2019

Teachers' Perceptions About Instructing Underachieving K-5 Students on Mathematical Word Problem-Solving

Crystal Yvette BaldwinDouglas
Walden University

Walden University

College of Education

This is to certify that the doctoral study by

Crystal Baldwin

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. Salina Shrofel, Committee Chairperson, Education Faculty
Dr. Jennifer Seymour, Committee Member, Education Faculty
Dr. Nicolae Nistor, University Reviewer, Education Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2019

Abstract

Teachers' Perceptions About Instructing Underachieving K-5 Students on Mathematical Word Problem-Solving

by

Crystal Baldwin

MA, Walden University, 2005

BS, Norfolk State University, 2000

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Walden University

April 2019

Abstract

The state of Maryland has implemented the Common Core State Standards for Mathematics (CCSSM) operations & algebraic thinking and number & operations-fractions with emphasis on students in Grades K-5 acquiring the ability to solve word problems for state and curriculum math assessments. However, since the implementation of CCSSM, 30% of elementary students in a Maryland school district have demonstrated underachievement (basic or below basic level) on problem-solving sections of the state and school standardized tests. This qualitative case study, guided by Polya's model of the four phases of mathematical problem-solving, was conducted to address this problem. The research questions addressed teachers' perceptions of how they teach underachieving students' word problem-solving skills, how prepared they feel, the challenges they experience when teaching word problem-solving skills, and the resources for instructing underachieving students on mathematical word problem-solving. Semi-structured interviews were conducted with 8 certified elementary classroom teachers. Data from the teacher interviews were analyzed using pattern coding and thematic analysis. The findings indicated that teachers are not fully prepared to teach the CCSSM, teachers need assistance in creating standards-based detailed lesson plans, and teachers need help with the development of pedagogical strategies that enhance students' math vocabulary. Findings may lead to positive social change by informing the design of professional development and increasing the number of students who achieve proficiency in mathematical word problem-solving.

Teachers’ Perceptions About Instructing Underachieving K-5 Students on Mathematical Word Problem-Solving

by

Crystal Baldwin

MA, Walden University, 2005

BS, Norfolk State University, 2000

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Walden University

April 2019

Dedication

To God Be All the Glory! I would not have been able to conqueror this mountain, without lots of praying (for myself, wisdom, and clarity), prayers (from family and friends), and patience! To my sons and husband, I say Thank you! To my mom, mother-in-law, and Pastor, who would not let me give up. To my Aunt Tana, I am smiling and laughing!

Acknowledgments

I would like to express love to my family, friends, and associates, thank you for the continued support and understanding all while helping me stay focused on accomplishing this goal. To my colleagues, thank you for all the encouragement during my journey. I would like also to express sincere appreciation and gratitude to the committee members; Dr. Salina Shrofel, Dr. Jennifer Seymour, and Dr. Nicolae Nistor for their support and guidance throughout this project study.

Table of Contents

List of Tables

List of Figures

Section 1: The Problem

The Local Problem

A significant focus for the advancement of American education needs to be on components of what happens in the classroom, who is teaching, and the curriculum (Jennings, 2012). For instance, as reported by the National Center for Education Statistics (2012), there was a significantly low nationwide percentage (60%) of fourth-grade students in 2012 scoring at basic level on state and national standardized mathematics assessments. Additionally, the National Center for Education Statistics (2017) report showed that 80% of fourth-grade students performed at the basic achievement level in mathematics, which was lower than the 2015 (82%) average. Bonny and Lourenco (2013) attributed this lack of mathematics achievement on standardized tests to students' lack of ability in mathematical problem-solving. The National Council of Teachers of Mathematics argued that students should be "given a chance to apply and adapt a variety of appropriate strategies to solve problems, and monitor and reflect on the process of mathematical problem-solving in instructional programs during the problem-solving process" (as cited in Karatas & Baki, 2013, p. 250).

Students not reaching achievement levels on state and curriculum word problem-solving assessments shows a need for further interventions that teachers can provide through direct instruction. There is also a need to improve students' word problem-solving skill because many states have implemented the Common Core State Standards for Mathematics (CCSSM), developed by the National Governors' Association Center for Best Practices and the Commissioner's Council of Chief State School Officers into their curriculum (Kober & Rentner, 2012). The operations and algebraic thinking and the number and operations-fractions standard of CCSSM requires students in Grades K-5 to solve word problems and teachers to be competent in teaching mathematical problem-solving skills and strategies (Chipman, Siegel, & Glaser, 2013). For students to gain proficiency in fundamental math skills and strategies, teachers need to focus on developing students' mathematical problem-solving abilities (Kaya, Izgiol, & Kesan, 2014). Providing students with the necessary mathematical skills and strategies to solve word problems gives them an opportunity to do well on the word problem-solving sections of state and curriculum testing (DiDonato, 2013) and achieve higher scores on the state and national assessments.

In addition to doing well academically and on assessments, evidence has shown that elementary students who have difficulty solving mathematical word problems lack competence in several areas: knowledge of analytical processes such as addition, subtraction, multiplication, and division (Haghverdi, Semnani, & Seifi, 2012). Other problematic areas have been reading comprehension (Pungut & Shahrill, 2014) and practical strategies related to mathematical problem-solving (Haghverdi et al., 2012). Furthermore, evidence has shown that students lack cognitive processing skills (Swanson, Moran, Lussier, & Fung, 2014). Cognitive processing of word problems requires students to use problem-solving skills, process information, understand the structure and patterns in given problems, and create and use mental imagery to develop feasible solutions to the problem (Poison & Jeffries, 2014; Zhu, 2015). In addition to these problems on the part of students is the fact that there is a lack of teacher understanding of mathematical problem-solving (McGee, Wang, & Polly, 2013).

Definition of the Problem

The problem at five Maryland elementary schools is that over 30% of students in Grades K-5 have exhibited poor performance on curriculum and state assessments during the 2013-2014 school years (Maryland State Department of Education, 2015). During the following 2015-2016 school year, there was also an increase in the percentage of K-5 students who performed poorly on state assessments (Maryland State Department of Education, 2016). The state of Maryland expects students to demonstrate proficiency or above on mathematical problem-solving on standardized exams; therefore, it is necessary for educators to identify and address students' deficiencies with mathematical word problem-solving.

Mathematics achievement of students in Grades K-2 at five Maryland elementary schools was evaluated using My Math and newly implemented scholastic math inventory assessments. The Maryland State Assessment and The Partnership for Assessment of Readiness for College and Careers (PARCC) evaluated the mathematics achievement of students in Grades 3-5. All assessments were reflective of the state standards and skills that students learn in the classroom. The PARCC math questions were aligned to meet the CCSSM that includes operations and algebraic thinking and number and operations-fractions. The CCSSM defined grade level appropriate skills and knowledge students needed to know to prepare for graduating high school and being successful in college or workforce programs (Common Core State Standard Initiative, 2016). The CCSSM also prepares students for national economic competitiveness in a global economy (Tienken & Mullen, 2014). Table 1 shows the Common Core curriculum mathematics standards related to mathematical word problem-solving that elementary level students meet and demonstrate to achieve proficiency on state assessments.

Table 1

Elementary Level Common Core Standards for Mathematical Problem-Solving

Grade Level	Objective	Standard
Kindergarten	Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.	CCSS.Math.Content.K.OA.A.2 Solve addition and subtraction word problems and add and subtract within 10.
First	Represent and solve problems involving addition and subtraction.	CCSS.Math.Content.1.OA.A.1 Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, and comparing, with unknowns in all positions.
Second	Represent and solve problems involving addition and subtraction.	CCSS.Math.Content.2.OA.A.1 Use addition and subtraction within 100 to solve one- and two-step word problems involving situations of adding to, taking from, putting together, and comparing, with unknowns in all positions.
Third	Represent and solve problems involving multiplication and division.	CCSS.Math.Content.3.OA.A.3 Students use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities.
Fourth	Use the four operations with whole numbers to solve problems.	CCSS.Math.Content.4.OA.A.3 Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted.
Fifth	Use equivalent fractions as a strategy to add and subtract fractions.	CCSS.Math.Content.5.NF.A.2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators. CCSS.Math.Content.5.NF.B.7.c Solve real-world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions.

Note. From Common Core State Standard Initiative (2016).

School administration requires teachers to examine state, district, and school-based data to determine the instructional needs of their students (Maryland State Department of Education, 2015). Data provided from the My Math and scholastic math inventory assessments for grade levels K-2, Maryland State Assessment, and PARCC for Grades 3-5 showed that there was a need for underachieving students (up to 33%) to demonstrate knowledge of word problem-solving related skills and strategies (Maryland State Department of Education, 2014).

The gap in practice that I investigated was (a) how teachers are teaching word problem-solving skills, (b) how prepared teachers perceive they are for instructing underachieving students in word problem-solving, (c) the challenges teachers face while teaching students mathematical word problem-solving, and (d) the support teachers perceive that they need to improve their teaching of mathematical word problem skills. The findings of this study provide the schools and district with an understanding that informs the development of interventions targeted to the specific needs of five Maryland elementary schools' teachers.

Rationale

Evidence of the Problem at the Local Level

The 2014-2015 scores on the curriculum assessment for five Maryland elementary schools showed that 33% of 851 pupils in Grades K-2 were functioning at a basic level on mathematics assessments (Maryland State Department of Education, 2015). Table 2 lists the percentages and number of students who scored at the basic level on county curriculum math assessments during the school years 2012-2015. The data show that between the 2012-2013 and 2013-2014 school years, the percentage of K-3 students who scored basic level decreased. During the following 2014-2015 school year, there was an increase in the percentage of students scoring at the basic level.

Table 2

Percentage of Grades K-2 Students Scoring Basic Level on Mathematics Assessment

Academic Year	# of Students in Grades K-2	# of Students Scoring Basic Level	% of Students Scoring Basic Level
2012-2013	853	310	36
2013-2014	822	264	32
2014-2015	851	279	33

Note. From Maryland State Department of Education (2017).

According to the 2013-2014 Maryland State Assessment scores, 28% of 882 students in Grades 3-5 at five Maryland elementary schools were functioning at a basic level in word problem-solving (Maryland State Department of Education, 2015). Table 3 presents the percentages of students in Grades 3-5 who scored basic level in word problem-solving on the Maryland State Assessment for the school years 2012-2015. The data showed that the percentage of students scoring basic level decreased from the 2012-2013 to 2013-2014 academic year, then it increased in the 2014-2015 school year. The results showed there is inconsistency in students' mathematical problem-solving abilities.

Table 3

Percentage of Grades 3-5 Students Scoring Basic Level on Maryland's State Assessment

Academic Year	# of Students in Grades 3-5	# of Students Scoring Basic Level	% of Students Scoring Basic Level
2012-2013	938	324	35
2013-2014	882	248	28
2014-2015	890	269	30

Note. From Maryland State Department of Education (2017).

During the 2014-2015 school year, third to fifth grade students took the PARCC assessment for the first time. Because this was the first time that the students and teachers experienced the new test, the district and the state considered that the scores were not reflective of student achievement. In the following 2015-2016 school year, the third to fifth graders took the PARCC assessment, and the district and the state considered the results reflective of student achievement. Table 4 shows the percentage of third to fifth graders that tested and the percentage of students that scored not met, which is equivalent to below grade level in mathematics achievements.

Table 4

Percentage of Grades 3-5 Students Scoring Not Met on PARCC Assessment

Academic Year	Grade Level	# of Students Tested in Grades 3-6	# of Students Scoring Not Met	% of Students Scoring Not Met
2015-2016	3-5	918	311	34
2016-2017	3-5	985	294	29
2017-2018	3-5	986	253	26

Note. From Maryland State Department of Education (2018).

As stated by a fifth-grade mathematics teacher,

> Fifth-grade students are still struggling [at Grade 5] with the word problem, even though they [students] were taught strategies in kindergarten, first, all the way up to the present moment. As a school, we as teachers need to figure out why this is happening.

Students’ low performance on word problem-solving sections on standardized testing was not just a problem in this study school but a problem at other Maryland elementary schools as well (Maryland State Department of Education, 2014). The implementation of Common Core standards operations and algebraic thinking and number & operations-fractions, which emphasizes mathematical problem-solving, has increased the need for teachers to provide effective instruction to students about problem-solving skills and strategies (Akkus, 2016).

Evidence of the Problem from the Professional Literature

The National Assessment of Educational Progress (2015) mathematics assessment is used for measuring students' math achievement at the national level. The assessment measures fourth- and eighth-grade student knowledge and skills in mathematics and the students' abilities to apply their knowledge in problem-solving situations. According to the 2015 Nations Report Card, fourth graders in Maryland achieved an average math score of 239 in a range from 0 to 500 on the national test that examined problem-solving and other mathematics concepts (National Center for Education Statistics, 2016). When compared to other states, Maryland's fourth-grade students were functioning lower in mathematics than fourth-grade students in 19 other U.S. states, similarly to fourth-grade students in 22 other U.S. states, and higher than fourth-grade students in nine other U.S. states. Furthermore, 60% of fourth graders in Maryland performed at or below the National Assessment of Educational Progress basic level in 2015. This percentage of fourth grade underachieving students showed that 60% of fourth-grade students had not mastered the fundamental skills needed for them to achieve success in mathematics.

