

Parrish, S. (2010). *Number Talks: Helping Children Build Mental Math and Computation Strategies.* Sausalito, CA: Math Solutions.

Rockoff, J. E., Jacob, B. A., Kane, T. J., & Staiger, D. O. (2008). *Can you recognize an effective teacher when you recruit one? NBER Working Paper 14485.* Cambridge, MA: National Bureau of Economic Research.

Root, R. (2009). Social justice through quantitative literacy: a course connecting numeracy, engaged citizenship, and a just society. *Democracy and Education, 18*(3), 37-43.

Rowland, T. (2008). The purpose, design and use of examples in the teaching of elementary mathematics. *Educational Studies in Mathematics, 69*, 149-163. doi: 10.1007/s10649-008-9148-y

Ryve, A. (2011). Discourse research in mathematics education: A critical evaluation of 108 journal articles. *Journal for research in mathematics education, 42*(2), 167-198.

Schilling, S. G. (2007). The role of psychometric modeling in test validation: An application of multidimensional item response theory. *Measurement, 5*(2/3), 93-106.

Schilling, S., & Hill, H. (2007, August). Assessing measures of mathematical knowledge for teaching: A validity argument approach. *Measurement, 5*(2/3), 70-80. doi: 10.1080/15366360701486965

Schmidt, W., Houang, R., & Cogan, L. (2002). A coherent curriculum: the case of mathematics. *American Educator*, 1-18.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Sousa, D. A., & Tomlinson, C. (2011). *Differentiation and the brain.* Bloominton, IN: Solution Tree.

Strickland, C. A. (2009). *Professional development for differentiating instruction.* Alexandria, VA: ASCD.

Thames, M. H., & Ball , D. L. (2010, November). What math knowledge does teaching require? *Teaching Children Mathematics, 17*(4), 220-229.

The Center for Research in Math and Science Education Michigan State University. (2010). *Breaking the cycle: An international comparison of U.S. mathematics teacher preparation.* National Science Foundation.

The Education Alliance of XYZ (2010, December). *XYZ K-16 data profile.* Retrieved October 2, 2010, from XYZ School District: http://www.XYZk12.nv.us/community/annual-reports-publications/data-profiles

Tomlinson, C., & Imbeau, M. B. (2010). *Leading and managing a differentiated classroom.* Alexandria , VA: ASCD.

Tomlinson, C., & McTighe, J. (2006). *Integrating differentiating instruction and understanding by design.* Alexandria, VA: ASCD.

U.S. Department of Education. (2009). *The American Recovery and Reinvestment Act of 2009: Saving and Creating Jobs and Reforming Education.* Retrieved June 5, 2011, from Ed.gov: http://ed.gov/print/policy/gen/leg/recovery/implementation.html

U.S. Department of Education, Office of Planning, Evaluation, and Policy Development. (2010). *ESEA Blueprint for Reform.* Washington, D.C.

Umland, K. (2012, May 22). *Tools for the Common Core Standards.* Retrieved from Illustrative Mathematics: http://commoncoretools.me/illustrative-mathematics/

United States Department of Education. (2009). *Mathematics 2009 Nevada Grade 4.* Retrieved May 6, 2011, from ies: National Center for Educational Statistics: http://nces.ed.gov/nationsreportcard/pdf/stt2009/2010454NV4.pdf

United States Department of Education. (2009). *Mathematics 2009 Nevada Grade 8.* Retrieved May 6, 2011, from ies: National Center for Educational Statistics: http://nces.ed.gov/nationsreportcard/pdf/stt2009/2010454NV8.pdf

United States Department of Education. (2010, August 16). *NAEP Overview*. Retrieved May 15, 2011, from Institute of Education Sciences: National Center for Education Statistics: http://nces.ed.gov/nationsreportcard/about/

Usiskin, Z. (2007). Do we need national standards with teeth? *Educational Leadership*, 38-42.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2010). *Elementary and Middle School Mathematics: Teaching Developmentally* (Seventh ed.). Boston, MA: Allyn & Bacon.

Wager, A. A., & Stinson, D. W. (Eds.). (2012). *Teaching Mathematics for Social Justice: Conversations with Educators.* Reston, VA: National Council of Teachers of Mathematics.

White, D. Y., & Spitzer, J. S. (Eds.). (2009). *Mathematics for Every Student: Responding to Diversity, Grades Pre-K-5.* Reston, VA: National Council of Teachers of Mathematics.

Wiggins, G., & McTighe, J. (2011). *The understanding by design guide to creating high-quality units.* Alexandria, VA: ASCD.

Wiliam, D. (2007). *Ahead of the Curve.* (D. Reeves, Ed.) Bloomington, IN: Solution Tree Press.

Wu, H.-H. (2009). What's sophistcated about elementary mathematics? Plenty-that's why elementary schools need math teachers. *American Educator*, 4-14.

Wu, H.-H. (2011, October). Straight up conversation: Math scholar Hung-Hsi Wu on the common core. (R. Hess, Interviewer)

Wu, H.-H. (2011). The impact of common core standards on the mathematics education of teachers. *MAA Section Meeting.* Menonomie.

XYZ School District. (2009). *Fast Facts.* Retrieved May 5, 2011, from XYZ School District: http://www.XYZ.k12.nv.us/docs/community/reports/fast-facts/FF_2009.pdf

XYZ School District. (2009-2010). *XYZ School District.* Retrieved May 5, 2011, from District Wide Accountability Plan: http://www.XYZ.k12.nv.us/docs/public-policy-accountability-assessment/09-10accountability-report/XYZ_District_Accountability_Report_09-10.pdf

XYZ School District. (2010). *Envision WCSD 2015.* Retrieved March 7, 2011, from XYZ School District: http://www.XYZ.k12.nv.us/docs/community/strategic-plan/StrategicPlan_webENGLISH.pdf

Yoon, K. S., Duncan, T., Lee, S.-Y., Scarloss, B., & Shapley, K. (2007). *Reviewing the evidence on how teacher professional development affects student achievement*

(Issues & answers report, REI 2007-No.033). Washington D.C.: U.S. Department of Education. Retrieved from http://ies.ed.gov/ncee/edlabs

Zambo, R., & Zambo, D. (2008). The impact of professional development in mathematics on teachers' individual and collective efficacy. *Teacher Education Quarterly, 35*(1), 159-168.

Zhao, Y. (2009, Fall). Comments on the common core standards initiative. *Journal of Scholarship and Practice, 6*(3), 46-54.

Zodik, I., & Zaslavsky, O. (2008). Characteristics of teachers' choice of examples in and for the mathematics classroom. *Educational Studies in Mathematics, 69*, 165-182. doi: 10.1007/s10649-008-9140-6

Appendix A:
PRIME Leadership Framework Elementary Mathematics Modules

Equity Modules 1. International, National and District Data 2. Working with ELL students 3. Exploring Mindset 4. Student Data 5. Math Practices 1.0 6. Math Practices 1.5 7. Math Practices 2.0 8. Math Practices 3.0 9. Collaborating as a PLC 10. Reflecting on Instruction	**Teaching & Learning Leadership Modules** 11. Differentiation Overview 12. Interventions in Mathematics 13. CCSS Mathematics Rigor 14. Estimation 15. Learning Basic Facts 16. Conceptual and Procedural Knowledge 17. Planning with Understanding by Design -- Overview 18. Mathematical Misconceptions 19. Writing in Mathematics 20. Analyzing Resources 21. Online Resources 22. Mathematical Representations 23. Teaching Through Problem Solving 24. Types of Mathematical Problems 25. Balancing Mathematics Instruction 26. Exploring Mathematical Understanding 27. Alternative and Traditional Algorithms
Curriculum Leadership Modules 28. CCSSM -- Focus 29. CCSSM -- Coherence 30. CCSSM Critical Areas 31. NBT Progression Document 32. CC and OA Progression Document 33. NF Progression Document 34. Mathematical Communication 35. Mathematical Vocabulary 36. Grade Level Standards 37. Understanding By Design – Clarifying Desired Results 38. Mathematical Tasks	**Assessment Modules** 39. Smarter Balanced Assessment Consortium (SBAC) 40. Rubric Design 41. Mathematical Discussions 42. Number Talks 43. Providing Feedback 44. Formative Assessment 45. Summative Assessment

<table>
<tr><td colspan="2">Equity Module 1</td></tr>
<tr><th colspan="2">International, National, and District Data</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers will be able to use their learning to address gaps in mathematics achievement expectations for all students.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that they can use student achievement data to develop a systematic plan to improve student performance.</td><td>How can monitoring student performance in subpopulations help to improve my instruction for all of my students?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know where specific gaps exist in the nation, the state and in their school.</td><td>Teachers will be skilled at identifying and analyzing student achievement data for various populations.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will show their understanding by developing and implementing instructional strategies that meet the needs of all subpopulations. Teachers will design formative and summative assessments to use as tools to monitor this plan and to eliminate achievement gaps.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Explore TIMSS study overview and 2007 results. http://nces.ed.gov/timss/
2. Explore NAEP study overview: http://nces.ed.gov/nationsreportcard/ltt/ then go to http://nationsreportcard.gov/ltt_2008/ to find the Math Trends and Math Gaps.
3. Look at the XYZ School District Data: http://www.nevadareportcard.com/ Find results from your school and compare subpopulations.</td></tr>
<tr><td colspan="2">Materials Needed: computer with internet access</td></tr>
<tr><td colspan="2">Differentiation Considerations: Teachers may need technology support to search and download data from websites. They may also need assistance with interpreting the data.</td></tr>
</table>

Equity Module 2	
Working with ELL students	
Stage 1 -- Desired Results	
Transfer	
Teachers will be able to use their learning to address gaps in mathematics achievement expectations for all students.	
Meaning	
Understandings	Essential Questions
Teachers will understand that teaching ELL students requires reflection on their current instruction techniques and strategies.	What do I need to consider when planning for my ELL students to learn mathematics while they learn English? How does the stage of language development for my students determine the instructional actions I must take?
Acquisition	
Knowledge	Skills
Teachers will know the five guiding principles for teaching mathematics to ELL students.	Teachers will be skilled at identifying the stage of language development in their students and the actions necessary at each stage.
Stage 2 -- Evidence	
Teachers will show their understanding by identifying, understanding and responding to the needs of their ELL learners.	
Stage 3 -- Learning Plan	
1. Read Chapter One – Answer at least 10 of the 25 reflection questions. Share your answers with your colleagues. 2. Read Chapter Two – Discuss the guiding principles and rank them in order of your current abilities. Set a goal for improving your skills in one area. Use the list of characteristics and common student actions for each stage to determine the current stage of language development for your students. Use the list of teacher actions for your goal area to set three sub goals.	

Materials Needed: Celedon, S., & Ramirez, N. G. (Eds.). (2012). *Beyond Good Teaching: Advancing Mathematics Education for ELLs.* Reston, VA: National Council of Teachers of Mathematics.
Differentiation Considerations: Teachers with limited experiences with ELL students may need more support. Teachers with TESOL or SIOP training can move to more advanced chapters of the book.