In another study, the Programme for International Student Assessment (2015) problem-solving mathematics assessment measured 15-year-old students' reasoning skills, abilities to apply problem-solving processes, and their desires to do so on a national level. According to the report, more than 29% of U.S. tested 15-year-old students did not perform at the baseline level of competency in solving problems that required reasoning, reading, and mathematics. Defining *problem-solving competencies* as "an individual's capacity to engage in cognitive processing to understand and resolve problem situations where a method of solution is not immediately obvious" (Programme for International Student Assessment, 2015, p. 1) leads to concern about low problem-solving, as it suggests that students are not capable of solving complex higher-order thinking problems and real-life problems.

Definition of Terms

In this study, I used the following terms in my study. The definitions of the terms reflect their meanings in the context of this study.

Basic level: This term is defined as "students' partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each assessed grade" (Samson & Collins, 2012, p. 6).

Common core state standards: These standards define knowledge and skills that students should learn during each school year in all subject areas (Common Core State Standard Initiative, 2016).

Instructional strategies: This term is defined as classroom procedures and strategies used by teachers to instruct students (Krawec, Huang, Montague, Kressler, & Melia de Alba, 2012).

Mathematical literacy: This term is defined as "students' ability to analyze, reason, and communicate ideas effectively while posing, formulating, solving, and interpreting solutions to math problems across a variety of situations" (Programme for International Students Assessment, 2015, p.1)

Mathematical word problems: This term is defined as descriptions of problem situations wherein one or more questions is posed and answers are obtained through the application of mathematical operations to numerical data presented in the problem statement (Haghverdi, Semnani, & Seifi, 2012; Verschaffel & De Corte, 1997).

Problem-solving: This term is defined as the processes that students use to solve simple and complex mathematical word problems (Huang, Liu, & Chang, 2012).

Proficient level: This term is used to identify students' academic performance on grade level assessments. Student achievement at this level shows students have demonstrated competency for challenging subject matter (National Assessment Educational Progress, 2015).

Significance of the Study

The purpose of this qualitative case study was to investigate how elementary teachers were teaching word problem-solving skills and strategies, how teachers perceived their preparedness for instructing underachieving students, the challenges teachers faced while teaching word problem-solving to students, and the support teachers perceived they needed to improve their teaching of mathematical word problem skills. The results of this study provided the study school with an understanding of (a) how teachers are teaching word problem-solving skills and strategies, (b) teachers' perparedness for instruction, (c) challenges teachers face while teaching mathematical word problem-solving, and (d) the resources teachers need to improve their instruction of mathematical word problem-solving. Results from the study provide information that enables the study school district to develop mathematical word problem-solving professional development (PD) for teachers.

My study results contribute to positive social change in that the PD may lead to increased number of students at the elementary level who achieve proficiency and/or advanced achievement on mathematical word problem-solving, which promotes independence in their critical thinking and self-efficacy. Because early success in mathematics relates to graduation from high school (Nguyen et al., 2016), my study may indirectly enable more students to remain in school long enough to graduate from high school.

Research Questions

Every year teachers in Maryland elementary teachers encounter students who struggle with solving mathematical word problems. As teachers strive to provide the necessary mathematical skills and strategies for word problem-solving, some students still need extra support. Because the statistics for the schools in this study showed that underachieving student numbers are consistently in the 30-38% range, I focused on how teachers instruct low achieving students in problem-solving. The study was designed to investigate teachers' instruction, preparedness, challenges, and support needed when teaching mathematical word problem-solving to underachieving students. I developed four research questions that my study answered:

1. How do teachers instruct underachieving students to help them learn how to solve mathematical word problems?

2. How prepared do teachers perceive they are for instructing students who are underachieving in solving mathematical word problems?
3. What challenges do teachers face when instructing underachieving students on mathematical word problem-solving?
4. What support and resources do teachers perceive they need to meet the needs of students underachieving in solving mathematical word problems?

Review of the Literature

For this literature review, I examined a variety of peer-reviewed journal articles, dissertations, books, and primary and secondary sources related to students and teachers' understandings of mathematical word problem-solving. Various databases including Google Scholar, Walden University's ProQuest, ERIC database, EBSCO Education Research Complete, Thoreau, ScienceDirect, Sage Publications, EBSCO, and ProQuest Dissertations were used to find relevant research literature.

I used the following search terms to guide my search of the literature: *problem-solving, problem-solving instruction, mathematical problem-solving methods and models, Common Core State Standards, Mathematics, working memory of struggling students, George Polya, how to solve word problems, and teaching instruction of word problems*, and *teachers' perception of word problem-solving.* I used the search terms individually and in combinations to search for relevant literature. When repeated searches did not reveal any new literature, I considered my search complete.

In the first subsection of the literature review, I describe the conceptual framework that grounded my study. Next, I present research about factors that affect students' learning of mathematical word problem-solving, which is focused on types of word problems, strategies used, and cognitive processing. In the rest of the literature review, I discuss research about teachers' understanding of mathematical problem-solving, which is focused on knowledge, beliefs, and abilities regarding mathematical problem-solving.

Conceptual Framework

The conceptual framework for this study was Polya's (1957) model of four phases of mathematical problem-solving. Polya argued that mathematical problem-solving is taught and not learned through experience (Carifio, 2015). To teach problem-solving, Polya devised four phases of problem-solving that teachers should teach their students: understanding the problem (preparation), devising a plan to solve the problem (thinking time), carrying out the plan (insight), and looking back (verification).

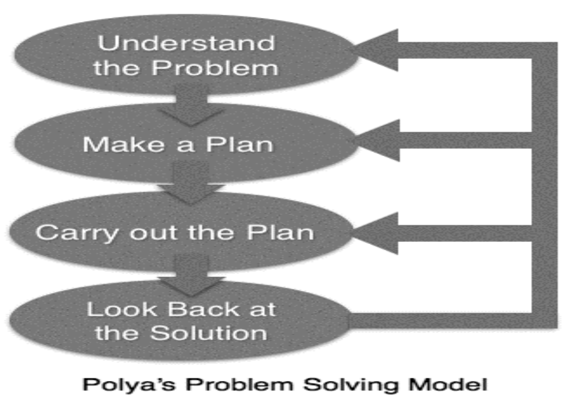


Figure 1. Polya's problem-solving model.

Each phase of Polya's (1957) mathematical problem-solving model transitions from one phase to the next. During the transition, the current phase shows resemblance to the previous phase. During Phase 1, the teacher teaches the problem-solver to understand the problem by identifying the known and the unknown data in the word problem, as it is difficult to answer a question that is not understood (Polya, 1957). During Phase 2, the teacher helps students devise a plan for solving the problem, which is important because without a plan, attempting to solve the word problem can be difficult (Polya, 1957). Therefore, students need to try various techniques such as drawing pictures and looking for patterns in the problem. In Phase 3, teachers teach students to carry out the plan, which involves students jotting down key information from the problem, planning different strategies to use to find a solution, and repeating trials until answers are satisfactory. Phase 4 is the looking-back stage. During this stage, teachers teach students to check over the problem and solution to ensure all aspects of the question have received attention. This phase also allows students to use problem extensions, connections to related problems and reflecting on their solution process (Polya, 1957; Donaldson, 2011). The conceptual framework of this study informed the analysis of the data and grounded my interpretation and discussion of the findings.

Review of the Broader Problem

Underachievement in mathematics problem-solving is a major problem in the United States and other countries and needs addressing by students, teachers, and other educational stakeholders (Hughes, Witzel, Riccomini, Fries, & Kanyongo, 2014). The review of literature is focused on how elementary students solve various types of mathematical word problems and how teachers instruct students on mathematical word problem-solving.

Factors That Affect Students' Mathematical Word Problem-Solving

As students' progress through years of schooling, they encounter various factors that lead to their success and failure as mathematics problem solvers. Studies have shown that computation and rote memorization are not the only factors student need to understand when learning mathematical word problem-solving (Krawec & Montague 2014; Schoenfeld, 1992). For example, the types of word problems such as routine and complex (Bayazit, 2013; Boonen & Jolles, 2015), the strategies such as reading and visual imagery (Björn, Aunola, & Nurmi, 2016; Csíkos, Szitányi, & Kelemen 2012), and cognitive processing skills such as working memory and metacognition (Passolunghi & Cornoldi, 2008; Swanson, 2015). These factors are important in students' mathematical word problem-solving learning as students' go from solving simple (one-step) to complex (multiple steps) problems.

Types of word problems. Students who struggle with mathematics exhibit low academic achievement on mathematical word problem-solving (DeFilippis, 2015; Jitendra, DiPipi, & Perron-Jones, 2002). Word problems are mathematical problem situations presented in verbal or written form and to solve them students must have mastered the foundational skills and concepts (Dewolf, Van Dooren, Cimen, & Verschaffel, 2014). Studies have shown that the types of mathematical word problems such as combined, compare, separate, routine, nonroutine and real-life, affect students' abilities to find solutions to the problems (Boonen & Jolles, 2015; Dewolf et al., 2014; Voyer, 2011).

There are multiple types of word problems, research has shown that students may be better at some types than others. For example, Boonen and Jolles (2015) investigated which type of mathematical word problems—combined (part-part-whole), change (separate), and compare problems, second-grade students (*n* = 47) had more difficulty solving. Combined word problems involve computing two sets of information that are put together or taken apart to find the difference (e.g., May has four apples. Jay has five apples. How many apples do they have altogether?). Change word problems start with identifying an initial quantity then a change occurs resulting in a new ending quantity (e.g., May has four apples. Then Jay gave her six apples. How many apples does May have now?). Compare word problems involve comparing two sets of information and identifying the differences between the sets, (e.g., May has six apples. Jay has ten apples. How many apples does Jay have more than May?). Results showed that students were more successful at solving combined problems and change problems and less successful at solving compare problems (Boonen & Jolles, 2015).

Research has also shown that students' understanding of the different types of word problems and steps to reach a solution is a part of mathematical word problem-solving (Bayazit, 2013; Dewolf et al., 2014; Voyer, 2011). Using a mixed-method approach to study 750 sixth grade elementary students' ability to understand real-life mathematical word problems, Voyer (2011) examined students' comprehension and arithmetic skills on a developmental mathematics test. The results revealed that students performed better when completing word problem questions that contained real-life situations (i.e., situations that students could relate to). This is similar to Bayazit's (2013) findings on how 116 seventh- and eighth-grade students solved nonroutine real-world word problems, which require students to use creative and critical thinking skills, multiple strategies, and alternative approaches. Results showed that that students did not incorporate real-world knowledge and lacked flexibility in interpreting word problem situations from different perspectives. Instead, students used result-oriented approaches (i.e., arithmetic operations, rules, and factual knowledge) that are used for routine word problems to find solutions.

Other research has addressed how to improve students' ability to solve nonroutine word problems. Dewolf et al. (2014) conducted two studies on whether fifth-grade students would solve nonroutine word problems better if there were an illustration (pictures of the problem content) or warning (explicit instruction or directions) present. Nonroutine (P-item) problems cannot be solved using only simple (S-item) mathematics operations but require judgment based on assumptions and real-world knowledge. In the first study, students received 10 problematic (P-item) nonroutine word problem question with four conditions: (a) with an illustration and without warning, (b) warning only, (c) with an illustration and warning, (d) without illustration or warning. In the second study, the students received 16 P-item-word problems using the same four conditions with no S-item word problems. The findings of both studies showed that when upper elementary students solved nonroutine problems, illustrations and warnings were irrelevant; however, students benefitted from the use of illustrations without warnings when solving routine problems.

Students' problem-solving strategies. As students become familiar with the various types of mathematical word problems, students must also learn how to implement and apply the appropriate strategies (e.g., counting skills, visual imagery, and reading) needed to solve word problems. According to Cai and Lester (2010), “As students solve problems, they can use any approach they can think of, draw on any piece of knowledge learned, and justify their ideas in ways that they feel are convincing.” (p. 3). Studies have shown that various strategies students apply to solve mathematical word problems helps in developing their learning, critical thinking, and understanding of mathematics word problem-solving (Björn et al., 2016; Boonen & Jolles, 2014; Nguyen et al., 2016).

One of the strategies that can help students solve word problems is illustrations. For example, Csíkos et al. (2012) designed a pre- and post-test experimental study of third-grade Hungarian students and found that students’ ability to solve real-life word problems increased when they contained drawings. David and Tomaz (2012) also studied fifth-grade students and indicated that illustrations helped the students to know when and how to apply the correct mathematical algorithm to find a solution in addition to limiting the need for memorizing facts (David & Tomaz, 2012). Furthermore, Edens and Potter (2008) found that students who constructed schematic representations (i.e., pictures using abstract symbols) did not score better than students using pictorial visual images (i.e., realistic pictures) on the word problems. However, this related to students’ drawing skills and problem-solving abilities, as students who drew schematic pictures with details demonstrating the relationship between the numbers scored higher on the problem-solving word problems (Edens & Potter, 2008).

Other studies have been conducted on strategies involving reading comprehension. Boonen, Koning, Jolles, and van der Schoot (2016) studied whether reading comprehension (e.g., inferring, synthesizing) or mental representation (e.g., mental images, comparing quantities, number words) affected students' abilities to solve word problems. The students were tested using two measurements: an inconsistency task (e.g., two-step compare problems) and a reading comprehension test, and results indicated the need for both mental representation skills and reading comprehension (semantic-linguistics). Reading comprehension skills help translate and understand the complexities of text terms, sequencing of the information, and building a connection between the known and unknown word problem information (Boonen et al., 2016).

In a similar study, Pape (2004) examined behaviors that Midwestern (n = 28) and Northeastern (n = 12) students exhibited as they solved word problems using cognitive processing and reading comprehension. Findings showed that students' ability to read and understand word problems directly affected their success with the given mathematics task. Results also showed that when students could comprehend the word problem and use the appropriate strategies, they were less likely to make errors during the mathematical word problem-solving process (Pape, 2004). As students implemented reading comprehension and mental representation strategies, they experienced a greater chance of success in solving mathematical word problems.

The strategies students apply to mathematical word problems when in elementary school are reflective of how successful students are mathematically in later school years (i.e., upper primary and secondary). Nguyen et al. (2016) studied the correlation between

1,305 preschooler counting skills and 785 of the same students as fifth graders regarding mathematics achievement. Nguyen et al. found that when early primary students can recognize that numbers represent quantities, one-to-one correspondence, fixed order, and cardinality, they have a greater chance of functioning successfully in more advanced math areas such as geometry, measurements, and patterns in later school years. The competencies students developed by fifth grade related to the counting and cardinality competencies learned in preschool. The results indicated that several domains of early mathematics knowledge, such as counting and spatial ability reasoning, need to be learned early by students because these skills are predictive of later mathematical problem-solving achievement (Nguyen et al., 2016).

Another study, by Björn et al. (2016), also showed the progress of problem-solving ability based on grade level. Björn et al. investigated the learning progress of 224 fourth-grade students' text comprehension skills and compared those scores to their mathematical word problem-solving scores when they were in seventh and ninth grade. Bjorn et al. assessed the fourth graders on reading text fluency (e.g., students read aloud a short story), text comprehension (e.g., students read an expository text and narrative text with 12 questions to answer), and basic calculation (e.g., forty-nine-mixed addition, subtraction, multiplication, and division problems). The same students, when in seventh and ninth grade, were reassessed on their mathematical word problem-solving skills using the KTLT-test developed by Rasanen & Leino (2005). The seventh-grade students' capabilities were greater than they were when the students were in fourth grade, possibly due to having more mature text comprehension and basic calculation skills (Rasanen &

Leino, 2005). However, when the same students were in ninth grade, their mathematical word problem-solving capabilities showed no correlation to their text comprehension in fourth grade and basic calculations scores in seventh grade. These results indicate that text comprehension and mathematical problem-solving skills are related from fourth through seventh, but the relationship disappears by ninth grade.

Cognitive processing skills. Cognition is the mental process of thinking or remembering something. The thinking aspect of cognitive processing includes retrieving, storing, processing, and applying information (Parsons & Sedig, 2014). Research has found that students' metacognitive skills (Tzohar-Rozen & Kramarski, 2014) and working memory (Rode, Robson, Purviance, Geary, & Mayr, 2014; Swanson, Moran, Lussier, & Fung, 2014) are important to students' development of interpretation, reasoning, problem-solving, and completion of mathematical tasks.

Research has shown that a lack of metacognitive ability and lack of motivation affects how students solve word problems. Tzohar-Rozen and Kramarski (2014) divided 118 fifth-grade students into two groups who each completed a pre-and post-intervention test and questionnaire. Group 1 worked on metacognitive awareness (i.e., general knowledge, and regulation and supervision of learning), and Group 2 focused on motivational-emotional awareness (i.e., learning to avoid failure and make achievements) by completing a series of verbal and numeric mathematical problems. The results indicated that poor performance on mathematical word problems resulted from students' inability to apply the necessary metacognition regulation (i.e., problem-solving, self-monitoring, assessing learning; Kajamies, Vauras, & Kinnunen, 2010; Dostal, 2015;

Tzohar-Rozen & Kramarski, 2014). The motivational-emotional regulation findings indicated that when students lacked motivation and enthusiasm (i.e., action, thoughts, and behaviors), they had difficulty solving mathematical word problems. Tzohar-Rozen and Kramarski also found that students' metacognitive awareness lead to improvement in self-regulation processing and motivational-emotional processing.

Research has shown that working memory capacity has a direct effect on students solving word problems. Swanson et al. (2014) conducted a quantitative study to investigate whether generative strategies and working memory capacity enhanced students' ability to solve mathematical word problems. Swanson et al. studied 82-second graders who were underachieving in mathematics. Swanson et al. taught three different propositions/ generative strategies to the students: restating, relevant, and complete. Swanson et al. divided the students into four groups: three treatment groups each one receiving instruction based one proposition, and one control group, with no proposition taught. Students in the restating proposition group were instructed to paraphrase the given word problem question to their level of understanding (e.g., How many rocks did Keisha have left?). Students in the relevant proposition group were taught to paraphrase relevant information in problems (e.g., Keisha found seventeen rocks, and she threw eight rocks into the lake.). The students in the complete proposition group were taught to use both the restating and relevant propositions together when word problem-solving (e.g., Keisha found 17 rocks. She threw eight rocks into the lake (relevant). Keisha found two rocks that were pink (irrelevant). Students in the control group received *business as usual* (p. 115) math instruction. In the study, students' working memory was measured using an S-

Cognitive Processing Test. Students' composite scores from the test were computed to assess students' working memory capacity. Results indicated that the effectiveness of generative strategies (i.e., propositions) used by students was dependent on students' level of working memory capacity. The findings showed that students with high working memory capacity had more success when solving problems through the complete propositioning phase. Students with lower working memory capacity were more successful at solving word problems that allowed them to identify relevant information (restating) and paraphrase information (relevant proposition) to meet their level of understanding (Swanson, Moran, Lussier, & Fung, 2014).

In a later study, Swanson (2015) investigated how strategy instruction and working memory effected students' problem-solving solution accuracy. The 204 third graders in the study were assigned randomly to one of four conditions: verbal strategies (e.g., underlining question sentence), visual strategies (e.g., correctly placing numbers in diagrams), verbal + visual strategies, and an untreated control. Swanson also focused on problem-solving accuracy and working memory transfer (operation span and visual-spatial span). Findings showed that strategy instruction benefitted students' problem-solution accuracy; however, some strategies (verbal and visual) yielded higher post-test scores than others. Results also showed that students with high working memory capacity benefitted more from strategy conditions (verbal or visual) on target and transfer measures than did children with lower working memory capacity (Swanson, 2015). The findings also revealed that problem-solving accuracy is directly related to students' working memory capacity level and strategy instruction.

Passolunghi and Cornoldi (2008) conducted a longitudinal study of 33 fourth grade Italian students, to examine the relationship between working memory and the solving of mathematical word problems. To test students working memory, Passolunghi and Cornoldi used two versions of a span test: simple version (e.g., auditory presentation and immediate repetition of words) and dual-task version (e.g., tapping during the presentation of stimuli). These tests are commonly used for examining short-term memory and psychometric properties (i.e., reliability and validity). Passolunghi and Cornoldi divided the students into two groups, 15 poor problem solvers and 18 good problem solvers, based on their arithmetic word problem-solving standardize test scores and a verbal intelligence test (PMA battery test). The students were required to solve 12 mathematical word problems taken from a fourth-grade word problem set. Study findings showed that there was a direct relationship between students' ability to solve word problems and working memory. When students held the irrelevant information (i.e., parts of the sentences not recallable) in working memory, there was greater success in solving mathematical word problems. Passolunghi and Cornoldi also found that when students held relevant information in working memory, students were better able to solve a mathematical word problem. Witt (2010) conducted a correlational research study with 32 primary students where he explored the relationships between working memory and mathematics. His findings showed that struggling students had issues with using stored multiple pieces of information embedded in working memory. The results indicated that because students ignored the relevant information yet struggled to disregard irrelevant information stored in working memory, they had difficulty with mathematical word problem-solving (Witt, 2010).

Teachers' Understanding of Mathematical Problem-Solving

Understanding how to problem solve mathematically is not just for students, but for teachers as well. Teachers' knowledge and abilities to reason abstractly, make sense of word problems, and progress through problem-solving tasks are critical elements for teachers' mathematical problem-solving teaching success (Yee & Bostic, 2014) Teachers' mathematical problem-solving understanding and abilities are important because they teach students the necessary skills and strategies needed for students to become problem solvers. Studies showed that teachers understanding of their mathematical problem-solving knowledge (Marchis, 2011; Sakshaug & Wohlhuter, 2010; Schoenfeld, 1992), their mathematical problem-solving beliefs (Lui & Bonner, 2016; McGee, Polly, & Wang, 2013), and their mathematical problem-solving capabilities (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013; Singer & Voica, 2013) matter in their ability to be an effective mathematical problem-solving educator. Teachers mathematical problem-solving knowledge, beliefs, and understanding enhance each teacher's ability in providing a mathematical teaching and learning environment (McGee et al., 2013) suitable for student problem solvers.

Teachers' mathematical problem-solving knowledge. Sakshaug and Wohlhuter (2010) conducted an action research study of forty-one teachers to examine how their problem-solving learning experiences helped improve their mathematics instruction. Sakshaug and Wohlhuter found that "teachers' successes and challenges occurred in these contexts: a) comfort level with mathematics, b) selection of problems, c) instructional components, d) impact on students and e) beliefs about the process." (p. 401). Results showed that 39% of the teachers were inexperienced with concepts, reasoning, and communication involved in solving complex word problems, which made their ability to teach complex word problems difficult. Due to the discomfort, teachers often provided students with the needed information and strategies instead of letting the students develop and construct meaning for themselves (Sakshaug & Wohlhuter, 2010).

Marchis (2011) used a qualitative design to understand how 62 teachers guided their students' in mathematical problem-solving. The teachers presented complex problems to the students to solve. The results revealed issues with the strategies teachers incorporated during problem-solving instruction. The teachers focused more on reading the text, highlighting key points, drawing diagrams, and rewording the text question to students' level of understanding. Also, two-thirds of the teachers failed in providing opportunities for students to implement multiple strategies and explain solutions (Marchis, 2011).

Schoenfeld (1992) conducted a series of studies designed to address math experts' capabilities to teach mathematical problem-solving. Schoenfeld developed four distinctive phases teachers implement to help students become better mathematical problem-solvers. During Phase 1, resource knowledge, the teacher assesses what students already know to aid students' in successfully applying mathematical concepts. During Phase 2, the teacher provides students with heuristic strategies that students can use to solve problems efficiently. The teachers educate students on how to implement these strategies such as symbolizing operations, sorting details, working backward, annotating problems, drawing figures, deleting details, and designating formulas to find valid solutions to various types of word problems. During Phase 3, monitoring and processing, the teacher helps students to understand themselves as the problem solver. The teacher encourages students to use self-monitoring and self-regulation (an aspect of metacognition), and visuospatial and relational processing, to learn, process, and implement mathematical strategies taught and shown how to apply when word problem-solving. Phase 4 looks at belief systems. During this stage, limited teacher assistance is on an as-needed basis; so, whenever needed, the teacher shows students methods and techniques they can implement to recognize, reflect upon, and provide the necessary word problem-solving corrections. Overall, Schoenfeld's four phases enhanced the teacher's competency in teaching (Schoenfeld, 1992) mathematical problem-solving to students.

Teacher's beliefs about mathematical problem-solving. Lui and Bonner (2016) used a questionnaire and a four-part survey to examine the knowledge, planning, and belief constructs beneficial in the successful shaping of 78 teachers' practices in teaching mathematics. Lui and Bonner argued that teachers' mathematical knowledge and word problem-solving instructions are derivatives of teachers' conceptual and procedural learning. Teachers' conceptual knowledge (i.e., knowledge of mathematical principles) involves their understanding and interpretation of ideas and connection between concepts. Teachers' procedural knowledge includes their ability to apply mathematical concepts to answer problems. Results showed that teachers believed that students constructed their knowledge and that instruction should be organized based on students' development of ideas. The findings also revealed that teachers' instructional planning must meet the standards of both conceptual and procedural knowledge and that teachers preferred conceptual learning over procedural learning. When teachers incorporated both conceptual and procedural knowledge during instruction, students' understanding of how to recognize, implement, and decipher concepts to solve mathematical word problems (Lui and Bonner, 2016), aided students in greater success on mathematical problem-solving tasks.