<table>
<tr><td colspan="2">Equity Module 3</td></tr>
<tr><th colspan="2">Exploring Mindset</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers will be able to provide each student access to relevant and meaningful mathematics experiences.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that their mindset affects their instructional planning and their choices.</td><td>How do my current beliefs about my students and their abilities influence my actions as a teacher?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know the six beliefs addressed by Tomlinson and Imbeau that influence our ability to teach in our diverse classrooms.</td><td>Teachers will be skilled at recognizing their beliefs during instruction and planning.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will examine their current beliefs and practices and set goals for future practice. Teachers will develop and implement lessons that are relevant and meaningful.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Read pages 27-37. As you read, mark each section: a checkmark for what you agree with, a question mark for what you are not certain about, and a star for what you really want to remember.
2. Share your reflections and set goals as a team.</td></tr>
<tr><td colspan="2">Materials Needed:
Tomlinson, C., & Imbeau, M. B. (2010). Leading and managing a differentiated classroom. Alexandria , VA: ASCD.</td></tr>
<tr><td colspan="2">Differentiation Considerations: Teachers may need support recognizing a fixed or flexible mindset. They may also need a facilitator to ensure that all teacher voices in the group are heard.</td></tr>
</table>

<table>
<tr><td colspan="2">Equity Module 4</td></tr>
<tr><th colspan="2">Student Data</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers will be able to provide each student access to relevant and meaningful mathematics experiences.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that there are patterns of data that they can address through effective instruction.</td><td>What are the patterns I see in my students’ data and how can I plan lessons to address those patterns?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know where there are equity gaps in their students’ data. They will be able to interpret the reports from various sources.</td><td>Teachers will be skilled at reading the data reports from MAP, Nevada CRT, and their own classroom assessments.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will develop a plan for improving their instruction based on the gaps they found in their data reports.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Gather data from MAP, Nevada CRT, and classroom assessments.
2. Analyze these data for your grade level and school. Look for equity gaps.
3. Develop a plan to address one of the gaps you found.</td></tr>
<tr><td colspan="2">Materials Needed: computer and internet access; student data reports.</td></tr>
<tr><td colspan="2">Differentiation Considerations: Teachers may need extra support in finding, printing, and analyzing their student data reports.</td></tr>
</table>

Equity Module 5	
Mathematical Practices 1.0	
Stage 1 -- Desired Results	
Transfer	
Teachers will be able to provide each student access to relevant and meaningful mathematics experiences.	
Meaning	
Understandings	Essential Questions
Teachers will understand that the Mathematical Practices are essential to the development of mathematically proficient students.	Why should I consider the practices during my instruction and planning?
Acquisition	
Knowledge	Skills
Teachers will know the eight practices and their overall definitions.	Teachers will be able to find the eight mathematical practices in the CCSSM document.
Stage 2 -- Evidence	
Teachers will present a chart for each of the eight mathematical practices.	
Stage 3 -- Learning Plan	
1. Read the eight Mathematical Practices on page 6 of the CCSSM document making notes as necessary. 2. Develop a chart describing what each practice looks like and sounds like in a classroom setting. 3. Share your chart with your group.	
Materials Needed: Common Core State Standards Mathematics http://www.corestandards.org/	
Differentiation Considerations: Teachers may need time to explore the entire CCSSM document if this is their first time using it. They may need an explanation of how the Mathematical Practices relates to the NCTM process standards or to their former state standards. They may have questions about how to read the standards.	

<table>
<tr><td colspan="2">Equity Module 6</td></tr>
<tr><td colspan="2" align="center">Mathematical Practices 1.5</td></tr>
<tr><td colspan="2" align="center">Stage 1 -- Desired Results</td></tr>
<tr><td colspan="2" align="center">Transfer</td></tr>
<tr><td colspan="2">Teachers will be able to provide each student access to relevant and meaningful mathematics experiences.</td></tr>
<tr><td colspan="2" align="center">Meaning</td></tr>
<tr><td align="center">Understandings</td><td align="center">Essential Questions</td></tr>
<tr><td>Teachers will understand that the Mathematical Practices are essential to the development of mathematically proficient students. They must plan for these practices and expect their use during mathematics instruction.</td><td>How does my understanding of the CCSSM Mathematical Practices influence my planning and instruction?</td></tr>
<tr><td colspan="2" align="center">Acquisition</td></tr>
<tr><td align="center">Knowledge</td><td align="center">Skills</td></tr>
<tr><td>Teachers will know that each practice requires specific planning in order to ensure its use in their students.</td><td>Teachers will identify questions and strategies that encourage the use of each Mathematical Practice.</td></tr>
<tr><td colspan="2" align="center">Stage 2 -- Evidence</td></tr>
<tr><td colspan="2">Teachers will construct a chart answering 7 questions about each mathematical practice.</td></tr>
<tr><td colspan="2" align="center">Stage 3 -- Learning Plan</td></tr>
<tr><td colspan="2">1. Review the definition of each of the eight Mathematical Practices.
2. Skim pages 25-60 in the Kanold book.
3. Answer the following questions about each practice. Prepare a chart with the answers.
a. Why is this practice important? (So what? Who Cares?)
b. What does this practice look like when students are doing it?
c. What questions could a teacher ask to encourage the use of this practice?
d. What questions can the teacher ask to help students to be more aware of their use of this practice?</td></tr>
</table>

e. What can a teacher do to model this practice? f. What does proficiency look like in this practice? g. What actions might the teacher make that inhibit the students' use of this practice? 4. Share your answers with your group. 5. Adjust your chart as indicated by the group feedback.
Materials Needed: 1. Common Core State Standards Mathematics http://www.corestandards.org/ 2. Kanold, T. D. (Ed.). (2012). *Common Core Mathematics in a PLC at Work.* Bloomington, IN: Solution Tree.
Differentiation Considerations: Teachers should have a basic understanding of the Mathematical Practices and their intention before completing this module. If necessary, complete Module 5 first.

Equity Module 7	
Mathematical Practices 2.0	
Stage 1 -- Desired Results	
Transfer	
Teachers will be able to provide each student access to relevant and meaningful mathematics experiences.	
Meaning	
Understandings	Essential Questions
Teachers will understand that the Mathematical Practices are intertwined and that the practices are not discreet tasks to be accomplished.	What are some steps I can take to ensure that my students are becoming mathematically proficient?
Acquisition	
Knowledge	Skills
Teachers will know that some of the teacher actions that can encourage the use of all of the Mathematical Practices.	Teachers will be skilled at recognizing the Mathematical Practices when the practices are being used by their students.
Stage 2 -- Evidence	
Teachers will make a list of teacher actions that support the Mathematical Practices.	
Stage 3 -- Learning Plan	
1. Use the answers to the seven questions from each practice from Module 6. 2. Synthesize the answers to each question from all 8 of the practices. (For example, find all 8 answers to the question "What does proficiency look like in this practice?") 3. Use this synthesis to create a list of teacher actions that help to develop mathematically proficient students.	
Materials Needed: 1. List of answers from Module 6. 2. Common Core State Standards Mathematics http://www.corestandards.org/	
Differentiation Considerations: Module 6 must be completed first.	

<table>
<tr><td colspan="2">Equity Module 8</td></tr>
<tr><th colspan="2">Mathematical Practices 3.0</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers will be able to provide each student access to relevant and meaningful mathematics experiences.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that the students’ use of a mathematical practice can influence their use of the other 7 practices.</td><td>How does a student’s proficiency at one mathematical practice influence their use of the other practices?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know some of the ways one practice affects the other 7 practices.</td><td>Teachers will be skilled at planning for one mathematical practice.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will plan a lesson with one Mathematical Practice as a focus while considering how that practice encourages the use of the other seven practices.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Choose one practice to work with.
2. Carefully examine the other 7 practices through the lens of the practice you chose. (For example, if students are “Constructing viable arguments and critiquing the reasoning of others,” what does that look like when they are reasoning abstractly or when they are using a model? How does a student construct a viable argument about their model?)</td></tr>
<tr><td colspan="2">Materials Needed: Common Core State Standards Mathematics
http://www.corestandards.org/</td></tr>
<tr><td colspan="2">Differentiation Considerations: Teachers need many experiences with the Mathematical Practices before attempting this module.</td></tr>
</table>

Equity Module 9	
Collaborating as a PLC	
Stage 1 -- Desired Results	
Transfer	
Teachers will work interdependently in a collaborative learning community to erase inequities in student learning.	
Meaning	
Understandings	Essential Questions
Teachers will understand that an effective PLC system is crucial for providing high quality instruction.	How can our PLC help each individual teacher meet the varied needs of their students?
Acquisition	
Knowledge	Skills
Teachers will know how their past PD experiences in mathematics influence their collaboration with their teammates.	Teachers will be skilled at identifying and addressing roadblocks to effective PLC collaboration.
Stage 2 -- Evidence	
Teachers will develop a plan for job embedded PD that includes adequate time and resources to support it.	
Stage 3 -- Learning Plan	
1. Read pages 5-20 in the Kanold book appropriate to your grade level. 2. Discuss the following with your PLC: a. What experiences have you had in mathematics PD? b. How have your experiences changed over the years? c. Does your PLC have adequate time to collaborate? d. What steps can be taken to ensure that you have adequate time? e. What has changed in instructional emphasis and assessment with the adoption of the CCSSM? f. Develop a schedule for collaboration for the next three months and a possible focus topic for each session.	

Materials Needed: Kanold, T. D. (Ed.). (2012). *Common Core Mathematics in a PLC at Work: Grades 3-5.* Bloomington, IN: Solution Tree. Kanold, T. D. (Ed.). (2012). *Common Core Mathematics in a PLC at Work: Grades K-2.* Bloomington, IN: Solution Tree Press.
Differentiation Considerations: PLCs vary widely in their ability to collaborate. Teachers may need systems support to implement effective collaboration.

Equity Module 10	
Reflecting on Instruction	
Stage 1 -- Desired Results	
Transfer	
Teachers will work interdependently in a collaborative learning community to erase inequities in student learning.	
Meaning	
Understandings	Essential Questions
Teachers will understand that the use of the teaching-assessing-learning cycle improves student learning.	How can the use of the teaching-assessing-learning cycle improve student learning in mathematics and begin to close achievement gaps?
Acquisition	
Knowledge	Skills
Teachers will know the five steps of the teaching-assessing-learning cycle.	Teachers will be skilled at implementing some of the strategies and suggestions in the chapter.
Stage 2 -- Evidence	
Teachers will align learning tasks, with learning targets and assessments. Teachers will use assessment strategies to improve instruction.	
Stage 3 -- Learning Plan	
1. Read Chapter 4 in the Kanold book. 2. Discuss the questions listed in Figure 4.1 (in either book) 3. Consider a current task, target, or assessment that is common to your grade level while reading this chapter. 4. Determine necessary changes to your planning and implementation. 5. Continue the cycle again using another target, task or assessment.	
Materials Needed: Kanold, T. D. (Ed.). (2012). *Common Core Mathematics in a PLC at Work: Grades 3-5.* Bloomington, IN: Solution Tree. Kanold, T. D. (Ed.). (2012). *Common Core Mathematics in a PLC at Work: Grades K-2.* Bloomington, IN: Solution Tree Press.	
Differentiation Considerations: Teachers may need support determining the learning targets. The CCSSM may include very different standards than they have had previously. Also, there may be some variation in the teachers' ability to create appropriate assessments. This may indicate the need for assessment modules 39-45.	

Teaching and Learning Leadership Module 11	
Differentiation Overview	
Stage 1 -- Desired Results	
Transfer	
Teachers will pursue the successful learning of mathematics for every student.	
Meaning	
Understandings	Essential Questions
Teachers will understand that lessons and units can be differentiated in many ways according to the needs of their students.	How can differentiation strategies help all of my students reach common mathematics goals?
Acquisition	
Knowledge	Skills
Teachers will know the basics of differentiation including the three methods of response (according to the students' readiness, interest, or learning profile).	Teachers will be skilled at identifying the differentiation strategies that they can use to differentiate the content, process, or product of a mathematical unit.
Stage 2 -- Evidence	
Teachers will use 2 differentiation strategies in their instruction. They will identify in their lesson plans if the strategies focus on the students' readiness, interests, or learning profile.	
Stage 3 -- Learning Plan	
1. Discuss your answers to the questions on pages 36-37 in the Sousa and Tomlinson book. 2. Read pages 7-35 book. 3. Determine 2 possible changes for your PLC to make. 4. Determine 2 possible changes for you to personally make. 5. Choose two differentiation strategies to use in your instruction this week. Are you differentiating by readiness, interest, or learning profile?	
Materials Needed: Sousa, D. A., & Tomlinson, C. (2011). *Differentiation and the brain.* Bloominton, IN: Solution Tree.	
Differentiation Considerations: When listening to the answers to the questions on pages 36-37, consider the mindset of the teachers. Is it fixed or flexible? What questions can you ask to help them shift to a more flexible stance?	

<table>
<tr><td colspan="2">Teaching and Learning Module 12</td></tr>
<tr><th colspan="2">Interventions in Mathematics</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers will pursue the successful learning of mathematics for every student.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that students need additional support and time to learn the content. This should occur as quickly as possible in response to formative assessment.</td><td>How can I plan interventions that ensure student learning?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know that interventions in elementary mathematics should supplement the current whole class instruction, not replace it.</td><td>Teachers will be skilled at comparing their schools' intervention plan with the recommendations in the IES report.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will create an implementation plan for one of the recommendations.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Download the IES Practice Guide from the What Works Clearinghouse.
2. Read the checklist for carrying out the 8 recommendations on pages 11- 12.
3. Discuss with your grade level the recommendations you already have in place and those that you would like to implement.
4. Read the details of each recommendation you chose, including the possible roadblocks.
5. Create a plan for implementing one of the recommendations in your grade level.</td></tr>
<tr><td colspan="2">Materials Needed:
http://ies.ed.gov/ncee/wwc/practiceguide.aspx?sid=2</td></tr>
<tr><td colspan="2">Differentiation Considerations: The PD provider should be familiar with the RTI system at the school they are working with. Some recommendations may need to be endorsed by the RTI team.</td></tr>
</table>

<table>
<tr><td colspan="2">Teaching and Learning Module 13</td></tr>
<tr><th colspan="2">CCSS Mathematics Rigor</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers will pursue the successful learning of mathematics for every student.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that the CCSS Mathematics expects a higher level of rigor than the previous standards in Nevada.</td><td>Should my teaching differ from the way that I learned math?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know the difference between traditional school math and CCSS Mathematics.</td><td>Teachers will use their math skills to follow the Adding Fractions example.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will write a journal entry explaining how they learned math and whether or not those same instructional methods are appropriate for the CCSS Mathematics.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Read the article highlighting the differences between traditional school math and common core math.
2. Discuss with your PLC where your math resources fit in this scenario.
3. Follow closely the “Adding Fractions” example on page 5.
4. How does this example fit with the way you were taught to add fractions?</td></tr>
<tr><td colspan="2">Materials Needed: Article: Phoenix Rising: Bringing the Common Core State Mathematics Standards to life.
http://www.achievethecore.org/you-ve-got-to-read-this</td></tr>
<tr><td colspan="2">Differentiation Considerations: This research project found that many K-2 teachers struggle with understanding the mathematics involved in the upper grades. They may need extra support with the adding fractions example.</td></tr>
</table>

Teaching and Learning Module 14	
Estimation	
Stage 1 -- Desired Results	
Transfer	
Teachers will implement research-informed best practices and use effective instructional planning and teaching strategies.	
Meaning	
Understandings	Essential Questions
Teachers will understand that estimation includes making a decision about estimating or computing an exact answer.	Can the use of real world examples help my students to understand when to estimate and when to compute?
Acquisition	
Knowledge	Skills
Teachers will know the three types of estimation. Teachers will know the estimation expectations for their grade level.	Teachers will use their skills to help students see the difference between estimating and guessing.
Stage 2 -- Evidence	
Teachers will implement one estimation strategy in their upcoming lessons. They will share their experiences with their PLC and with their PD provider.	
Stage 3 -- Learning Plan	
1. Read pages 240-242 in the Van de Walle book. 2. On page 242, there are 6 suggestions for teaching computational estimation. 3. Discuss with your PLC one of the six strategies that you have used in the past. 4. Plan to use the first strategies and one of the others in your lessons this week. 5. Using your computer open the CCSS Mathematics. Use the "Find" feature to search for the words "estimate" and "estimation".	
Materials Needed: Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2010). *Elementary and Middle School Mathematics: Teaching Developmentally* (Seventh ed.). Boston, MA: Allyn & Bacon.	
Differentiation Considerations: In this study only 11.4% of teachers indicated that estimation was a major focus in their classroom. Teachers may need support in searching for the words in their standards and in developing real world examples.	

Teaching and Learning Module 15	
Learning Basic Facts	
Stage 1 -- Desired Results	
Transfer	
Teachers will implement research-informed best practices and use effective instructional planning and teaching strategies.	
Meaning	
Understandings	Essential Questions
Teachers will understand the three phases of fact mastery.	Which of my students are at each phase of fact mastery and how can the games we play help them to move up one phase?
Acquisition	
Knowledge	Skills
Teachers will know the phase of fact mastery development for each of their students.	Teachers will use their skills to identify the strategies their students are currently using.
Stage 2 -- Evidence	
Teachers will share the list of strategies their students are using and their plan for introducing more strategies.	
Stage 3 -- Learning Plan	
1. Share with your PLC the successful and unsuccessful strategies that you have tried when helping students learn basic facts. 2. Read pages 167-170 in the Van de Walle book. What phase of fact mastery are your students current at? 3. Read the section on page 182 "Mastering the Basic Facts". 4. Read one other section: addition, subtraction, multiplication, or division. 5. Practice naming the strategies your students are using in your classroom. 6. What strategies do you need to help your students master next?	
Materials Needed: Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2010). *Elementary and Middle School Mathematics: Teaching Developmentally* (Seventh ed.). Boston, MA: Allyn & Bacon.	
Differentiation Considerations: Teachers may insist they learned their facts by memorizing them. Ask them specifically how they learned one of the more difficult facts. Name the strategy they used to figure out the difficult fact. Point out the second phase (reasoning).	

Teaching and Learning Module 16

Conceptual and Procedural Knowledge

Stage 1 -- Desired Results

Transfer

Teachers will implement research-informed best practices and use effective instructional planning and teaching strategies.

Meaning

Understandings	Essential Questions
Teachers will understand that procedural and conceptual instruction are both important.	How can a focus on conceptual understanding help my students learn mathematical procedures?

Acquisition

Knowledge	Skills
Teachers will know that the CCSS Mathematics requires that teachers teach for understanding. Teachers will know that teaching for understanding comes with an expectation of assessing that understanding.	Teachers will use their skills to determine which strategies they currently use are procedural and which are conceptual.

Stage 2 -- Evidence

Teachers will write in their journal about helping their students to understand mathematics.

Stage 3 -- Learning Plan

1. With your PLC develop a definition of “procedural” and “conceptual” instruction.
2. Sort the activities used in your classroom this week into these two categories.
3. Read pages 23-25 in the Van de Walle book.
4. Was there a time in your own math history when you were competent in the procedure, but not in the concept? Share.
5. Read page 4 in the CCSS Mathematics book “Understanding Mathematics.”
6. Write in your journal about changes you can make in your classroom to help your students understand mathematics.

Materials Needed: Common Core State Standards Mathematics http://www.corestandards.org/ Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2010). *Elementary and Middle School Mathematics: Teaching Developmentally* (Seventh ed.). Boston, MA: Allyn & Bacon.
Differentiation Considerations: Some teachers are able to follow procedures without understanding the concepts of the math. They may need support making the connection between the two.

Teaching and Learning Module 17	
Planning with Understanding By Design (UbD) Overview	
Stage 1 -- Desired Results	
Transfer	
Teachers will implement research-informed best practices and use effective instructional planning and teaching strategies.	
Meaning	
Understandings	Essential Questions
Teachers will understand that UbD is a format that guides backwards lesson planning in order to focus on understanding (as opposed to completing activities).	How will my classroom change if I plan backwards?
Acquisition	
Knowledge	Skills
Teachers will know that UbD requires three stages: desired results, evidence, and learning plan.	Teachers will be skilled at identifying each stage within their current lesson plans.
Stage 2 -- Evidence	
Teachers will use the UbD framework to plan and revise one lesson.	
Stage 3 -- Learning Plan	
1. Read Module A in the UbD book. 2. Consider a math lesson you taught recently. Use this lesson to determine the desired results, the evidence, and the learning plan. 3. Discuss how this lesson would have been different if you had planned it backwards. 4. Use the chart on page 9 to help you plan a future math lesson. Share this lesson with your PLC. Use their ideas to revise your plan.	
Materials Needed: Wiggins, G., & McTighe, J. (2011). *The understanding by design guide to creating high-quality units.* Alexandria, VA: ASCD.	
Differentiation Considerations: Some teachers may already plan this way using their standards. Others may plan activities first indicating a need for extra support in seeing the benefits to the UbD format. They may also need guidance to see that some of their planned activities do not fit when they consider the desired results.	

Teaching and Learning Module 18	
Mathematical Misconceptions	
Stage 1 -- Desired Results	
Transfer	
Teachers will implement research-informed best practices and use effective instructional planning and teaching strategies.	
Meaning	
Understandings	Essential Questions
Teachers will understand how to plan for the most common misconception in their grade level for one Number and Operation topic.	How does preparing for student misconceptions change my instruction?
Acquisition	
Knowledge	Skills
Teachers will know how to use research and strategies to address the most common misconceptions in their grade level for one Number and Operation topic.	Teachers will be skilled at identifying errors.
Stage 2 -- Evidence	
Teacher share a common misconception for their grade level, including the errors, research, and ideas for instruction.	
Stage 3 -- Learning Plan	
1. Read the Foreword on pages v-vii. 2. Read the sections of Chapter 1 that are appropriate for your grade level. 3. Make a chart to share the following: identifying error patterns, research, ideas for instruction. 4. Share your chart with your group. 5. As a group, answer the “questions to ponder.”	
Materials Needed: Bamberger, H. J., Oberdorf, C., & Schultz-Ferrell, K. (2010). *Math Misconceptions: From Misunderstanding to Deep Understanding.* Portsmouth, NH: Heinemann.	
Differentiation Considerations: Teachers themselves may have some of these misconceptions. It is important that PD providers help teachers understand the mathematics at the conceptual level.	