McGee, Polly, and Wang (2013) explored the relationship between teachers' beliefs and instructional practices, teachers' beliefs and student learning outcomes, and teachers' instructional practices and student learning outcomes. The study consisted of 35 (K-5) teachers and 464 elementary school students. The teachers completed two separate questionnaires and the Mathematical Knowledge for Teaching assessment (MKT). The first questionnaire examined teachers' beliefs about mathematics, their teaching style, and students' learning styles. The second questionnaire examined the instructional practices teacher implement when teaching mathematics, and the MKT assessed teachers' knowledge of mathematics content. The students completed pre-and post-end-of-unit assessments to measure their math achievements. Results indicated that there is a relationship between teacher practices and student achievement. The findings showed that teachers' beliefs about mathematics did not influence the way they taught their students. Nevertheless, when teachers provided more student-centered learning, there were higher gains for students on problem-solving assessments (Polly, McGee, Wang, Lambert, Pugalee, & Johnson, 2013) and an increase in student learning of mathematical problem-solving. The findings also showed that instruction based on teacher-centered beliefs and teacher-centered practices contributed to students having significantly lower gains on given assessments, due to students' abilities to solve problems, implement appropriate strategies, and justify processes and solutions (McGee et al., 2013).

Teachers' mathematical problem-solving abilities. As teachers prepare students to become problem solvers, teachers must know the challenges and difficulties that may prevent students from successfully solving word problems (Lampert, 1985). Pearce, Bruun, Skinner, and Lopez-Mohler (2013) conducted a qualitative study that examined teachers' perspectives about classroom practices and specific strategies they use with students to promote success in mathematical problem-solving. Pearce et al. found that only 21% of the teachers used cooperative learning and only 19% used manipulative based instruction. Pearce et al. also found that when students were incapable of completing tasks (i.e., working independently and identifying key strategies), students did not use higher-level thinking, which made completing mathematical word problem-solving difficult. The findings also revealed that teachers perceived that students' difficulties in solving mathematical word problems were the result of students' reading difficulties (e.g., comprehension, strategies, and fluency), lack of vocabulary knowledge, and the inability to make plans to solve word problems. Twenty-four percent of the teachers reported that text difficulty was a major factor in student's difficulties in solving word problems. Also, twenty-nine percent of the teachers reported that text anxiety was another major challenge for students when solving word problems. The findings showed that the students become anxious and unable to focus, in fear of not knowing what to expect on the exam and a lack of computational understanding needed to find a solution to the problems.

Summary of Literature Review

The research that I reviewed for this study described the factors that lead to students learning and processing of mathematical word problem-solving and teachers understanding and teaching of mathematical problem-solving. The literature review included both qualitative and quantitative studies. All the large-scale studies took place in districts that have several schools. Research in this literature review shared similar findings on underachieving students’ ability to recognize, understand, and solve diverse types of word problems during mathematical problem-solving. Current research also showed that low achieving students apply drawings and visual representation to elicit understanding. Current research showed that when word problems are presented to students in a way that students can relate to them (i.e., real-life), students’ level of understanding increases. Also, research confirmed that underachieving students do not focus on reading and text comprehension and counting and navigating multiple-step tasks when mathematical word problem-solving. Research studies confirmed that students’ cognitive processing (working memory) affects students’ inability to retain and recall stored information in short-term and long-term memory and limited metacognitive thinking, contributes to poor- performance on mathematical problem-solving. In addition, the research indicated that teachers need to have a clear understanding of what mathematical problem-solving is and how to teach word problem-solving skills and strategies to students. The research indicates that teachers' instructional preparedness (i.e., the content taught, and content delivery) allows teachers to incorporate cooperative learning and real-life instruction to improve students' mathematics learning. Moreover, the research does not discuss factors that contribute to achieving students' success on math word problem-solving. The research neglects to report teachers' perceptions and the challenges teachers face when instructing students on mathematical problem-solving, which aids in students becoming improved mathematics problem-solvers.

Implications

In this qualitative case study, the aim was to investigate teachers' perceptions of how teachers are teaching word problem-solving skills and strategies, their preparedness, and challenges of teaching, and the support and resources teachers perceive that they need to improve their teaching of mathematical word problem skills. The findings of my study lead to the development of a PD program designed to help teachers better teach students how to solve mathematical word problems. The study findings may also be used to inform district administrators about the results of the study and argue for the implementation of on-going coaching support for elementary mathematics teachers.

Summary

Students' underachievement in mathematical word problem-solving (Maryland State Department of Education, 2014) was an area of concern for teachers and administrators located in a suburban area in Maryland. The purpose of this study was to gain an understanding of teacher perceptions, practices, challenges, and resource needed for teaching mathematical word problem-solving to underachieving students.

In Section 1, I defined the problem and provided research evidence of the problem and evidence from the professional literature. I discussed the significance of the study, introduced the research questions, and discussed the research literature referencing the problem.

In Section 2, I discuss the research design and methodology. I describe a justification for the research design, how I selected the sample, and how I protected participants’ confidentiality and obtained informed consent. I also describe how data was collected and analyzed. In Section 3, I describe the PD project I designed, and in Section 4, I reflect upon the strengths of the project and the study and how the project contributes to positive social change.

Section 2: The Methodology

Introduction

In this qualitative case study, I aimed to address the problem related to students' underachievement in mathematical word problem-solving at the elementary level. At five Maryland elementary schools, more than 30% of students in K-5 are struggling with mathematical word problem-solving, which limits their mathematics success on state, county, and curriculum assessments. The state of Maryland aims toward having all underachieving students perform above basic level in math, which prepares students for college and career readiness (Common Core State Standards for Mathematics, 2016; Maryland State Department of Education, 2014). The purpose of this qualitative case study was to gain an in-depth understanding of elementary grade teachers' perceptions about (a) teaching word problem-solving skills and strategies, (b) teachers' preparedness for instruction, (c) challenges faced during instruction, and (d) the support and resources teachers perceive they need to improve their teaching of mathematical word problem-solving. Using a qualitative case study allowed investigation of the following research questions:

1. How do teachers instruct underachieving students to help them learn how to solve mathematical word problems?
2. How prepared do teachers perceive they are for instructing students who are underachieving in solving mathematical word problems?
3. What challenges do teachers face when instructing underachieving students on mathematical word problem-solving?

4. What support and/or resources do teachers perceive they need to meet the needs of students underachieving in solving mathematical word problems?

Research Design and Approach

I chose to conduct a qualitative study because qualitative research is exploratory and is used to answer questions and understand phenomenon and perspectives of an individual or individuals in various social settings (Creswell, 2012). As a qualitative researcher, there were many research designs to employ such as phenomenology, grounded theory, case study, ethnography, and narrative (Creswell, 2013). I reviewed all the qualitative methods before selecting a case study design. A case study is an in-depth description and analysis of a case that occurs within a bounded system (Merriam, 2009; Miles & Huberman, 2013; Yin, 2011). In this study, the bounded system was defined as K-5 teachers employed at a school that has identified student acquisition of mathematical word problem-solving skills and strategies as an issue to address. The case reveals more about the phenomenon of interest (Merriam, 2009). In this study, the case was K-5 teachers' perceptions of teaching mathematical word problem-solving to students who are underachieving in mathematics.

I chose a case study design over other approaches for multiple reasons. Phenomenological studies are used to investigate the lived experiences of people, the subjective meaning of their experiences, and the meaning individuals attach to their experience (Gallagher & Zahavi, 2012). A phenomenological study would have provided the rich, detailed information; however, I was not interested in exploring the lived experiences of teachers as they instruct mathematics in their classrooms. The grounded theory approach has as its purpose the development of a theory, but I was not attempting to develop a theory to explain teachers' instruction of mathematical word problem-solving. The narrative inquiry approach is the process of collecting information for the purpose of research through storytelling (Creswell, 2012). Because I was not seeking to gather stories about teachers' experiences and the meanings they attribute to the instruction of underachieving students in mathematical word problem-solving, I did not choose to conduct a narrative study.

Setting and Sample

The sites for this case study were five elementary schools in a large school district in Maryland. The mission of Maryland's schools is to provide rigor and a nurturing and safe environment for students that will ensure that students learn at high levels. The five Maryland elementary schools currently have a total enrollment of 1,802 student in grades pre-kindergarten through fifth grade. The ethnic makeup of the student population at the study schools are 76.5% Black/African American students, 11.5% Hispanic students, 8.9% White, and 3.1% Mixed Race students. The gender demographic is 51.7% male students and 48.3% female students. The study schools have a joint total of 94 core academic subjects' teachers (Maryland State Department of Education, 2017).

Before selecting participants and collecting data, I obtained approval to conduct the study from the Walden Institutional Review Board (08-04-17-0020094). I also received research approval from the county district superintendent and the five Maryland elementary school principals.

For this study, purposeful sampling was used to select a sample of eight teachers. K-5 teachers from the five approved elementary schools were e-mailed a copy of the invitation to participate letter, with a demographic survey (Appendix B), and consent to participate form. The e-mailed invitation letter explained the rationale, procedures, research questions, potential risks, and benefits of the study. The e-mail also informed the volunteers that if they were going to consent to be a part of the study, they were to complete the demographic survey and consent form and e-mail the documents back to me by the end of a 1-week period. After 6 days had passed, a reminder e-mail went out to all the K-5 teachers along with another copy of the invitation letter, demographic survey, and consent form. The teachers were asked to sign and send the documents back as soon as possible. Because this process did not attract enough participants after 10 days had passed, I sent a final electronic request to all the K-5 teachers. I received 11 volunteers; however, only eight qualified based on my demographic criteria.

In this study, the demographic questions (see Appendix B) were critical in the collecting of in-depth data for the researcher's further analysis. The demographic information received from participants was as follows: years of teaching experience, years taught teaching mathematics, current teaching grade level, highest degree earned, and earlier participation in professional math development. A summary of the demographic information for the eight teacher participants is presented in Table 5.

Table 5

Teacher Participants' Demographic Information Per Grade Level

Grade level	Number of participants	Years teaching math (average)	Bachelor's	Master's
First grade	3	13	1	2
Third grade	2	22	0	2
Fourth grade	1	14	0	1
Fifth grade	2	23	1	1

The sample of participants included three first-grade teachers (37.5%), two third-grade teachers (25%), one fourth-grade teacher (12.5%), and two fifth-grade teachers (25%). Out of the sample, 25% of teachers hold a bachelor degree, and 75% hold a master's degree.

The study's criteria required participants to have at least 3 years of teaching experience. The overall range of teaching experience reported by participants was 4 to 33 years. The first-grade teacher group ranged from 4 to 22 years of teaching experience, the third-grade teacher group ranged from 16 to 33 years of teaching experience, the fourth-grade teacher group had 14 years of teaching experience, and the fifth-grade teacher group ranged from 18 to 29 years of teaching experience. The years of teaching experience for the study participants ranged from 0-28+ years. Only one teacher (12.5%) had been teaching between 0-8 years. There were four teachers (50%) who had been teaching between 9-18 years. There was only one teacher (12.5%) who had between 19-27 years of teaching experience. Lastly, there were two teachers (25%) who had been teaching over 29 years. teaching experience.

Ethical Concerns

As the researcher, I paid close attention to ethical matters such as protecting the confidentiality and privacy of all the participants. All the participants' names and information were labeled with a pseudonym to shield their identity. All materials used in the study such as audio recordings, transcripts, and interview notes are stored and secured in a locked cabinet in my classroom and at my home, both of which are accessible only by me. All information stored on my personal computer is kept secured by a password that is known only to me. After 5 years, all participant data will be destroyed to safeguard participants' privacy.

Role of the Researcher and Researcher Bias

I am a third-grade teacher in this study district. Several of the participants know who I am because we have interacted at various county workshops. They view me as a colleague and not as someone who has authority over then. The faculty at these school are collegial, and I have formed good relationships with the interviewees at each location. My researcher role did not interfere with scheduled teaching time because I assumed the researcher role after work hours.

Additionally, it is important for a researcher to self-disclose biases and assumptions (Creswell, 2013). I have acquired experience in working with struggling students, which could have created biases. Therefore, I refrained from bringing preconceived notions about instruction for struggling elementary mathematics students into the study project process.

Data Collection

To collect data for this study, I employed face-to-face, semi structured interviews (Creswell, 2012) using a self-created interview protocol (Appendix E) or written responses to interview questions. I conducted three face-to-face interviews with first-grade teachers, two face-to-face interviews with fifth-grade teachers, and received two written responses from third-grade teachers and one written response from a fourth-grade teacher. Before I began data collection, each participant signed the consent to participate form. The interviews or written responses allowed the participants to provide their subjective perspectives about the research topic (Creswell, 2013). Interviews or written responses to interview questions provide data that can lead to a deeper understanding of the phenomenon and are most appropriate when the researcher desires to gather detailed insights from individual participants (Bloomberg & Volpe, 2015). Table 6 shows that the interview protocol questions were sufficient to answer the research questions.