Teaching and Learning Module 19	
Writing in Mathematics	
Stage 1 -- Desired Results	
Transfer	
Teachers will implement research-informed best practices and use effective instructional planning and teaching strategies.	
Meaning	
Understandings	Essential Questions
Teachers will understand that writing in mathematics helps to solidify their understanding.	How can adding writing to my instructional time increase my students' level of understanding about the math content?
Acquisition	
Knowledge	Skills
Teachers will know the reasons for including writing in their math instruction.	Teachers will be skilled at the four types of writing to learn in mathematics.
Stage 2 -- Evidence	
Teachers will solve a task and then describe in writing how they got their answer. Teachers will write one Haiku poem using math vocabulary.	
Stage 3 -- Learning Plan	
1. Read pages 87-94 in the Benjamin book. 2. Solve the following problem: Lauren drove 62 miles to get to the beach. Danielle drove twice that far to meet her there. How many miles did they drive altogether? 3. Describe in writing how you got your answer. 4. Discuss how your students would write their descriptions. Share strategies for encouraging your students to explain their thinking in writing. 5. Think of a math vocabulary word. Write a Haiku for the word. Share with your PLC and your students!	
Materials Needed: Benjamin, A. (2011). *Math in Plain English.* Larchmont, NY: Eye on Education.	
Differentiation Considerations: Teachers may need support writing the details to such a simple problem. It is much easier to write the numerical answer! Ask the teachers to start writing in their math class just a few minutes a day at first.	

Teaching and Learning Module 20	
Analyzing Resources	
Stage 1 -- Desired Results	
Transfer	
Teachers will implement research-informed best practices and use effective instructional planning and teaching strategies.	
Meaning	
Understandings	Essential Questions
Teachers will understand that in order for a resource to be aligned to the CCSS Mathematics certain criteria need to be met.	How does my instruction change if I am able to address all of the components in the Criteria document?
Acquisition	
Knowledge	Skills
Teachers will know the 7 components and they will know how to modify a lesson to address the Criteria.	Teachers will be skilled at identifying the 7 components in their resources.
Stage 2 -- Evidence	
Teachers will develop a plan to modify one lesson in order to address all components in the Criteria document.	
Stage 3 -- Learning Plan	
1. Read the document by Zimba (He was one of the 3 main authors of the CCSS Mathematics.) 2. Use one of the resources common to your grade level. Analyze one lesson in the resource according to the criteria in the document. 3. What is missing? Can you modify the lesson in your resource to address this gap? 4. Write a lesson plan that addresses all components using your resource as a starting point.	
Materials Needed: Download pdf by Jason Zimba http://usny.nysed.gov/rttt/docs/criteriaresources-math.pdf	
Differentiation Considerations: Teachers may need more information regarding #4 on Balancing instruction. See module 25 for additional support.	

Teaching and Learning Module 21	
Online Resources	
Stage 1 -- Desired Results	
Transfer	
Teachers will implement research-informed best practices and use effective instructional planning and teaching strategies.	
Meaning	
Understandings	Essential Questions
Teachers will understand that there are many resources available developed by credible sources as well as websites that are not useful.	How can I use credible websites to enhance my understanding of the CCSS Mathematics?
Acquisition	
Knowledge	Skills
Teachers will know how to determine if a website is credible by looking at several credible sites and then comparing those to other sites.	Teachers will be skilled at finding useful online resources.
Stage 2 -- Evidence	
Teachers will write a plan for using one tool found on one of the websites.	
Stage 3 -- Learning Plan	
1. Look at the websites below. 2. Find the website developers and authors. Are they credible sources? 3. Make a list of useful sections of each website. 4. Find one tool that you can use in your planning. Write a plan for using it. 5. Search for another CCSS Mathematics website. Is it credible and valuable to you?	
Materials Needed: computer with online access http://www.achievethecore.org/ http://illustrativemathematics.org/ (be sure to find the illustrations for your standards) http://illuminations.nctm.org/ http://www.nctm.org/	
Differentiation Considerations: Teachers may need technology support. They may also need help with ensuring that the activities they find are appropriate to use within the UbD framework (see Module 17).	

Teaching and Learning Module 22	
Mathematical Representation	
Stage 1 -- Desired Results	
Transfer	
Teachers participate in continuous and meaningful mathematics PD and learning in order to improve their practice.	
Meaning	
Understandings	Essential Questions
Teachers will understand the value in modeling the mathematics. Teachers will understand that models and manipulatives can sometimes be used ineffectively.	Will using representations more frequently improve student learning in my classroom?
Acquisition	
Knowledge	Skills
Teachers will know the difference between models and manipulatives.	Teachers will be skilled at helping their students move between the five different types of representations.
Stage 2 -- Evidence	
Teachers will create a chart of the five representations including examples from their teaching.	
Stage 3 -- Learning Plan	
1. Read pages 27-29 in the Van de Walle book. 2. When is it appropriate to use a manipulative instead of an abstract model? 3. Make a chart of the five representations. Include an example of each from your own teaching. 4. Has there been a time when you have used a model or manipulatives inappropriately? Add this to your chart.	
Materials Needed: Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2010). *Elementary and Middle School Mathematics: Teaching Developmentally* (Seventh ed.). Boston, MA: Allyn & Bacon.	
Differentiation Considerations: Teachers need many experiences with using models in their classroom. They need to see how and why some models are more effective than others are. Ask them to draw a model for one problem individually, then share their drawings and choose the most effective model. Experienced teachers tend to be more confident in their use of appropriate models.	

<table>
<tr><td colspan="2">Teaching and Learning Module 23</td></tr>
<tr><th colspan="2">Teaching Through Problem Solving</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers participate in continuous and meaningful mathematics PD and learning in order to improve their practice.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that teaching through problem solving is an effective instructional technique.</td><td>How does the learning of my students change when I teach through problem solving?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know the three types of problem solving.</td><td>Teachers will be skilled at using problem solving in their instruction.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will solve a problem, look at the problem through the eyes of their students, and then make a plan for using the problem.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Read pages 32-36 in the Van de Walle book.
2. Consider this statement paraphrased from Phil Daro (one of the three main authors of the CCSS Mathematics) –U.S. teachers ask “How can I get my students to get the answer to this problem.” Japanese teachers ask “How can I use this problem to teach the mathematics.”
3. How do these statements relate to the three teaching strategies on page 32?
4. Choose the appropriate grade-level problem on pages 34-35. Solve it. Then write about the struggles or misconceptions that your students might have in solving it. How would you plan for addressing those concerns?
5. Write a plan for using this problem with your students.</td></tr>
<tr><td colspan="2">Materials Needed:
Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2010). Elementary and Middle School Mathematics: Teaching Developmentally (Seventh ed.). Boston, MA: Allyn & Bacon.</td></tr>
<tr><td colspan="2">Differentiation Considerations: Teachers may need support in finding appropriate problems to use in their classrooms. See Modules 20 and 21 for additional support.</td></tr>
</table>

Teaching and Learning Module 24	
Types of Mathematical Problems	
Stage 1 -- Desired Results	
Transfer	
Teachers participate in continuous and meaningful mathematics PD and learning in order to improve their practice.	
Meaning	
Understandings	Essential Questions
Teachers will understand that there are several different problem types and that each type addresses a specific mathematical strategy.	How does my understanding of problem types influence my selection of problems for my students to solve?
Acquisition	
Knowledge	Skills
Teachers will know the types of problems.	Teachers will use their skills to identify the types of problems their students are solving.
Stage 2 -- Evidence	
Teachers will create new problems for each of the problem types appropriate to their grade level. They will analyze a lesson to determine the problem types used.	
Stage 3 -- Learning Plan	
1. Read page 88 or 89 in the CCSS Mathematics document, whichever is appropriate for your grade level. 2. Create new problems for each of the categories. 3. Look at an upcoming math lesson. Which problem types does it include?	
Materials Needed: Common Core State Standards Mathematics http://www.corestandards.org/	
Differentiation Considerations: Point out that when just looking at numbers, the chosen operation may stay the same. Use the “Add to—change unknown” and the “Compare—difference unknown” as examples. It is imperative that our students know how to choose an operation appropriate for the problem. Using only number problems without a context does not give students practice in making those decisions.	

Teaching and Learning Module 25	
Balancing Mathematics Instruction	
Stage 1 -- Desired Results	
Transfer	
Teachers participate in continuous and meaningful mathematics PD and learning in order to improve their practice.	
Meaning	
Understandings	Essential Questions
Teachers will understand that the CCSS Mathematics requires a balance of approach.	How does attending to the balance of my instruction influence the mathematical understandings of my students?
Acquisition	
Knowledge	Skills
Teachers will know how the balance of their instruction varies according to the current instructional goals.	Teachers will be skilled at identifying the balance of a lesson.
Stage 2 -- Evidence	
Teachers will draw a model of the balance shown in their lessons and justify their choices.	
Stage 3 -- Learning Plan	
1. Read the document by Jason Zimba (one of the 3 main authors of the CCSS Mathematics. 2. Focus on section #4. 3. Look at your lesson plan for the next week. Do you have a balance? Do you need to adjust the balance of your lessons or are you in one of the "spiky" phases that Zimba discusses? 4. Draw a model showing the balance of your lessons for next week. Explain your reasoning for choosing this balance.	
Materials Needed: Download pdf by Jason Zimba http://usny.nysed.gov/rttt/docs/criteriaresources-math.pdf Watch this video: http://www.youtube.com/watch?v=5dUQtIXoptY&feature=plcp	
Differentiation Considerations: Teachers may need support categorizing their lessons according to the list in #4a. This is a task best done with a PLC.	

Teaching and Learning Module 26	
Exploring Mathematical Understanding	
Stage 1 -- Desired Results	
Transfer	
Teachers participate in continuous and meaningful mathematics PD and learning in order to improve their practice.	
Meaning	
Understandings	Essential Questions
Teachers will understand that mathematics may be taught differently now than it was when they were in school.	How is mathematical instruction in my classroom similar to real world application of math? How is it different?
Acquisition	
Knowledge	Skills
Teachers will know how math should be experienced by the learner.	Teachers will use their math skills to solve problems and to understand the solutions of others.
Stage 2 -- Evidence	
Teachers will journal their experiences with math while reading the pages. Teachers will discuss the questions in step three of the Learning Plan.	
Stage 3 -- Learning Plan	
1. Read pages 13-19 in Chapter 2—"Exploring what it means to know and do mathematics" in the Van de Walle book. 2. Be sure to try all of the problems on your own along the way. 3. Share your process with your team. 4. How does this compare to the way you were taught math in school? How does this compare with how you are teaching math now? Which way is more like doing math in the real world?	
Materials Needed: Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2010). *Elementary and Middle School Mathematics: Teaching Developmentally* (Seventh ed.). Boston, MA: Allyn & Bacon.	

Differentiation Considerations: Some of these problems may be very difficult for some teachers. They may feel uncomfortable with their own math skills or upset that the book does not provide the answers. It is important to maintain a safe stress-free environment during this exercise. Offer support with the problems as needed. Support teachers in increasing their mathematical competence and confidence.