Table 6

Research Questions and Protocol Questions Alignment

Research Questions	Protocol Questions
How do teachers instruct underachieving students to help them learn how to solve mathematical word problems?	• What skills and strategies do you use to instruct • underachieving students to help them learn how to mathematical problem-solve? • What types of word problems do you use to teach mathematical problem-solving?
How prepared do teachers perceive they are for instructing students who are underachieving in solving mathematical word problems?	• How confident do you feel about instructing students on mathematical problem-solving? • What types of PD training do you have that helps you in instructing students on mathematical problem-solving?
What challenges do teachers face when instructing underachieving students on mathematical word problem-solving?	• What do you find challenging when teaching mathematical word problem-solving? • What are the challenges you face concerning the students learning during mathematical problem-solving instruction? • What are the challenges you have concerning your teaching of mathematical problem-solving?
What support and resources do teachers perceive they need to meet the needs of students underachieving in solving mathematical word problems?	• Describe the types of assistance you perceive you need to aid you in increasing your underachieving students' success in mathematical problem-solving? • What resources do you need to aid in teaching students how to solve word problems? • What resources are you currently using doing mathematical problem-solving instruction? • What else would you like to share concerning your experiences in working with underachieving students on mathematical problem-solving?

Interviews

The interviews were conducted over a 3-week period. Participants had the option of scheduling a convenient time and location for their interview. The day before the participant scheduled interview session, each participant received a friendly reminder e-mail about their upcoming appointment. Each interview was slotted 60 minutes and was digitally recorded using two devices. Additionally, the interviews were logged with the date, time, attendee (pseudonyms), and the interview location site. At the beginning of the interview, I extended a greeting, reminded participants of their rights, and discussed the reason for the session. The participants were reminded that at any time they were free to withdraw from participation with no repercussions. During the interview taping as the participant responded to the questions, I used a reflective journal to jot down notes on the nonverbal communication actions (e.g., pointing at something, shaking head), interruptions to the interview, and other information relevant to the study (see Irvine, Drew, & Sainsbury, 2013). At the conclusion of the interview, I asked the participants if they had anything they would like to share and then thanked them for their time and participation in this study. I also gave each participant a $10 gift card as a token of appreciation.

Written Responses

The participants who opted to complete a written response in lieu of an interview were asked to complete their written responses within the same 3-week period as the interviewed participants. Each participant was allotted 60 minutes for completion of their written responses. Before participants received their written response questions to complete, I reminded them of their rights to withdraw from the study at time. After I received their written responses, each participant was thanked for their time and participation in this study, and each participant received a $10 gift card as a token of appreciation.

Data Analysis

The initial process of analyzing the interview data consisted of transcribing participants' interview responses into a text format. I then transcribed the interviews manually into Word documents. This process was a way to be close and hands-on with the data (Creswell, 2012, p. 240). After the initial transcriptions of the interview data, I reread the transcripts to ensure the text matched the participants' responses and to become even more familiar with the data. I also read the participants' written responses. To ensure organization of the data, I created an Excel spreadsheet for each interview question. On each sheet, I entered each participant's responses to the interview questions and written responses. Then, I pattern coded the data for each question by color-coding the responses and recording the codes in a column next to each response. Next, I analyzed the codes to identify four to six themes. Lastly, I created excel sheets for each created theme and rearranged the codes and responses accordingly.

Reliability and Validity

When analyzing data, ensuring credibility and accuracy of the collected data is important. Credibility reflects the precision with which the researcher describes the perceptions of the participants (Lodico, Spaulding, & Voegtle, 2010). The participants were given a copy of their transcribed coded interview and were asked to review their interview responses for accuracy. The participants provided me with feedback about transcript accuracy and any concerns that they had about the transcripts, which were addressed and corrected as appropriate. Only one participant asked for a change in wording and I made that change. I used member checking (Bradley-Levine, 2012) after all coding and analysis of the interviews were completed (Houghton, Casey, Shaw, & Murphy, 2013). This process is important as member checking is valuable in confirming the accuracy of the data. I provided each participant with the codes and the themes for their feedback. None of the participants disagreed with my analysis.

Once analysis was complete, I asked my doctoral chairperson and external reviewer who is experienced in qualitative research transcripts to read the unidentifiable transcripts, my journal notes, the coding and thematic analysis, and the findings. The feedback from the external reviewer and my doctoral chairperson confirmed my coding and thematic analysis.

Discrepant Cases

Investigating discrepant cases is an essential part of case study research (Lodico et al., 2010). Merriam and Tisdell (2016). Actively and purposefully seeking discrepancies cases that may challenge data results, expectations, and potential findings is what makes identifying these cases imperative in research. There was only one response that could be analyzed as a discrepant case. Participant 8, when asked at the end of his interview if he would like to add any extra information to his response, responded that parents should be educated to understand the common core standards so that they could help their children to learn mathematics at home. Because the focus of my study was to achieve and understanding of teachers' perception, I identified this response as a discrepant case.

Research Findings

The purpose of this qualitative case study was to explore 8 elementary teachers' perceptions about instructing underachieving K-5 students on mathematics word problem-solving. I used interviews and written responses to collect data from eight teacher participants. After reviewing the data, I began the data coding process. I pattern coded the data by color-coding the responses and recorded the codes in a column next to each participant's response. Next, I analyzed the codes and identified four themes with subthemes (see Table 7).

Table 7

Codes and Themes from Interview Data

Codes	Themes	Subthemes
Confidence in teaching, workshop training, grade-specific teaching, attending math institutes, PD training.	Teachers' perceptions of their preparedness	1. Confidence 2. Professional Education
Manipulative usage, small group instruction, whole group instruction, peer tutoring, problem-solving instruction, types of word problems used, using visual representation.	Teachers' Pedagogy	1. Manipulatives 2. Problem-Solving Instructional Techniques 3. Small Group Instruction/Peer Tutoring
Vocabulary, lesson planning, students' mindset, understanding what the word problem is asking, breaking down the word problem, teaching various strategies, differentiated instruction, teaching Common Core standards., students lacked motivation, poor foundational education preparation, retaining information, and reading deficits.	Challenges teachers faced when teaching word problem-solving	1. Instructional Challenges 2. Personal Challenges 3. Student Learning Challenges
Teacher assistants, technology, working apps, county approved apps, computers, curriculum materials, language translation device, creative activities.	Teachers' needs regarding support and resources	1. Technology 2. Teacher Assistance Curriculum Materials

Four major themes emerged from the data during the data analysis stage: (1) teachers' perceptions of their preparedness (2) teachers' pedagogy, (3) challenges teachers faced when teaching word problem-solving and (4) teachers' needs regarding support and resources. Each major theme and subthemes are described in the findings of the study below.

Theme 1: Teachers' Perceptions of Their Preparedness

To answer research question #1, "How prepared do teachers perceive they are for instructing students who are underachieving in solving mathematical word problems," one major theme, "Teacher Preparedness," and two subthemes, "Confidence" and "Professional Education" emerged from the data. All eight of the participants interviewed discussed their preparedness to teach underachieving student mathematical word problem-solving.

Confidence. All participants revealed that they are confident in their preparedness to teach students who are underachieving in math. For example, Participant 3 stated,

> I feel fairly confident that I'm good at doing problem-solving mathematical problem-solving, mostly because I have been doing this for a long time now… So for me you know I feel like I am able to express it [problem-solving techniques] to kids the best way I can…I just show them strategies they can use to solve any math problem…[and this works].

Participant 2 stated, "I can understand the struggle that students have when they are trying to solve word problems, and so I teach strategies… and other important information to help them solve word problems." Participant 6 stated that because she had taught lower grade students her confidence for teaching struggling students had increased. Participant 6 declared,

> the reason I feel more confident and at ease teaching in the lower grades, is because the math problems are not as complex as they are in the upper grades. The less complex the problems, I am able to break them down into smaller steps

> or scaffold the delivery of my instructions to permit students to grasp the concepts.

Participant 5 explained that she is more confident in teaching when her lesson plans are readily available. She stated, “If I have to plan a lesson on my own, I am not as confident about teaching the correct procedures and all that.”

Professional education. Another subtheme that emerged from the theme related to teacher preparedness revealed that professional education gave teachers more confidence in helping them to teach problem-solving strategies to underachieving students. For example, Participant 3 stated that, “I attend Math Solutions training and this training helps me to grow as a teacher.” Other participants (2, 6, and 7) expressed that attending a county workshop that was specific to their grade level better prepared them by providing the comfort and resource support they needed for teaching their struggling students. For example, Participant 7 stated that

> my struggling fourth-grade students do not know basic addition and multiplication facts, which are taught in lower grade levels; therefore, attending training for primary grade levels has equipped me with assurance, and increased my confidence level in providing my students with strategies and math facts that they [students] can use when solving word problems.

Participant 2 stated,

> I have attended several math institutes on my own. It was something that I wanted to do to improve my skills as a teacher. I also attend training for my grade level . .

. But for me, I have to attend training because I want to continue to learn the best strategies to use, so my students can be successful.

Theme 2: Teachers' Pedagogy

To answer research question 2, which asked how teachers instruct underachieving students to help them learn how to solve mathematical word problems, a major theme, "Teachers' Pedagogy" and three subthemes: (a) manipulatives, (b) problem-solving instructional techniques, and (c) small group instruction/peer tutoring, emerged from the data. The teachers at the elementary schools in this study revealed that they used these pedagogies to instruct underachieving students in mathematics word problem-solving.

Manipulatives. Participants indicated that their use of manipulatives varied according to what they were teaching to their students. Moyer-Packenham, Salkind, and Bolyard (2008) stated that using manipulatives helps students by providing a visual representation that they can use for a more in-depth understanding of math concepts. For example, Participant 6 stated that because "my students are "visual learners" I provide them with calculators, multiplication charts/graphic organizers to help them solve problems." Other participants (1, 7, and 8) stated that they use manipulatives such as counters, charts, base ten blocks, cubes, and calculators on a daily basis during instruction. Participant 1 stated "We use a lot of manipulatives, counters, part-part-whole maps, cubes all kinds of different things. We use manipulatives more during math center time, where the students can work independently or in groups." Participant 7 commented that "Students are allowed to use aides to assist in daily work such as multiplication charts, base ten blocks, calculators, etc." Participant 8 stated, "We also do a lot of hands-on activities, that way they can have a visual representation of what they are to do. I use concept maps, different charts, and lots of manipulatives."

Problem-solving instructional techniques. Participants in the study described the strategies they use during classroom activities to help students in solving math word problems. This subtheme was best captured by Participants 2, 3, 4, and 5. For example, Participant 2 stated, "I give the students real-life problems. Problems that they can solve that relate to them personally. They love video games, things that are real-world situations and many times when the interest level of the problem is higher then they will have more of a vested interest because it is meeting the types of things that they are interested in." Participant 3 stated that "most of the times I just give them a problem and have them just try to come up with ways to solve it." Participant 8, explained that his students complete real-life, and self-created word problems. He stated, "I create my own real-world problems to help enhance student's perception of real-life situations." Participants 1, 3, and 5 expressed that they provide their students with word problems that afford students the opportunity to use visual drawings to help develop their understanding of mathematical concepts. Participant 3 stated, "We [teacher and students] use a lot of drawings of pictures. . . . to solve problems. I model for them for the most part, but most times I actually just give them a problem and have them come up with ways to solve it."

Small group instruction/peer tutoring. According to Connor et al. (2014), during daily instruction, transitioning between whole group and a small group is important in teaching students. Haager and Vaughn (2013) agree and stated that small group instruction offers teachers time to reteach difficult concepts and skills needed to complete a given task successfully. For this subtheme, five participants (1, 2, 7, 6, and 8) described how they conduct small group instruction/peer tutoring to provide further teaching to their students to aid them in gaining a deeper understanding of mathematical word problem-solving concepts. For example, Participant 6 stated that "my special education students need direct instruction so working in a small group or one-to-one works well with them." Participant 7 explained, "when I implement small group instruction three to five days a week in my classroom, this gives me more direct [concentrated] instruction time with my students." Participant 8 stated, "When instructing my students, I use various techniques. I start by teaching whole class lessons; then I have small group lessons for those students who need extra support."

Research shows that teachers engage students in peer tutoring which can affect individual student achievement (Burke & Sass, 2013). Burke et al. described peer tutoring as a method used for instructing students to understand mathematical word problem-solving. For example, Participant 2 stated that "peer-grouping/peer tutoring motivates struggling students to engage in learning word problem-solving strategies." Participant 2 also stated that "many times if the answer does not make sense [to the student], many times with struggling students if you pair them with higher ability students, this will encourage [motivate] them to step up their game so to speak and give them confidence."

Even though some of the participants referenced that they provide real-life, self-created, and multi-step word problems for their students to solve, other participants did not appear to know the scientific names of the different types of words problems (e.g., combining, separating, and comparing), even though they provide instruction and require their students to complete these types of word problems. For example, Participant 1 stated, “I have never heard anyone talk about combined word problem you know, but I do multi-step word problems. . . even word problems with extra information.” Similarly, Participant 5 stated, “When [I] am talking about the different types of problems, I did not realize, Part-Part Whole or comparing problems, I always work on multistep word problems, even though they are the hardest types of problems.”

Theme 3: Challenges Teachers Face Teaching Word Problems Solving

To answer research question 3 which asked about the challenges that teachers face when instructing underachieving students on mathematical word problem-solving, a major theme, “Teachers’ Challenges” and three subthemes: (a) instructional challenges, (b) personal challenges, and (c) student learning challenges, emerged from the data.

Instructional challenges. This subtheme described the challenges that participants face during instruction, whether it is providing lessons that convey new or old skills and strategies or teaching how to solve simple or complex word problems to students. Participants acknowledged that a major reason for students not being able to understand word problems is due to students’ deficiency in vocabulary knowledge. Vocabulary is an essential component in the content area of mathematics (Palmer, Boon, & Spencer, 2014; Riccomini, Smith, Hughes, & Fries, 2015); therefore, students need to have a clear understanding of math and general vocabulary to understand math word problems. For example, Participant 1 stated that “my biggest challenge during instruction is that students do not know the vocabulary." She explained that students do not understand the meaning of the vocabulary words; therefore, understanding what the question is asking is problematic for them. She stated, "You know, to me, there's only so many ways you can explain what *sum* is…" Participant 6 agreed and stated, "Even though posted within the classroom we have math vocabulary words; …, many students with learning disabilities still demonstrate challenges in applying the words or concepts to solve word problems…" Participant 6 also expressed the importance of repeating vocabulary instructions to help students understanding. Participant 6 stated, "…they [students] require repeated directions and reminders to apply vocabulary terms and skills."

Participant 2, 4, 5, and 6 described challenges they face when teaching students skills and strategies that can be used to solve mathematical word problems. Participant 2 stated, "I teach my students how to break the word problem down piece by piece instead of looking at the question as a whole…" Participant 4 explained that she tries to get her students to understand what the problem entails. Participant 5 explained that challenges occur when she has to teach various strategies to ensure all her student's complete word problem tasks. Participant 5 stated,

> So, I would say I teach it one way, and okay, 75 percent of the class got it. Now how can I teach it a different way, so the other 25 percent of the class gets it? But then when you get to that other way, you have another group of students that now are confused about how to do it because you taught it another way. And know you have to think of a third way to teach it so that they all understand… And then you

tell them OK, we are going to solve this type of problem pick the strategy that is best for you.

Personal challenges. All participants discussed the challenges they experience when teaching mathematical word problem-solving to students. Participant 2 stated, "a major challenge for me, is being able to build students' confidence when they [students] are trying to solve various types of word problems. I find it difficult in helping students change their mindset about how they feel about word problems [especially if they have a weak foundational preparation]." Participant 5 explained that her challenge is the allotted time structure of the math lesson plan. Each section (i.e., Engagement, Exploration, Explanation, Extension and Evaluation) of the provided lesson has a proposed time limit for completion. Participant 5 stated, her challenge is when " the lesson plan say this would take me five seconds to say but if I say this in five seconds this way, they are not going to get it. I have to turn this five-second thing into a 20-minute lesson so that they understand." Adequate planning is a critical component in math instruction. Motlhabane (2013), stated that without proper planning a lesson could go awry and cause students to become even more confused than before the lesson started."

Participant 1 expressed that she thinks that teachers are not taught about math Common Core standards. She stated, "I do not think we [teachers] were really trained in how to achieve what they want us to achieve with it [Common Core math standards]… But I do not feel we are trained at all on exactly what the standards are, what the standards look like. I see the standards in print. But what do you want to see the kids do." Teachers are left to figure these standards out on their own but are evaluated on meeting the standard requirements. Participant 5 expressed her challenge of trying to teach students skills she as an adult knows, such as basic math facts. Participant 5 stated, “It is hard trying to teach them [students] basic things that we already know, to understand things that are basic to us, and understand things that come automatically to us.

Student learning challenges. Participants provided their perceptions of students learning and understanding of mathematical word problem-solving. These perceptions relate to students’ lack of motivation, poor foundational education preparation, retaining information, and reading deficits. For example, Participant 2 said, “most students do not like word problems for various reasons… Many students do not have success in solving word problems, and some have not had success in the past.” Participants 2, 3, and 4 each argued that students lack motivation for learning mathematical word problem-solving skills and strategies and this lack of motivation creates a stumbling block in their mathematical learning. Participant 2 stated that “I get frustrated when students appear to have no vested interest in their learning nor perseverance in trying to figure out how to master word problems.” Participant 3 stated that “because my students believe they do not have what it takes to understand mathematical problem-solving, they begin to develop a ‘whatever’ attitude towards word problem-solving learning [and this frustrates me].” Participant 4 expressed that her students struggle with seeing the connection between problem-solving and real life. Participant 4 stated, “students’ failure to make the connection often stems from a just don’t care attitude and lack of exposure to real-life situations.”

Participant 7 explained that her students lack understanding of mathematical word problems solving skills and concepts. For example, she stated that “My students lacked the ability to transfer new knowledge to similar word problems, stopping and thinking about what the problem is asking them to do, and how their new learning is going to help later in life.” Participant 8 acknowledged that his struggling students lacked the foundational background needed to solve problems. He stated, “The biggest challenge is the foundational background, the deficit children come in with (5th grade yet comprehension skills are at a 2nd or 3rd-grade level…)” Participant 8 further explained that students struggle with understanding how word problem skills relate to real-world situations. He stated, “A lot of students are good at memorizing facts or rotational memory, but when it comes to applying the skills to real-world situations or being able to show the “how” aspect of problem-solving, they cannot.”

According to Participant 5 and 6, students struggle with retaining information taught previously. For example, Participant 6 stated “I believe the most challenging thing is teaching them new skills when it seems as though they completely forgot previously taught skills. Therefore, I must… reteach before moving forward.”

Participant 4 and 7 observed that even though some students can computationally solve word problems, reading deficits are an issue that students face when solving word problems. For example, Participant 7 stated, “reading comprehension affects the understanding of what the math real-world based problems are asking and how to apply the skills to the specific word problems pertaining to that standard.” Similarly, Participant 4 stated, “It is challenging having children who cannot read because this causes a huge problem even if they can do the math if they cannot read they cannot understand the problem."

Theme 4: Teachers Needs Regarding Support and Resources

To answer research question 4 that asked about the support and resources teachers perceive they need to meet the needs of students who are underachieving in solving mathematical word problems, one theme, "Teachers' Need for Support and Resources" and three subthemes: (a) Technology, (b) Teacher Assistance, and (c) Curriculum Materials, emerged from the data. All participants discussed their views on support and resources needed to enhance their overall effectiveness in teaching and student learning of mathematical word problem-solving skills. Below are participants responses organized around the three subthemes.

Technology. As a subtheme, participants discussed that technology is a significant resource that teachers need as a supplementary aid for teaching students, and the use of technology helps their students in completing math tasks. Two of the eight participants commented that they need working computers that students can use to solve, check and practice word problems. For example, Participant 6 stated, "It helps when students have access to a working computer where they [students] could practice their math skills on a weekly basis especially… at home." Participant 4 stated, "if they [students] can practice word problem-solving using some kind of technology…where the word problems can be read to them like on a computer… or maybe it [word problems] can be translated into the child's original language… to help them, that might help." Research shows that English learner students perform slightly lower on math word problem-solving tasks when the instructions were not delivered in their native language (Alt, Arizmendi, Beal, & Hurtado, 2013; Verzosa & Mulligan, 2013). Additionally, Participant 3 stated, "I would love for my kids to have Chromebooks or some form of laptop for each student. I think that would be very helpful."

Participant 4 and 8 expressed that their students have access to Chromebooks that they use during instruction time, but lack the necessary apps and programs to complete math word problems skills and strategies. The computers were not the only technology resource, or support teachers stressed they need when providing students with skills and strategies that can promote mathematical word problem-solving success. For example, Participant 2 explained that as a math teacher "I believe I must find creative and informative ways to instruct each [underperforming] student [individually] that I encounter…"

Teacher assistance. Gottfried (2018), suggested that teacher aides can be useful in helping to improve struggling students learning in the classroom. According to Participant 2, 3, and 7, both teachers and students can benefit from having an extra person inside the classroom to offer support. Participant 2 expressed how useful it would be to have a teacher aide in the classroom, but she knows the reality of getting one is impossible. Participant 3 expressed that it would be nice to have a teacher's aide that can come to the classroom a few days a week to help assist with small group instruction. She stated, "it would be nice to have a teacher's aide that can help with the students because overall…50 percent [students] are on grade level, but then the other 50 percent are really struggling… it becomes too much.” Participant 5 articulated that it would be nice seeing how other teachers instruct their students during math word problem-solving instruction.

Curriculum materials. Participant 5 and 6 discussed the importance of having curriculum materials available for effective mathematics instruction. Zhang (2014) argued that when teachers are equipped with the necessary resources needed, then quality instruction can take place. Participant 6 explained how she utilizes the teacher edition of the math books to obtain differentiated lessons she can use. Participant 6 stated, “I have access to the curriculum and pacing guide… I also have access to the teacher’s edition math books. However, I utilize the teacher’s guide to obtain examples of the lessons to conduct reteaching of the skills to the students in my small group or accessing similar lessons on line.” She also stated, “I would like to receive more resources that are of course aligned with common core for my students with complex learning styles because currently the students work is modified.” Participant 5 explained how she takes advantage of the county math book provided and the intervention kits that are available for teacher and parent use.

Discussion of the Findings

The analysis revealed four themes and several subthemes. The themes were: teachers’ perceptions of their preparedness, teachers’ pedagogy, challenges teachers faced during instruction, and the support/resources teachers need for teaching math to underachieving students.

Theme 1, Teachers’ Perceptions of Their Preparedness, revealed that teachers confidence and professional education prepared them to instruct students in mathematics word problem-solving. All eight participants described various factors that enhanced their confidence in teaching mathematical word problem-solving. These factors included their teaching experience, the grade level they taught, and having lesson plans created by experts, such as curriculum developers. Participants also explained that having received different types of professional education such as math grade level specific, math curriculum, and Math Solutions over the years has helped prepare them for math word problem instruction.

Theme 2, Teachers' Pedagogy, revealed that teachers used manipulatives, problem-solving instructional techniques, and small group/peer tutoring as teaching tools to help students complete mathematics word problem-solving tasks. Participants revealed that based on the students'learning styles, they used different types of manipulatives (e.g., multiplication charts, calculators, base ten blocks, etc.) to provide instruction and meet the needs of their students. The participants also described various problem-solving instructional techniques such as real-life, self-created, and easy to solve problems, and opportunities to use visual representation (drawings), to aid students in mathematical word problem-solving instruction. The findings also revealed that small group instruction/peer tutoring gave teachers more time to directly work with and provide extra support to students while they engaged in mathematics word problem-solving learning.

Theme 3, Challenges Teachers Face When Teaching Word Problems Solving, revealed that there are instructional, personal, and student learning challenges that teachers face in the classroom. Findings associated with instructional challenges acknowledged that many students are not able to understand word problems due to their vocabulary deficiency. As a result, teachers stated that they need to find effective ways for students to enhance their general vocabulary since a strong math vocabulary helps to increase students' knowledge of mathematical word problem-solving. Using differentiated instruction techniques such as repeating vocabulary instructions, breaking down the word problem into parts and using graphic organizers are some of the ways that teachers stated that they use to help students enhance their vocabulary. Findings revealed that not receiving the necessary training on how to implement Common Core State Standards of Mathematics (CCSSM), struggling with being able to build students' confidence towards learning and not having sufficient time to prepare lesson plans are all personal challenges expressed by teachers that hinder their teaching. Findings also revealed that participants encounter student learning challenges when conducting instruction. These findings showed that teachers believe that students do not display motivation for learning, experience difficulty in retaining information taught from lesson to lesson, lack foundational background knowledge and struggle with reading comprehension skills needed for word problem-solving learning.

Theme 4, Teachers Needs Regarding Support and Resources, revealed that technology, teacher aide(s), and curriculum materials are necessary for providing math word problem-solving instruction. The findings showed that teachers perceived that having technology in the form of computers (e.g., desktop, handheld) and computer apps are strongly needed as supportive teaching and learning resources. Findings revealed that teachers and students expressed a need for extra classroom support such as in the form of a Teachers' Aid. Findings also revealed that teachers believed that having another adult in the classroom can offer the extra/additional support needed for one-on-one and small group instruction, which is not just valuable for teachers but could also benefit students. For curriculum materials (instructional resources), findings revealed that teachers perceived that having an adequate curriculum and teaching materials can increase their preparedness for instruction, which will also enable them to provide differentiated instruction to meet the needs of those students who struggle with mathematics word problem-solving.

Findings from my study revealed that participants were confident in their ability to teach underachieving students mathematical word problem-solving. Teachers in the study also used various teaching tools and manipulatives to meet the needs of these students. Additionally, teachers expressed that they provide instructional strategies consistent with the phases developed by Polya (1957) when helping students solve various types of word problems. The conceptual framework of Polya's (1957) four phases of mathematical problem-solving include: (a) understanding the problem, (b) devising a plan to solve the problem, (c) carrying out the plan, and (d) looking back. Polya stated that teachers should teach their students how to solve word problems using these different phases. However, according to Marchis (2011), teachers did not always provide students with opportunities to use different strategies when solving word problems.