<table>
<tr><td colspan="2">Teaching and Learning Module 27</td></tr>
<tr><th colspan="2">Alternative and Traditional Algorithms</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers participate in continuous and meaningful mathematics PD and learning in order to improve their practice.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that there are many possible methods for computing each having its own level of efficiency.</td><td>What understandings are necessary for a student to use flexible methods for computation?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know the reason for encouraging invented strategies in the classroom. Teachers will know the relationship between invented strategies and traditional algorithms.</td><td>Teachers will be skilled at identifying invented strategies that are used by their students.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will share their created problem and the multiple solution methods.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Read pages 213-219 in the Van de Walle book.
2. Then read one of the following sections: addition and subtraction, multiplication, or division.
3. Write one problem using the operation you have chosen.
4. Solve the problem using as many of the strategies and algorithms as you can.</td></tr>
<tr><td colspan="2">Materials Needed:
Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2010). Elementary and Middle School Mathematics: Teaching Developmentally (Seventh ed.). Boston, MA: Allyn & Bacon.</td></tr>
<tr><td colspan="2">Differentiation Considerations: Teachers may struggle with understanding alternative or invented strategies. They may need to practice some of these before attempting to solve the problem.</td></tr>
</table>

Curriculum Module 28	
CCSS Mathematics -- Focus	
Stage 1 -- Desired Results	
Transfer	
Teachers implement the curriculum and use instructional resources that are coherent and reflect the CCSS Mathematics and national curriculum recommendations.	
Meaning	
Understandings	Essential Questions
Teachers will understand the connection between a focused curriculum and effective instruction and student achievement.	How can I focus my instruction in order to improve student achievement?
Acquisition	
Knowledge	Skills
Teachers will know the reason that “focus” was considered one of the main premises in the development of the CCSS Mathematics.	Teachers will use their skills to adapt their current practices to allow for more focused instruction.
Stage 2 -- Evidence	
Teachers will share their focus for their grade level and plan for the focus for the next few weeks of instruction.	
Stage 3 -- Learning Plan	
1. Watch the video from the Hunt Institute on the importance of focus. 2. Read the article “The Structure is the Standards” by Daro, Zimba and McCallum. 3. Think about your current practices, is your instruction focused? 4. Make a chart showing your grade level focus for the year and the focus of instruction for the next few weeks.	
Materials Needed: Video: http://www.youtube.com/watch?v=2rje1NOgHWs&feature=plcp Article by Daro, Zimba and McCallum (the 3 main authors of the CCSS Mathematics) http://commoncoretools.me/2012/02/16/the-structure-is-the-standards/	
Differentiation Considerations: This is an important concept for implementation of the CCSS Mathematics. The article lends itself to in-depth conversation about current practices.	

<table>
<tr><td colspan="2">Curriculum Module 29</td></tr>
<tr><th colspan="2">CCSS Mathematics -- Coherence</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers implement the curriculum and use instructional resources that are coherent and reflect the CCSS Mathematics and national curriculum recommendations.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that appreciating the coherence between lessons and between grade levels helps to define the student learning goals.</td><td>What changes should I make to ensure that my instruction is coherent?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know the reason that “coherence” was considered one of the main premises in the development of the CCSS Mathematics.</td><td>Teachers will be skilled at identifying the coherence between a standard in their grade level and a standard from previous grades.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will create a chart showing a mathematical concept from K-6.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Watch the Hunt Institute Video.
2. Read the article “The Structure is the Standards” by Daro, Zimba and McCallum.
3. Choose one standard in your grade level. Determine the coherence required from previous grades and future grades.
4. Make a chart show this coherence from K-6.</td></tr>
<tr><td colspan="2">Materials Needed:
Video: http://www.youtube.com/watch?v=83Ieur9qy5k&feature=plcp
Article by Daro, Zimba and McCallum (the 3 main authors of the CCSS Mathematics)
http://commoncoretools.me/2012/02/16/the-structure-is-the-standards/</td></tr>
<tr><td colspan="2">Differentiation Considerations: This is an important concept for implementation of the CCSS Mathematics. The article lends itself to in-depth conversation about current practices.</td></tr>
</table>

Curriculum Module 30	
CCSS Mathematics Critical Areas	
Stage 1 -- Desired Results	
Transfer	
Teachers implement the curriculum and use instructional resources that are coherent and reflect the CCSS Mathematics and national curriculum recommendations.	
Meaning	
Understandings	Essential Questions
Teachers will understand the critical areas for instruction in their grade level.	How can I use the critical areas to focus my instruction?
Acquisition	
Knowledge	Skills
Teachers will know how the critical areas relate to the standards in their grade level.	Teachers will be skilled at matching their grade level standards to their critical areas.
Stage 2 -- Evidence	
Teachers will present a chart of the critical areas for their grade level. They will include activities that no longer meet the grade level standards. They will label each standard by its critical area.	
Stage 3 -- Learning Plan	
1. Read the Critical Areas for your grade level. (It is in the CCSS Mathematics, on the first page for your grade level.) 2. How many critical areas does your grade level have? What are they? How do they compare to the previous standards for your grade level? 3. Make a chart showing the critical areas with examples of how each would look in your classroom. At the bottom of the chart, list the activities that no longer fit into your math instruction for this grade level. 4. Label each standard according to the number of the critical area that it represents.	
Materials Needed: Common Core State Standards Mathematics http://www.corestandards.org/	
Differentiation Considerations: One way to encourage teachers to carefully consider some of their classroom activities is to share some that you have seen. "Last week I observed a classroom working with coins in first grade. Does that fit into the critical areas for first grade?" (It might, if the coins were used as a tool to teach place value!)	

Curriculum Module 31	
NBT Progression Document	
Stage 1 -- Desired Results	
Transfer	
Teachers implement the intended curriculum with needed intervention and makes certain every student attains it.	
Meaning	
Understandings	Essential Questions
Teachers will understand that each domain has a specific, researched based learning progression.	How can the progression documents inform my planning and instruction?
Acquisition	
Knowledge	Skills
Teachers will know how their grade level contributes to the domain and the understandings the students should have when they arrive in the grade level.	Teachers will be skilled at identifying the current spot on the learning progression for each of their students.
Stage 2 -- Evidence	
Teachers will construct charts showing the progression of the domain. They will also share their concerns about one grade level not contributing to the domain. Teachers will describe a struggling student by noting the student's current place in the progression.	
Stage 3 -- Learning Plan	
1. Read the overview on pages 1-4. 2. Read the grade level section assigned. 3. Make a chart showing the major work at the grade in this domain. 4. Share charts. 5. Review the chart and section for your own grade level and add notes as needed. 6. Consider what happens if one grade level does not provide the necessary instruction. Share your thoughts. 7. Think of a student who is struggling in this domain. Where is their current level	

of understanding in this domain?
Materials Needed: Progressions Document Number and Operations in Base Ten http://ime.math.arizona.edu/progressions/
Differentiation Considerations: If working with a PLC they can split the grades so all grades are covered. If working with a large group of K-6 teachers, assign a grade level at least two grades away from their current grade. For example, K teachers should work on 3rd grade and 5th grade teachers should work on 1st grade. This helps primary teachers to see how their instruction contributes to future grade levels. It also helps primary teachers work with mathematics that they do not normally work with. This helps upper grade teachers see how the progression starts and helps them to see possible intervention strategies for their struggling students. It also allows them to see the complicated mathematics in the primary grades.

Curriculum Module 32

CC & OA Progression Document

Stage 1 -- Desired Results

Transfer

Teachers implement the intended curriculum with needed intervention and makes certain every student attains it.

Meaning

Understandings	Essential Questions
Teachers will understand that each domain has a specific, researched based learning progression.	How can the progression documents inform my planning and instruction?

Acquisition

Knowledge	Skills
Teachers will know how their grade level contributes to the domain and the understandings the students should have when they arrive in the grade level.	Teachers will be skilled at identifying the current spot on the learning progression for each of their students.

Stage 2 -- Evidence

Teachers will construct charts showing the progression of the domain. They will also share their concerns about one grade level not contributing to the domain. Teachers will describe a struggling student by noting the student's current place in the progression.

Stage 3 -- Learning Plan

1. Read the overview on pages 2-3.
2. Read the grade level section assigned.
3. Make a chart showing the major work at the grade in this domain.
4. Share charts.
5. Review the chart and section for your own grade level and add notes as needed.
6. Consider what happens if one grade level does not provide the necessary instruction. Share your thoughts.
7. Think of a student who is struggling in this domain. Where is their current level of understanding in this domain?

Materials Needed: Progression Document Counting and Cardinality/Operations and Algebraic Thinking http://ime.math.arizona.edu/progressions/
Differentiation Considerations If working with a PLC they can split the grades so all grades are covered. If working with a large group of K-6 teachers, assign a grade level at least two grades away from their current grade. For example, K teachers should work on 3rd grade and 5th grade teachers should work on 1st grade. This helps primary teachers to see how their instruction contributes to future grade levels. It also helps primary teachers work with mathematics that they do not normally work with. This helps upper grade teachers see how the progression starts and helps them to see possible intervention strategies for their struggling students. It also allows them to see the complicated mathematics in the primary grades.

Curriculum Module 33	
NF Progression Document	
Stage 1 -- Desired Results	
Transfer	
Teachers implement the intended curriculum with needed intervention and makes certain every student attains it.	
Meaning	
Understandings	Essential Questions
Teachers will understand that each domain has a specific, researched based learning progression.	How can the progression documents inform my planning and instruction?
Acquisition	
Knowledge	Skills
Teachers will know how their grade level contributes to the domain and the understandings the students should have when they arrive in the grade level.	Teachers will be skilled at identifying the current spot on the learning progression for each of their students.
Stage 2 -- Evidence	
Teachers will construct charts showing the progression of the domain. They will also share their concerns about one grade level not contributing to the domain. Teachers will describe a struggling student by noting the student's current place in the progression.	
Stage 3 -- Learning Plan	
1. Read the overview on pages 1-4. 2. Read the grade level section assigned. 3. Make a chart showing the major work at the grade in this domain. 4. Share charts. 5. Review the chart and section for your own grade level and add notes as needed. 6. Consider what happens if one grade level does not provide the necessary instruction. Share your thoughts. 7. Think of a student who is struggling in this domain. Where is their current level of understanding in this domain?	

Materials Needed: Progression Document Number and Operations –Fractions http://ime.math.arizona.edu/progressions/
Differentiation Considerations This document is Grades 3-5. If working with a PLC they can split the grades so all grades are covered. If working with a large group of K-6 teachers, double up on each grade level. This helps primary teachers to see how their instruction contributes to future grade levels. It also helps primary teachers work with mathematics that they do not normally work with, while offering them upper grade teachers as support. This also helps upper grade teachers see how the progression starts and helps them to see possible intervention strategies for their struggling students.

Curriculum Module 34	
Mathematical Communication	
Stage 1 -- Desired Results	
Transfer	
Teachers implement the intended curriculum with needed intervention and makes certain every student attains it.	
Meaning	
Understandings	Essential Questions
Teachers will understand the value of asking students to communicate mathematically.	How does increasing communication in my mathematics instruction improve student understanding?
Acquisition	
Knowledge	Skills
Teachers will know the two Mathematical Practices that address communication in mathematics.	Teachers will be skillful at recognizing different strategies that encourage communication in their students.
Stage 2 -- Evidence	
Teachers will share their answers to the questions and make an action plan for increasing the mathematical communication in their classrooms.	
Stage 3 -- Learning Plan	
1. Read the Communication page on the NCTM website (National Council of Teachers of Mathematics) 2. Read CCSS Mathematics Practices #3 and #6 3. What do these practices look like at your grade level? 4. What changes can you implement to ensure that your students are using this practice? 5. What actions do teachers sometimes take that prevent students from using these practices? Share your answers with your PLC. 6. As a group make an action plan for increasing the mathematical communication in your classroom.	
Materials Needed: NCTM description of communication: http://www.nctm.org/standards/content.aspx?id=26854 Common Core State Standards Mathematics http://www.corestandards.org/	
Differentiation Considerations: Teachers may need practice in communicating their own mathematical thinking. Experienced teachers tend to use explanation more frequently in their classrooms than new teachers.	