My findings also revealed that teachers have personal and instructional challenges in helping students solve math word problems. The teachers expressed that they are not fully trained on what the math standards (Common Core Math) are and how to implement these standards even though they are provided with curricula and pacing guides. They also expressed a need for help with the development of pedagogical strategies that enhance and strengthen students' vocabulary, and they acknowledged that they need assistance in creating detailed lesson plans.

Based on these findings, I developed a three-day PD program for teachers to help them understand and apply the Common Core math standards and how to translate the standards into lessons for instruction. The PD program also includes creating effective ways to help teachers enhance students' math vocabulary and creating standards-based lessons plans that guide teachers' development of math word problem-solving instruction.

The Project as an Outcome

The project deliverable is a 3-day PD on the topic of Problem-Solving in Math. The PD is supported by the research findings. The projected audience is math teachers who seek to explore and implement practical problem-solving skills and strategies to help students acquire an in-depth understanding of mathematics word problem-solving. The project is explained in detail in Section 3. A literature review that supports the project is provided. Section 3 also includes the project implications, possibilities for social change, and the importance of the PD project at the local level.

Section 3: The Project

Introduction

The purpose of this qualitative case study was to understand elementary math teachers' perceptions about instructing underachieving students about mathematical word problem-solving. For this study, I collected and analyzed data from face-to-face interviews and written responses to interview questions. The findings of my study showed that teachers were in need of PD that increases their knowledge of the CCSSM, developing standards-based lessons plans, and creating activities that enhance students' math vocabulary knowledge. Based on these findings, I developed a PD plan that would support elementary teachers in implementing Common Core math standards, math vocabulary strategies, and standards-based lesson plans to improve students' understanding and success when solving math word problems.

In this section, I provide a rationale for choosing to develop a PD project for teachers, a literature review related to PD and PD for math teachers, and a discussion about the project description that addresses the potential resources and existing support, potential barriers, proposal timelines, and implementation of the PD project as well as the components of the project. Lastly, I explain the roles and responsibilities of the facilitator, presenters, and participants, and provide a brief discussion about the project evaluation plan and positive social change for the local context.

Rationale

Teachers need the support of PD to help maintain productive instructional contexts and to adapt to new challenges (Bostic & Matney, 2013). The findings of my study indicated that teachers could benefit from PD during which they would learn how to identify and understand the CCSSM, develop standards-based lessons plans that guide mathematical word problem-solving instruction, and create math vocabulary activities that enhance students' math vocabulary understanding.

Review of the Literature

For this literature review, I read a variety of peer-reviewed journal articles, dissertations, primary and secondary sources related to PD and PD for math teachers. Various databases including Google Scholar, Walden University's ProQuest, Academic Search Complete, Education Research Complete, ScienceDirect, EBSCO host, PsycINFO, Thoreau, and Sage Publications were used to find relevant research. During the literature search, I also reviewed scholarly books, seminal journal articles, and research documents.

I used the following search terms to guide my search of the literature: *professional development/elementary, professional development/math, common core math standards, teacher pedagogy, curriculum instructional strategies, math vocabulary instruction, teacher planning models, math vocabulary strategies, Common Core math standards, and lesson planning.* I used the search terms individually and in combinations to search for relevant literature. The search generated many articles. During the search process when repeated searches did not reveal any new literature, I considered my search completed.

In the first subsection of the literature review, I discuss research on effective PD. Next, I present research about Common Core standards-based planning and instruction.

In the rest of the literature review, I discuss research about math vocabulary instruction at the elementary level. The review of the literature was designed to review the findings of the use of PD to provide teachers with the necessary educational tools needed to provide effective math word problems solving instruction to students.

Professional Development

The implementation of teacher PD is important to the academic success of students and teachers as educators (Kunter et al., 2013). Teachers' participation and collaboration in PD allows them to learn from each other, which can enhance their instructional practices and build working relationships. PD is designed to improve teachers' pedagogy and students' learning outcomes (Stevens, Aguirre-Munoz, Harris, Higgins, & Liu, 2013; Sun et al., 2013). As teachers participate in PD that aids them in adapting to the continuous changes in learning environments, teachers become equipped with the necessary skills, strategies, and instructional techniques to help students achieve math success. PD can include workshops, staff meetings, content, and standard-based conversation, conferences, and seminars (Desimone, 2009; Guskey, 2014). Research shows that structural features needed for PD for teachers should: (a) be sustained over time, (b) contain subject-specific content and skills (reform orientation), and (c) be based on pedagogical strategies that improve teacher knowledge which allows teachers to collaborate with one another, receive feedback, and develop new knowledge (Akyuz, Dixon, & Stephan, 2013; DeMonte, 2013; McNeill & Knight, 2013; Sun, Penuel, Frank, Gallagher, & Youngs, 2013). The duration of PD is essential for its effectiveness (Polly, Neale, & Pugalee, 2014). According to Bayar (2014), the shorter the PD, the less time there is for teachers to learn how to implement change in teaching practice, address the effectiveness of teaching and learning issues, and reach desired goals.

Research About Professional Development for Elementary Math Teachers

PD that promotes best practices for teaching mathematics provides opportunities for teachers to understand math standards (DeMonte, 2013; Powell, Fuchs, & Fuchs, 2013), use standards as a basis for instructional planning (Dixon et al., 2014; Marrongelle, Sztajn, & Smith, 2013), and teach using best practices (Alliance, 2006; Taton, 2015) that will impact students' academic success. Additionally, according to Avalos (2011), there must be a connection between subject content matter knowledge, teachers' instructional abilities, and the impact teachers have on students and the school to promote best practices.

Common core math standards. PD can be used for educating teachers on CCSSM. As teachers prepare for math instruction, understanding CCSSM is essential (McDonnell & Weatherford, 2013), because the CCSSM are designed to ensure all students are ready for college, careers, and competition in the global economy (Neuman & Roskos, 2013). The math standards are also designed to provide students with rigorous content and application knowledge, specific math topics (skills), and across grade level instruction (DeMonte, 2013). Additionally, the CCSSM are designed to allow teachers to engage in best practices needed for instruction (Powell et al., 2013), and share instructional goals with other teachers (Marrongelle et al., 2013). Teachers' knowledge of CCSSM is important to develop standards-based lessons.

Instructional planning. Standards-based lesson plans are essential for teachers to implement during mathematics instruction (Marrongelle et al., 2013). Teachers need to implement math standards during instruction to provide students the opportunity to problem-solve, use critical and creative thinking, collaborate with peers, and conduct research inquiry (Hirsch, 2003). Additionally, teachers' planning and implementation of math standards and practices into everyday lessons lead to detailed and authentic instruction that impacts students' academic success in mathematics (Marrongelle et al., 2013). Common core standards are focused on application and knowledge in authentic situations; therefore, it is important that teachers incorporate CCSSM into their lesson plans. According to the National Council of Teachers of Mathematics (2013), there are eight mathematics teaching practices that should be a part of every mathematics lesson

1. Establish mathematics goals to focus on student learning.
2. Implement tasks that promote student reasoning and problem-solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking. (p. 3)

The implementation of the eight teaching practices into math lessons by teachers ensures that teachers meet the learning needs of all their students.

Collaboration. Participation in PD also allows teachers to collaborate and reflect on their learning (Horn & Kane, 2015) and prepares teachers for planning lesson and implementing instruction (Dixon, Yssel, McConnell, & Harding, 2014). As teachers develop lessons, it is a good practice for teachers to collaborate with other teachers from other grade levels, discover personal assumptions about teaching and instruction, and take responsibility as a part of an instructional team (Hirsch, 2003). According to the Principles of Action (NCTM, 2013), "too many mathematics teachers remain professionally isolated, without the benefits of collaborative structures and coaching, and with inadequate opportunities for PD related to mathematics teaching and learning" (p. 2).

Collaboration is also significant to teacher development, learning for students, and school improvement (Chapman & Muijs, 2014). For example, Ronfeldt, Farmer, and McQueen (2015) conducted a longitudinal study with over 9,000 teachers and suggested that instructional teams' performance improves when teachers work in schools that encourage quality collaboration. The findings also showed that teachers and schools that engage in quality collaboration have more significant gains in mathematics and reading achievement (Ronfeldt et al., 2015).

Additionally, Forte and Flores (2014) conducted a study with 80 teachers and showed that time, working conditions, motivation, and personal difficulties, as well as a lack of training in collaboration, affected opportunities to work collaboratively. Findings also indicated that teachers favor collaboration because it increases their interpersonal relationships and it provides opportunities for teachers to experience new ideas, monitor students' work, and develop skills for better work results.

Finally, Vries, Jansen, and van de Grift (2013) conducted an exploratory study of 250 teachers and found that teachers' participation in continuing PD provided opportunities to collaborate, share values and visions, and improve educational practices. Findings also showed that the more time teachers spent in continuing their PD, their orientation for collaboration and reflecting on their work increased (Vries et al., 2013).

Teaching using best practices. As teachers participate in PD that aids them in adapting to the continuous changes in learning environments (Stewart, 2014), teachers equip themselves with the necessary skills, strategies, and instructional techniques needed to achieve students' math success (Lattuca, Bergom, & Knight, 2014). The instructional techniques and activities teachers use for instruction must be planned and provide students with the opportunity to engage in activity-based learning (Garet et al., 2001; Hochberg & Desimone, 2010). There are several best practices that teachers can employ to help students meet math success. The best practices include implementing differentiated instruction (Bender, 2012; Chen & Herron, 2014; Dixon et al., 2014), instructional instruments such as technology and manipulatives (Baroody, 2017; Kablan, 2014; Shin et al., 2017), and vocabulary instruction (Vesel & Robillard, 2013; Wright & Neuman, 2014).

Differentiated instruction. Differentiated instruction is imperative when instructing students with diverse levels of mathematics achievement. According to Chen and Herron (2014) and Bender (2012), differentiated instruction is necessary when teaching students math skills, strategies, and concepts. Chen and Herron argued that meeting the mathematical needs of diverse learners includes the effective teaching method of differentiated instruction. Bender also suggested that differentiated instruction helps students to succeed academically in mathematics. It is also important that teachers be knowledgeable about the different types of math strategies and concepts (e.g., small group instruction, manipulatives) required to provide students with differentiated instruction (Chen & Heron, 2014).

A study conducted on differentiation instruction showed the challenges and ways to overcome them to achieve effective instruction. Weber, Johnson, and Tripp (2013) conducted a case study to provide an overview of a pre-K-eighth-grade private school's journey toward implementing differentiation instruction in their classrooms. Weber et al. suggested that teachers were struggling with implementing and conceptualizing differentiated strategies due to time and energy constraints. Weber et al. also suggested that teachers need expert support from administration and math coaches and need extra time to implement differentiated strategies and instructional lessons. Weber et al. argued that for differentiated instruction to be effective, teachers have to be knowledgeable about curriculum and instructional resources, be able to manage students' differentiated learning in the classroom and maintain accountability for instruction.

Instructional instruments. Instruments used to incorporate the best practices for math instruction are technology and manipulatives. The technology tools (e.g., computers, smart boards, language translators) and manipulatives (e.g., multiplication charts, counting cubes, fraction sets) are used in classrooms and homes to assist students in completing mathematical tasks (Baroody, 2017). Instructional technology tools and manipulatives allow students to engage in math instruction using visual and auditory representations and hands-on approaches. With technology and manipulatives, students browse the Internet in search of information, interact with math tutorials and games, and complete web-based activities. Integrating technology in the classroom also creates a learning atmosphere centered around students rather than the teacher.

Though both tools can be used for instruction, research has indicated the use of technology more than manipulatives. Martin, Shaw, and Daughenbaugh (2014) surveyed 238 K-5 and showed that 59.1% of teachers used SMART Boards more than manipulatives and hands-on activities, and 25.6% used them an equal amount of time. Findings also suggested that teachers prefer using SMART Boards more than manipulatives because students tend to respond with higher quality activities and a variety of resources that are more available when using the SMART Boards compared to using manipulatives.

Other research has shown the benefit of both virtual and concreate manipulatives. Bouck, Satsangi, Taber-Doughty, and Courtney (2014) conducted a study with three male elementary students with autism spectrum disorder to explore the effectiveness of teaching single- and double-digit subtraction skills using both concrete (physical objects) and virtual (3-D objects from the Internet) manipulatives. Results suggested that concrete and virtual manipulatives were helpful tools when teaching the students subtraction skills. Results also revealed that both types of manipulatives increased the student’s percentage of accuracy and their independent performance when solving subtraction problems.

Lastly, the results suggested that concrete manipulatives appeared to be slightly less effective than virtual manipulatives, students were able to increase their level of independence when using the concrete and virtual manipulatives, and the use of technology and manipulatives during instruction and learning has the potential to meet the needs of teachers and students (Bouck et al., 2014).