<table>
<tr><td colspan="2">Curriculum Module 35</td></tr>
<tr><th colspan="2">Mathematical Vocabulary</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers implement the intended curriculum with needed intervention and makes certain every student attains it.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that different categories of mathematical and academic words require different instructional strategies.</td><td>How does categorizing vocabulary improve my vocabulary instruction and the accurate use of vocabulary in my students?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know the categories of words and some instructional strategies.</td><td>Teachers will be skilled at identifying mathematical and academic vocabulary words.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will share their plans for explicitly and implicitly teaching mathematical and academic vocabulary words.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Read the first two chapters in the Benjamin book.
2. Use your resources as a starting place. Categorize the vocabulary words for the next week into the three categories suggested in chapter 1.
3. Make a plan for teaching these some of these words explicitly.
4. Search for words in the Academic Word list on pages 17-18 that students in your grade level encounter and struggle with.
5. Make a plan for teaching these words implicitly.</td></tr>
<tr><td colspan="2">Materials Needed:
Benjamin, A. (2011). Math in Plain English. Larchmont, NY: Eye on Education.</td></tr>
<tr><td colspan="2">Differentiation Considerations: Teachers often attempt to teach too many vocabulary words. Research suggests 5-7 words per week for explicit instruction.</td></tr>
</table>

Curriculum Module 36

Grade Level Standards

Stage 1 -- Desired Results

Transfer

Teachers implement a curriculum that is focused on relevant and meaningful mathematics.

Meaning

Understandings	Essential Questions
Teachers will understand the details of the standards in one domain in their grade level.	How does my current instruction address the requirements in the standards?

Acquisition

Knowledge	Skills
Teachers will know one domain including the cluster headings, and the details of the standards.	Teachers will be skilled at defining the terms within the standards.

Stage 2 -- Evidence

Teachers will create a chart closely examining each standard in one domain including the cluster heading.

Stage 3 -- Learning Plan

1. Choose a domain to work with.
2. Put each standard on its own piece of chart paper. Add the cluster heading to each chart.
3. Have a silent conversation with your grade level about each standard. Record your conversation on the chart paper. Be sure that everyone has a different colored marker. Use questions, statements, pictures, and instruction strategies in your conversation.
4. Discuss your results with your team. Share more ideas for instruction. Make a list of questions you still have.
5. Check the progressions documents and the Illustrative Mathematics website for answers to your questions.

Materials Needed: Common Core State Standards Mathematics http://www.corestandards.org/ Progression Documents http://ime.math.arizona.edu/progressions/ Illustrations for individual standards http://illustrativemathematics.org/
Differentiation Considerations: Be sure to add the cluster headings each standard. It is essential to closely examine a standard with the cluster heading as a guide. Using the silent conversation allows each member to participate equally and helps the PD providers to see where the needs are. Teachers may need support with new vocabulary or modeling expectations in the CCSS Mathematics. Some areas of confusion may be: 6th grade RP tape diagrams, 3rd grade NF number line models for fractions, 1st OA "add and subtract within 20" versus "demonstrating fluency within 10", 2nd grade OA fluency within 100 versus know from memory sums of one-digit numbers. Teachers may show concern for what is "missing" in their grade level. Remind them of the research required when the standards were written. Also, remind them of Module 28 "Focus." Adding their own items to the standards takes time away from focusing where the standards focus.

Curriculum Module 37	
Understanding By Design UbD—Clarifying Desired Results	
Stage 1 -- Desired Results	
Transfer	
Teachers implement a curriculum that is focused on relevant and meaningful mathematics.	
Meaning	
Understandings	Essential Questions
Teachers will understand the importance of including all four goal types in instruction.	How can the different types of goals influence the instructional decisions I make?
Acquisition	
Knowledge	Skills
Teachers will know the four types of goals in the UbD framework: transfer, meaning, knowledge, and skills.	Teachers will be skilled at writing and identifying types of goals.
Stage 2 -- Evidence	
Teachers will label provided goals and they will create their own goals for an upcoming unit.	
Stage 3 -- Learning Plan	
1. Read Stage 1: Clarifying Learning Results on pages 14-21. 2. Examine Figures B.1 and B.2. 3. Identify the types of goals as the PD provider reads the goals from Figure E.1. 4. Practice writing each type of goal for a future math unit.	
Materials Needed: Wiggins, G., & McTighe, J. (2011). *The understanding by design guide to creating high-quality units.* Alexandria, VA: ASCD.	
Differentiation Considerations: Module 17 UbD Overview should be completed first.	

Curriculum Module 38	
Mathematical Tasks	
Stage 1 -- Desired Results	
Transfer	
Teachers use assessments that are congruent and aligned by grade level or course content.	
Meaning	
Understandings	Essential Questions
Teachers will understand that good mathematical tasks are interesting, focused on important mathematical ideas, require planning and persevering, and offer discussion opportunities.	How does my students' level of understanding change when they are presented with a good task?
Acquisition	
Knowledge	Skills
Teachers will know the components of a good task.	Teachers will be skilled at identifying tasks that meet the "good task" criteria.
Stage 2 -- Evidence	
Teachers will discuss the tasks in their resources using the evaluation criteria from the documents.	
Stage 3 -- Learning Plan	
1. Choose an assessment or teaching task from two of your current resources. 2. Read "What is a task and what makes a good task?" by Umland. 3. Use this document to evaluate the task. Is it a "good task"? If not, what can you modify to make it a good task? 4. Does one of your resources have more good tasks that the other? 5. Discuss other good tasks from the NCSM document and your resources with your team.	
Materials Needed: An article by Kristin Umland on Good Tasks http://commoncoretools.me/illustrative-mathematics/ Sample Tasks from the National Council of Supervisors of Mathematics www.mathedleadership.org/docs/ccss/Great**Tasks**Handout2012.pdf	
Differentiation Considerations: Resources vary widely in their task quality. Teachers may need support in evaluating the tasks. This is best done as a team.	

<table>
<tr><td colspan="2">Assessment Module 39</td></tr>
<tr><th colspan="2">Smarter Balanced Assessment Consortium (SBAC)</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers use assessments that are congruent and aligned by grade level or course content.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that the SBAC will dramatically change the assessment system currently used in our schools</td><td>How will my instruction need to change in order to help my students meet the demands of the SBAC system?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know the timeline and some of the format of the SBAC assessments.</td><td>Teachers will use their skills to recognize performance tasks.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will create a graphic showing the difference between the current state assessment system and the new SBAC system.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Open the SBAC website. Click on “Resources and Events” then “Publications and Resources.”
2. Find and read the “Factsheet for Teachers.”
3. Click on the “Smarter Balanced Assessments” then find and read the pdf called “Performance Task Specifications.”
4. Click on the link below and look at the 4th grade performance task.
5. Create a graphic demonstrating the difference between the current Nevada CRT system and the SBAC system that will replace it.</td></tr>
<tr><td colspan="2">Materials Needed:
SBAC website http://www.smarterbalanced.org/</td></tr>
</table>

SBAC Showcase 2 Fourth grade performance task starts on page 45 https://www.google.com/url?q=http://www.smarterbalanced.org/wordpress/wp-content/uploads/2012/03/SBAC04Showcase2.pdf&sa=U&ei=brLYT465Ns_MmAW42fWEAw&ved=0CBEQFjAG&client=internal-uds-cse&usg=AFQjCNFMLRW1zh-Vr5aeDAqzrZhpVLmmIQ
Differentiation Considerations: Looking at this website can be overwhelming for teachers. If there is time, try to analyze the parts of the 4th grade sample demonstrating that it is a huge task that can be broken down into understandings, knowledge and skills. Ask them to consider this statement: "If we are going to teach to the test, let's have a test worth teaching to!" (author unknown)

Assessment Module 40	
Rubric Design	
Stage 1 -- Desired Results	
Transfer	
Teachers use assessments that are congruent and aligned by grade level or course content.	
Meaning	
Understandings	Essential Questions
Teachers will understand that they can use rubrics to guide instruction and to evaluate student understanding more effectively.	How can using rubrics help improve my instruction and my students' understanding?
Acquisition	
Knowledge	Skills
Teachers will know the difference between a checklist and a rubric.	Teachers will use their skills to create rubrics.
Stage 2 -- Evidence	
Teachers will analyze the rubric samples in the chapter, they will create a "fun" rubric, and they will create a rubric to use for a math task.	
Stage 3 -- Learning Plan	
1. Read chapter 6 in the Burke book. 2. Discuss the sample rubrics that are relevant to your grade level. 3. Create a "fun" rubric as described on page 114. 4. Develop a rubric for a math task that your grade level will all use.	
Materials Needed: Burke, K. (2010). *Balanced Assessment: From Formative to Summative.* Bloomington, IN: Solution Tree Press.	
Differentiation Considerations: If the teachers currently use a math resource that includes rubrics, analyze one of the rubrics from their resource according to the criteria in the chapter.	

Assessment Module 41	
Mathematical Discussions	
Stage 1 -- Desired Results	
Transfer	
Teachers use formative assessment processes to inform teacher practice and student learning.	
Meaning	
Understandings	Essential Questions
Teachers will understand that mathematical discussions are not only high quality instructional techniques; they also provide formative assessment opportunities.	How can I use mathematical discussions to determine the understanding level of my students?
Acquisition	
Knowledge	Skills
Teachers will know how to plan for a mathematical discussion.	Teachers will be skilled at identifying the characteristics of an effective mathematical discussion.
Stage 2 -- Evidence	
Teachers will develop a plan for a mathematical discussion.	
Stage 3 -- Learning Plan	
1. Read pages 1-6 in chapter 1 in the Lamberg book. 2. Share your mathematical discussion experiences with your PLC. 3. Discuss which types of lessons lend themselves more to discussion. 4. Prepare a plan for a mathematical discussion for an upcoming lesson. Be sure to plan for meeting the instructional goals and for possible student misconceptions that may arise.	
Materials Needed: Lamberg, T. (2013). *Whole Class Mathematics Discussions: Improving In-Depth Mathematical Thinking and Learning.* Upper Saddle River, NJ: Pearson Education, Inc.	
Differentiation Considerations: Teachers may want additional support in their classrooms after this module. They may want support while they are conducting the mathematical discussion in their classroom. Some teachers may be uncomfortable with allocating their math time to discussion.	

<table>
<tr><td colspan="2">Assessment Module 42</td></tr>
<tr><th colspan="2">Number Talks</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers use formative assessment processes to inform teacher practice and student learning.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand that number talks are an important teaching and assessing technique.</td><td>What can I learn about my students' current understanding by conducting a number talk?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know how to conduct a number talk for their grade level.</td><td>Teachers will be skilled at recognizing the strategies used by their students.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will create a plan for and implement 3 number talks.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Watch the following videos from the Parrish book:
a. Author Clips: A.1 Why number talks? and A.3 Number talks: teachers as learners.
b. Choose one of the following appropriate for your grade level: Teachers Clips: T.K, T.2, T.3, T.5.
c. Watch Classroom Clips: K.1 to see what Kinder can do! (after much practice!)
d. Choose a topic from the classroom clips appropriate for your grade level. Attend to the way the teacher is naming the strategies the students are using.
2. Create a plan to try three number talks in your classroom in the next week. Be sure to label the strategies the students are using during the talks. This helps to determine which strategies need further instruction and which strategies your</td></tr>
</table>

students are already competent with.
Materials Needed: Parrish, S. (2010). *Number Talks: Helping Children Build Mental Math and Computation Strategies.* Sausalito, CA: Math Solutions.
Differentiation Considerations: Teachers may want additional support in their classrooms after this module. They may want support while they are conducting the number talks in their classroom. Some teachers may be uncomfortable with allocating their math time to discussion. They may also need more practice in naming the strategies their students are using.

Assessment Module 43	
Providing Feedback	
Stage 1 -- Desired Results	
Transfer	
Teachers use formative assessment processes to inform teacher practice and student learning.	
Meaning	
Understandings	Essential Questions
Teachers will understand that feedback helps students move toward the instructional goals.	How does giving feedback instead of grades change my students reactions to their papers?
Acquisition	
Knowledge	Skills
Teachers will know how to give specific feedback that moves learning forward.	Teachers will use their skills to provide timely feedback before their students reach a frustration stage in their learning.
Stage 2 -- Evidence	
Teachers will collaboratively provide specific feedback for their students.	
Stage 3 -- Learning Plan	
1. Gather a set of papers from an assignment in your classroom that has not been graded. 2. Read "Why is feedback and important component of assessment? on pages 21-22. 3. With your PLC, give students feedback on 5 of the papers. Try not to think about grades, just focus on providing specific feedback to help the students' deepen their understanding. 4. Repeat with 5 papers from another teacher.	
Materials Needed: Burke, K. (2010). *Balanced Assessment: From Formative to Summative.* Bloomington, IN: Solution Tree Press.	
Differentiation Considerations: This is a very difficult task. Providing feedback instead of grades requires a different thought process for teachers and for students. It is best to work as a group on one set of papers at a time.	

<table>
<tr><td colspan="2">Assessment Module 44</td></tr>
<tr><th colspan="2">Formative Assessment</th></tr>
<tr><th colspan="2">Stage 1 -- Desired Results</th></tr>
<tr><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Teachers use formative assessment processes to inform teacher practice and student learning.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><th>Understandings</th><th>Essential Questions</th></tr>
<tr><td>Teachers will understand what formative assessment is.</td><td>How does incorporating more formative assessment opportunities improve my instruction?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><th>Knowledge</th><th>Skills</th></tr>
<tr><td>Teachers will know strategies for implementing formative assessment.</td><td>Teachers will be skilled at identifying formative assessment opportunities in their classrooms.</td></tr>
<tr><th colspan="2">Stage 2 -- Evidence</th></tr>
<tr><td colspan="2">Teachers will create an action plan to incorporate more formative assessments into their instruction.</td></tr>
<tr><th colspan="2">Stage 3 -- Learning Plan</th></tr>
<tr><td colspan="2">1. Read “What is formative assessment?” on pages 20-21 in the Burke book.
2. Consider this statement “When the cook taste the soup, it’s formative. When the guests taste the soup, it’s summative.” (author unknown)
3. What formative assessments do you already have in place in your classroom?
4. What formative assessments do you want to incorporate into your instruction?
5. Use the chart on page 25 and Chapter 7 to help you develop a plan for including more formative assessments in your classroom.</td></tr>
<tr><td colspan="2">Materials Needed:
Burke, K. (2010). Balanced Assessment: From Formative to Summative. Bloomington, IN: Solution Tree Press.</td></tr>
<tr><td colspan="2">Differentiation Considerations: Schools may require specific assessment strategies to be used. Teachers may need support in determining what types of assessment are needed to assist in their students’ understanding.</td></tr>
</table>

Assessment Module 45	
Summative Assessment	
Stage 1 -- Desired Results	
Transfer	
Teachers use summative assessment data to evaluate mathematics grade-level, course and program effectiveness.	
Meaning	
Understandings	Essential Questions
Teachers will understand the difference between formative and summative assessment.	How can summative assessments help me to improve my instruction and the learning of my future students?
Acquisition	
Knowledge	Skills
Teachers will know how to use summative assessments for evaluation.	Teachers will use their skills to interpret data from summative assessments.
Stage 2 -- Evidence	
Teachers will use two summative assessments to develop an action plan for improving their instruction for future students.	
Stage 3 -- Learning Plan	
1. Read “What is summative assessment” on page 23-24 in the Burke book. 2. What summative assessments do you already have in place in your classroom? 3. Use the chart on page 25 and Chapter 8 to help you develop a plan for effectively utilizing 2 summative in your classroom.	
Materials Needed: Burke, K. (2010). *Balanced Assessment: From Formative to Summative.* Bloomington, IN: Solution Tree Press.	
Differentiation Considerations: Teachers may not have a choice in which summative assessments they use. They may need support understanding how to interpret the data from district or state summative assessments.	

Appendix B: Consent Form

Focusing Professional Development by Differentiating for Teachers Consent Form

You are invited to take part in a research study of the mathematical knowledge required for teaching. The researcher is inviting first-fifth grade teachers to be in the study. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part. Twelve schools in the [redacted] County School District have been randomly selected to participate. There are three schools from each of the four categories: low risk schools, moderate risk schools, challenge schools, and Title I schools.

This study is being conducted by a researcher named Amy Weber-Salgo, who is a doctoral student at Walden University. You may already know the researcher as a mathematics trainer for the RPDP program, but this study is separate from that role.

Background Information:
The purpose of this study is to investigate the professional development needs of the first-fifth grade teachers in mathematics. Data will be collected using a mathematical knowledge assessment specifically created for elementary school teachers. The results from this portion of the project will help to determine if the needs vary within the school district and if those results are related to the schools' success on the Nevada Criterion Referenced Tests.

Procedures:
If you agree to be in this study, you will be asked to:

- Fill out a 3-question survey. (2-3 minutes)
- Take an online assessment focusing on number concepts and operations, patterns, functions, and algebra. (approximately 45 minutes, taken within the next 7 days.)

Here is a sample question from the survey:
What percentage of time do you currently use the Everyday Math series with your students?

Voluntary Nature of the Study:
This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at your school or within the school district will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind during or after the study. You may stop at any time.

Risks and Benefits of Being in the Study:
Being in this type of study involves some risk of the minor discomforts that can be encountered in daily life, such as concerns about getting the answers correct. Being in this study would not pose risk to your safety or wellbeing.
The benefit for this study will be in the development of a professional development plan in elementary mathematics which is consistent with the specific needs of [redacted] County schools.

Privacy:
This study has been designed so that all identities are completely protected. Data collection for this study will be anonymous. Any information you provide will be kept using a coding system that is not associated with your identity. Codes, not names, will be entered into all statistical

software and printed on all reports. Codes will identify the category of school, the code of the school and your participant number. For example, a code of "LA42" will be used to identify the category of low risk, school A, and participant number 42. The researcher will not use your personal information for any purposes outside of this research project. The data collected in this research study will not be used for any evaluation purposes. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact the researcher via phone [redacted] **or email** [redacted]. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 1-800-925-3368, extension 1210. Walden University's approval number for this study is **01-31-12-0024532** and it expires on **January 30, 2013.**
Please keep this consent form for your records.
In order to protect your privacy, signatures are not being collected.

Statement of Consent:

I have read the above information and I feel I understand the study well enough to make a decision about my involvement.
By returning a completed survey and taking the online assessment, I understand that I am agreeing to the terms described above.

This has been approved by the Institutional Review Board of WALDEN UNIVERSITY as an acceptable documentation of the informed consent process and is valid for one year after the stamped date.

2012.01.31 15:06:08 -06'00'

Appendix C: Teacher Survey

Participant Code

1. What percentage of time do you currently use the Everyday Math series with your students?
   (choose one)
   A. 80-100%
   B. 60-79%
   C. 40-59%
   D. 20-39%
   E. 0-19%

2. In the past five years, how many hours of math training have you had? (In answering this question, please consider in-service courses, district trainings, and trainings at your school site.)
   (choose one)
   A. 40+
   B. 30-39
   C. 20-29
   D. 10-19
   E. 0-9

3. How many years have you taught at your current school? (choose one)
   A. 5+
   B. 1-5
   C. This is my first year at this school.

Appendix D: MKT Sample Items

LEARNING MATHEMATICS FOR TEACHING

MATHEMATICAL KNOWLEDGE FOR TEACHING (MKT) MEASURES

MATHEMATICS RELEASED ITEMS
2008

University of Michigan, Ann Arbor
610 E. University #1600
Ann Arbor, MI 48109-1259
(734) 647-5233
www.sitemaker.umich.edu/lmt

 Measures development supported by NSF grants REC-9979873, REC- 0207649, EHR-0233456 & EHR 0335411, and by a subcontract to CPRE on Department of Education (DOE), Office of Educational Research and Improvement (OERI) award #R308A960003.

December 26, 2008

Study of Instructional Improvement/Learning Mathematics for Teaching
Content Knowledge for Teaching Mathematics Measures (MKT measures)
Released Items, 2008
ELEMENTARY CONTENT KNOWLEDGE ITEMS

1. Ms. Dominguez was working with a new textbook and she noticed that it gave more attention to the number 0 than her old book. She came across a page that asked students to determine if a few statements about 0 were true or false. Intrigued, she showed them to her sister who is also a teacher, and asked her what she thought.

Which statement(s) should the sisters select as being true? (Mark YES, NO, or I'M NOT SURE for each item below.)

	Yes	No	I'm not sure
a) 0 is an even number.	1	2	3
b) 0 is not really a number. It is a placeholder in writing big numbers.	1	2	3
c) The number 8 can be written as 008.	1	2	3

2. Imagine that you are working with your class on multiplying large numbers. Among your students' papers, you notice that some have displayed their work in the following ways:

Student A	Student B	Student C
$\begin{array}{r} 35 \\ \times 25 \\ \hline 125 \\ +75 \\ \hline 875 \end{array}$	$\begin{array}{r} 35 \\ \times 25 \\ \hline 175 \\ +700 \\ \hline 875 \end{array}$	$\begin{array}{r} 35 \\ \times 25 \\ \hline 25 \\ 150 \\ 100 \\ +600 \\ \hline 875 \end{array}$

Which of these students would you judge to be using a method that could be used to multiply any two whole numbers?

	Method would work for all whole numbers	Method would NOT work for all whole numbers	I'm not sure
a) Method A	1	2	3
b) Method B	1	2	3
c) Method C	1	2	3

3. Ms. Harris was working with her class on divisibility rules. She told her class that a number is divisible by 4 if and only if the last two digits of the number are divisible by 4. One of her students asked her why the rule for 4 worked. She asked the other students if they could come up with a reason, and several possible reasons were proposed. Which of the following statements comes closest to explaining the reason for the divisibility rule for 4? (Mark ONE answer.)

a) Four is an even number, and odd numbers are not divisible by even numbers.

b) The number 100 is divisible by 4 (and also 1000, 10,000, etc.).

c) Every other even number is divisible by 4, for example, 24 and 28 but not 26.

d) It only works when the sum of the last two digits is an even number.

4. Ms. Chambreaux's students are working on the following problem:

Is 371 a prime number?

As she walks around the room looking at their papers, she sees many different ways to solve this problem. Which solution method is correct? (Mark ONE answer.)

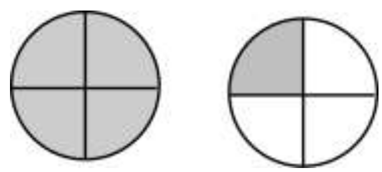
a) Check to see whether 371 is divisible by 2, 3, 4, 5, 6, 7, 8, or 9.

b) Break 371 into 3 and 71; they are both prime, so 371 must also be prime.

c) Check to see whether 371 is divisible by any prime number less than 20.

d) Break 371 into 37 and 1; they are both prime, so 371 must also be prime.

5. Mrs. Johnson thinks it is important to vary the whole when she teaches fractions. For example, she might use five dollars to be the whole, or ten students, or a single rectangle. On one particular day, she uses as the whole a picture of two pizzas. What fraction of the two pizzas is she illustrating below? (Mark ONE answer.)



a) 5/4

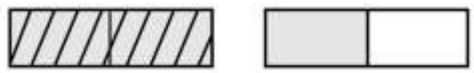
b) 5/3

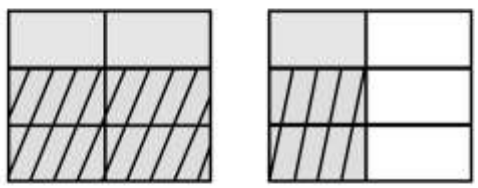
c) 5/8

d) 1/4

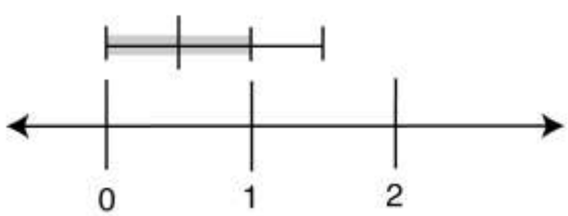
6. At a professional development workshop, teachers were learning about different ways to represent multiplication of fractions problems. The leader also helped them to become aware of examples that do not represent multiplication of fractions appropriately.

Which model below cannot be used to show that $1\frac{1}{2} \times \frac{2}{3} = 1$? (Mark ONE answer.)

A) 

B) 

C) 

D) 

7. Which of the following story problems could be used to illustrate $1\frac{1}{4}$ divided by $\frac{1}{2}$? (Mark YES, NO, or I'M NOT SURE for each possibility.)

	Yes	No	I'm not sure
a) You want to split $1\frac{1}{4}$ pies evenly between two families. How much should each family get?	1	2	3
b) You have $1.25 and may soon double your money. How much money would you end up with?	1	2	3
c) You are making some homemade taffy and the recipe calls for $1\frac{1}{4}$ cups of butter. How many sticks of butter (each stick = $\frac{1}{2}$ cup) will you need?	1	2	3

8. As Mr. Callahan was reviewing his students' work from the day's lesson on multiplication, he noticed that Todd had invented an algorithm that was different from the one taught in class. Todd's work looked like this:

$$\begin{array}{r} 983 \\ \underline{\times\ \ 6} \\ 488 \\ +\underline{5410} \\ 5898 \end{array}$$

What is Todd doing here? (Mark ONE answer.)

a) Todd is regrouping ("carrying") tens and ones, but his work does not record the regrouping.

b) Todd is using the traditional multiplication algorithm but working from left to right.

c) Todd has developed a method for keeping track of place value in the answer that is different from the conventional algorithm.

d) Todd is not doing anything systematic. He just got lucky – what he has done here will not work in most cases.

ELEMENTARY KNOWLEDGE OF STUDENTS AND CONTENT ITEMS

9. Mr. Garrett's students were working on strategies for finding the answers to multiplication problems. Which of the following strategies would you expect to see some elementary school students using to find the answer to 8 x 8? (Mark YES, NO, or I'M NOT SURE for each strategy.)

	Yes	No	I'm not sure
a) They might multiply 8 x 4 = 32 and then double that by doing 32 x 2 = 64.	1	2	3
b) They might multiply 10 x 10 = 100 and then subtract 36 to get 64.	1	2	3
c) They might multiply 8 x 10 = 80 and then subtract 8 x 2 from 80: 80 – 16 = 64.	1	2	3
d) They might multiply 8 x 5 = 40 and then count up by 8's: 48, 56, 64.	1	2	3

10. Students in Mr. Hayes' class have been working on putting decimals in order. Three students — Andy, Clara, and Keisha — presented 1.1, 12, 48, 102, 31.3, .676 as decimals ordered from least to greatest. What error are these students making? (Mark ONE answer.)

b) They are ignoring place value.

c) They are ignoring the decimal point.

d) They are guessing.

e) They have forgotten their numbers between 0 and 1.

f) They are making all of the above errors.

11. You are working individually with Bonny, and you ask her to count out 23 checkers, which she does successfully. You then ask her to show you how many checkers are represented by the 3 in 23, and she counts out 3 checkers. Then you ask her to show you how many checkers are represented by the 2 in 23, and she counts out 2 checkers. What problem is Bonny having here? (Mark ONE answer.)

a) Bonny doesn't know how large 23 is.

b) Bonny thinks that 2 and 20 are the same.

c) Bonny doesn't understand the meaning of the places in the numeral 23.

d) All of the above.

12. Mrs. Jackson is getting ready for the state assessment, and is planning mini-lessons for students focused on particular difficulties that they are having with adding columns of numbers. To target her instruction more effectively, she wants to work with groups of students who are making the same kind of error, so she looks at a recent quiz to see what they tend to do. She sees the following three student mistakes:

I) $\begin{array}{r} {\scriptstyle 1} \\ 38 \\ 49 \\ +\ 65 \\ \hline 142 \end{array}$ II) $\begin{array}{r} {\scriptstyle 1} \\ 45 \\ 37 \\ +\ 29 \\ \hline 101 \end{array}$ III) $\begin{array}{r} {\scriptstyle 1} \\ 32 \\ 14 \\ +\ 19 \\ \hline 64 \end{array}$

Which have the same kind of error? (Mark ONE answer.)

a) I and II

b) I and III

c) II and III

d) I, II, and III

13. Ms. Walker's class was working on finding patterns on the 100's chart. A student, LaShantee, noticed an interesting pattern. She said that if you draw a plus sign like the one shown below, the sum of the numbers in the vertical line of the plus sign equals the sum of the numbers in the horizontal line of the plus sign (i.e., 22 + 32 + 42 = 31 + 32 + 33). Which of the following student explanations shows sufficient understanding of why this is true for all similar plus signs? (Mark YES, NO or I'M NOT SURE for each one.)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

	Yes	No	I'm not sure
a) The average of the three vertical numbers equals the average of the three horizontal numbers.	1	2	3
b) Both pieces of the plus sign add up to 96.	1	2	3
c) No matter where the plus sign is, both pieces of the plus sign add up to three times the middle number.	1	2	3
d) The vertical numbers are 10 less and 10 more than the middle number.	1	2	3

14. Mrs. Jackson is getting ready for the state assessment, and is planning mini-lessons for students around particular difficulties that they are having with subtracting from large whole numbers. To target her instruction more effectively, she wants to work with groups of students who are making the same kind of error, so she looks at a recent quiz to see what they tend to do. She sees the following three student mistakes:

I	II	III
$\begin{array}{r} \overset{4}{\cancel{5}}0\overset{12}{\cancel{2}} \\ -\ 6 \\ \hline 406 \end{array}$	$\begin{array}{r} 3\overset{4}{\cancel{5}}00\overset{15}{\cancel{5}} \\ -\ \ \ 6 \\ \hline 34009 \end{array}$	$\begin{array}{r} \overset{6}{\cancel{7}}\overset{9}{\cancel{0}}\overset{8}{\cancel{0}}\overset{15}{\cancel{5}} \\ -\ \ 7 \\ \hline 6988 \end{array}$

Which have the same kind of error? (Mark ONE answer.)

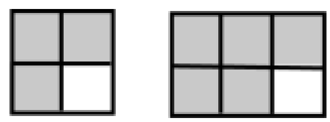
a) I and II

b) I and III

c) II and III

d) I, II, and III

15. Takeem's teacher asks him to make a drawing to compare $\frac{3}{4}$ and $\frac{5}{6}$. He draws the following:



and claims that $\frac{3}{4}$ and $\frac{5}{6}$ are the same amount. What is the <u>most likely</u> explanation for Takeem's answer? (Mark ONE answer.)

a) Takeem is noticing that each figure leaves one square unshaded.

b) Takeem has not yet learned the procedure for finding common denominators.

c) Takeem is adding 2 to both the numerator and denominator of $\frac{3}{4}$, and he sees that that equals $\frac{5}{6}$.

d) All of the above are equally likely.

16. A number is called "abundant" if the sum of its proper factors exceeds the number. For example, 12 is abundant because 1 + 2 + 3 + 4 + 6 > 12. On a homework assignment, a student incorrectly recorded that the numbers 9 and 25 were abundant. What are the most likely reason(s) for this student's confusion? (Mark YES, NO or I'M NOT SURE for each.)

	Yes	No	I'm not sure
a) The student may be adding incorrectly.	1	2	3
b) The student may be reversing the definition, thinking that a number is "abundant" if the number exceeds the sum of its proper factors.	1	2	3
c) The student may be including the number itself in the list of factors, confusing proper factors with factors.	1	2	3
d) The student may think that "abundant" is another name for square numbers.	1	2	3

Curriculum Vitae

Amy Weber-Salgo

Education

Ed.D. Administrative Leadership, Walden University, 2012

M.S. Literacy, Walden University, 2005

Teaching Certification, Graduate Special Program, University of Nevada, Reno, 1995

B.A. Health Education, University of Nevada, Reno, 1990

Work Experience:

Math Trainer, [redacted] School District, 2011-Present

Implementation Specialist, [redacted] School District, 2010-2011

Elementary Teacher, [redacted] School District, 1995-2010

Response to Intervention Consultant K-6, [redacted] School District, 2008-2010

Teacher-Trainer [redacted] School District, 1997-Present
Facilitator for the PBS Teacherline Program, 2002
University Instructor, "Math Methods for Elementary Pre-Service Teachers", University of Nevada, Reno, 2000

Substitute Teacher, [redacted] School District, 1992-1995

HIV/AIDS Educator 1990-1992

Training

CCSS, Differentiation, Data Driven Dialogue, PLC Facilitation, SIOP for Implementation Specialists, SLF for Implementation Specialists, Response to Intervention, Depth of Knowledge, PDCA, Avenues, GLAD, NELIP, Skillful Teacher, Best Practices in Mathematics, Marzano, MARE, TRIBES, Guided Reading, Opening Eyes to Mathematics, Project Teach, Reading Recovery for Classroom Teachers, Multiage Teaching, What Matters Most For Teachers.

Awards and Honors

- Recipient, [redacted] Teachers Association, **Distinguished Teacher Award**, 2001
- Recipient, Northern Nevada Math Council, **Math Teaching Award**, 2000
- Recipient, Sallie Mae Award for **Outstanding First Year Teachers**, Representing the State of Nevada, 1996