Vocabulary instruction. The depth and breadth of students' math vocabulary knowledge have a significant influence on students' math success (McDonough & Sullivan, 2014). As students encounter math problems from a simple to complex level, the vocabulary level increases; therefore, student understanding of the word meaning is necessary. It is imperative that students understand words specific to math, words with multiple-meaning, and math symbols to help students read and solve word problems (Pierce & Fontaine, 2009). Thus, math vocabulary instruction is significant for students' mathematical literacy (numeracy; Ball, Paris, & Govinda, 2014). Researchers have suggested that math vocabulary instruction should include activities that provide opportunities for students to encounter math-specific vocabulary and learn the meaning of the vocabulary words (Ball et al., 2014). These activities should be meaningful and fun (Beck, McKeown, & Kucan, 2013; Pierce & Fontaine, 2009).

As an example of vocabulary instruction, Wright and Neuman (2014) conducted a study on the use of oral vocabulary instruction and teacher pedagogy when teaching vocabulary lessons to kindergarten classrooms of low, middle, and high socioeconomic status schools. Wright and Neuman addressed four researched-based features of vocabulary instruction: the amount of instruction (the number of words taught), systematic word selection (tier level of words), in-depth instruction (depth of processing words), and context of instruction (way words are presented to students). The results revealed that teachers presented the students with various words through different contexts while providing word meaning during the lesson or activity. Findings revealed that vocabulary instruction is consistent throughout the day, but consisted of "single, brief, word explanations" (p. 20) directed by the teacher. Findings also suggested that vocabulary development instruction is important, especially in the early years of schooling since it is essential to long-term comprehension (Wright & Neuman, 2014).

Summary of Literature Review

The literature review briefly outlined and discussed the importance of PD and PD for math teachers. The literature review addressed the structural features needed for effective PD such as duration, subject content areas, and teacher collaboration. The literature review also addressed the importance of the PD for math teachers, which focused on Common Core math standards, instructional planning, and teaching using best practices. Lastly, the literature addressed teachers using differentiated instruction, incorporating technology and manipulatives during instruction, and providing math vocabulary literacy in meeting the academic math needs of all students.

Project Description

Based on the findings of my study, I determined a PD workshop was needed to help teachers learn and understand Common Core math standards, create math vocabulary activities, and develop standards-based lesson plans for math instruction. Elementary math teachers participating in the *Learning to Word Problem Solve* PD will work in grade-level small groups, work collaboratively to exchange ideas, experiences, and experiences, develop lesson plans, learn about Common Core math standards, and use strategies and resources to create math vocabulary activities. This project will lead to teachers developing their mathematical word problem-solving instructional capabilities, thus furthering their ability to help students achieve academic and math success.

The *Learning to Word Problem Solve* project is designed to enhance participants' understanding of CCSSM, developing standards-based lesson plans, and creating math vocabulary activities. The project provides opportunities for participants to engage in collaborative discussions about lesson planning, receive updated math vocabulary resources, and participate in their own instructional development. The *Learning to Word Problem Solve* project includes three formative assessments that teachers complete at the end of each day. These assessments allow participants to evaluate the PD daily activities and complete a summative evaluation to measure the overall success of the project.

Potential Resources and Existing Supports

The existing supports for this project will consist of the county math coach (CMC) as a presenter, professional development lead teachers who will assist all participants, and me as the facilitator. Many of the PD resources (e.g., stationery items, math manipulatives, chart paper) needed are already available at the school at which I teach, thus the need for a few additional resources. However, the district will provide a location to conduct the workshop along with other resources for the study such as internet access, personal computers, and a projector, which will be used during the PowerPoint presentations, small group meetings, lesson planning and locating online resources.

Potential Barriers

Potential barriers facing my PD project are budget insufficiencies (compensation, supplies, resources, and participants), location, duration/timing, and participation. The first barrier, lack of an adequate budget, poses limitations in providing participants with snacks, copies of materials, and other resources such as manipulatives. Another budget limitation is the cost associated with a lack of monetary compensation available for teachers to participate in the PD during their summer break. Teacher participation is vital for ensuring the implementation of the PD. The second barrier is providing a convenient location. The PD is geared towards adults; therefore, a convenient location such as a media center will provide for a more conducive learning environment than a primary classroom, a setting that may provide a distraction if participants view it as similar to their daily classroom environments. The third barrier is timing since three consecutive seven-hour days are required during the summer months to implement the PD. Summer months compete with other commitments such as summer employment, family vacations, and camp activity for their children, causing teachers to be less willing and available to participate in a PD activity. Moreover, it might not be practical to implement the PD during the school year because the county already provides PD throughout the school year for teachers to attend that includes a pre-planned agenda that professional development lead teachers are encouraged to follow.

Proposal for Implementation and Timetable

The implementation of this PD project is 3 consecutive days during the teachers' summer break, close to the start of a new school year. An e-mail generated by the county will go out to administration and teachers informing them of the upcoming PD. Principals are also asked to encourage their teachers to make the necessary provisions to attend the workshop. Table 8 shows the timetable for the PD.

Table 8

Time Table for Implementing Professional Development

Schedule	Activity	Presenter
Day 1	• Presentation of the study's purpose and findings • Math word problem-solving pretest • Small group problem-solving article discussion • Open forum discussion on what is problem-solving, types of word problems, and strategies used to solve word problems	• Facilitator, county math coach, and PD lead teachers
Day 2	• Create math vocabulary activities • Introduction to Common Core State Standards of Mathematics (CCSSM) • Math word problem-solving posttest	• Facilitator, county math coach, and PD lead teachers
Day 3	• Pre- and post-test results • Writing CCSSM lesson plans • Evaluation	• Facilitator, math coach, and PD lead teachers

Note. 3 Consecutive Days

The purpose of this table is to provide participants with a summary and visual representation of the session activities they will be participating in each day, including the individual(s) responsible for presenting the information during the PD workshop.

Components of the workshop. The proposed PD is designed to occur over 3 consecutive days. Teachers are required to attend all three 8-hour days of the workshop. Each workshop day will be allotted a 60-minute "On Your Own" lunch break.

Day 1 includes the following:

1. A 90-minute session entitled *Teachers' Perceptions of Problem-Solving*. The PD includes a 90-minute presentation of my study. The purpose of this session

is for teachers to learn about my study, the findings, and the implications of the findings. I will be the presenter for the session.

2. A 30-minute session entitled *Problem-Solve It!* During this PD session, participants complete a Math Word Problem-Solving Pretest. The purpose of this session is for teachers to use their knowledge of math word problem-solving strategies and math vocabulary to solve Common Core-based word problems. I will be the administrator of the test.
3. A 60-minute session entitled *Understanding Students Who Problem-Solve.* The purpose of this small group activity is to engage participants in a collaborative discussion about students' problem-solving abilities, and the importance of problem-solving in mathematics. The CMC will be the presenter of this activity. During the first 20-minutes of this small group activity, participants will read a journal article about mathematics problem-solving instruction, and its effect on students learning. During the remaining 40-minutes, participants will discuss the content from the article and respond to questions posed by the CMC to demonstrate their understanding and learning of the concepts from the article read.
4. A 120-minute session, entitled *What is Problem-Solving?* The purpose of this activity is to present participants with information (e.g., strategies, types of word problems) that teachers can use later within the PD and in future lesson planning and instruction. During this PD session, the CMC will present information to the audience about types of word problems, and the strategies

used to solve word problems. The CMC will also use videos to convey information during the presentation.

Day 1 will conclude with two 15-minute evaluation sessions. During the first 15 minutes, participants will discuss and reflect on the day's activities. During the second 15 minutes, participants will complete an evaluation of the day's activities (see Appendix A). The overall purpose of the evaluation is to provide me and the CMC with feedback referencing the effectiveness and clarity of the day's activities. This information will help me to improve the project in the future.

Day 2:

1. A 105-minute session, entitled *Math Vocabulary: Resources and Where to Look for Them.* The purpose of this session is to engage teachers in learning what resources and strategies (see Appendix A) are available and where to find them when needed to create math vocabulary activities. During this session, the CMC will provide and discuss math vocabulary resources and strategies that are available for teachers use.
2. A 105-minute session entitled *Creating Math Vocabulary Fun!* The purpose of this session is for teachers to use the resources and strategies they learned in the previous session to create math vocabulary activities that students can use independently or in a small group (videos included). The CMC and I will facilitate the session. We will ask participants to break into small groups and work collaboratively with them to create two math vocabulary activities.

3. A 90-minute session entitled *What is Common Core?* The purpose of this session is to re-familiarize teachers with the standards identified in the CCSSM when developing standards-based lesson plans. During this session, the CMC will review the CCSSM, and ask participants to share with each other the standards they have used in developing lesson plans for the classes they teach. Teachers, through small group activity, also will be asked to devise a list of the standards that they have frequently used in their classroom instruction to be shared with each other and the CMC. The CMC will provide participants with feedback during this small group activity.
4. A 30-minute session entitled *Problem-Solve It Two!* The purpose of this session is for teachers to learn and implement the appropriate mathematical word problem-solving strategies and math vocabulary needed to solve Common Core-based word problems. During this session, participants will complete the Math Word Problem Solving Posttest. I will administer the test, and the results of this activity will be discussed with participants on Day Three, Activity One by me and the CMC.

Day 2 also will conclude with an evaluation, similar to Day 1. For the first 15 minutes of the evaluation session, participants will be asked to discuss and reflect on the day's activities. During the second 15 minutes, participants will complete an evaluation of the day's activities (see Appendix A).

Day 3:

1. A 60-minute session entitled *The Results Are In!* The purpose of this session is to discuss with teachers the various strategies and math vocabulary they implemented to complete the pretest and posttest and their reasoning for using such strategies. In this session, I will discuss the math pretest and posttest results with the participants.
2. A 90-minute session, entitled *Choosing the Best Standards.* The purpose of this session is for teachers to learn how to choose the appropriate CCSSM needed to create lesson plans, that teachers will use during the school year. During this session, participants will work collaboratively in small groups based on their current grade level teaching. The participants will choose five Common Core math standards appropriate to their grade level and two problem-solving strategies. Referring to the standards and strategies, teachers will develop math lesson plans. The participants will discuss their rationale for choosing those standards, how they plan to use the standards as a basis for their lesson plans, and what types of activities will they use to help students achieve the goal of the standards. The CMC and I will oversee this session.
3. A 120-minute session entitled *Standard-Based Lesson Planning.* The purpose of this session is for teachers to learn how to develop standards-based math lesson plans. During this session, participants will continue to work in small groups to develop standards-based lesson plans. The participants will develop five standards-based math lesson plans, using Common Core math standards,

the eight mathematics teaching practices and the problem-solving strategies they chose during the previous session. The CMC will oversee this session.

4. A 60-minute session entitled *Characteristics of an Effective Lesson Plan*. The purpose of this session, in the form of a whole group activity, is for teachers to collaborate and learn from each other through the sharing of experiences, expertise, and knowledge about problem-solving. During this session, participants will choose one representative from their grade level to present an overview of one planned lesson. The participants will be asked to provide suggestions, ideas, or constructive feedback. The CMC and I will direct this session.

Day 3 also will conclude with an evaluation process, similar to Day 1 and 2. During the first 15 minutes, participants will discuss and reflect on the day’s activities and complete the day’s evaluation tool (see Appendix A). During the second 15-minutes, participants will complete the summative evaluation of the project (see Appendix A).

Roles and Responsibilities

My role and responsibilities in this PD are to present my research study and its findings, facilitate the PD, provide all resources, arrange the setup, and conduct the evaluation. The participants will be responsible for attending all three days, interacting with group members, facilitators, and completing the evaluation. The math coach will present information related to the CCSM and facilitating the discussion related to developing standards-based lesson plans. Administrators and professional development lead teachers will also be responsible for attending each workshop day, interacting with participants, and making sure participants are actively engaged.

Project Evaluation Plan

For this PD project, participants will complete formative and summative evaluations. On Days 1 and 2, participants will complete Exit Tickets at the close of each day. These formative evaluation "Exit Tickets" will be used to provide an overview of teachers understanding of the days' activities. On Day 3, teachers will complete an evaluation of the entire PD project. This summative evaluation will be used to gain evidence of the effectiveness of the PD project (Nieveen & Folmer, 2013). The summative evaluation is used to gather feedback from participants, and to determine whether the PD met its goals.

The overall goals of this PD project are for math teachers to learn and understand the CCSSM, learn and develop standards-based lesson plans, and learn and create math vocabulary activities using various forms of resources. The goal is to increase underachieving students' performance and success in solving mathematics word problems through the strengthening of the teachers' pedagogical skills in developing standards-based lesson plans.

Project Implications

Local Community and Far-Reaching

This PD project may contribute to better teaching and more in-depth learning for teachers and contribute to social change at the local level. Math teachers from five elementary schools that instruct underachieving students on mathematical word problem-solving have expressed concerns about understanding Common Core math standards, implementing the standards into their lesson plans, and students math vocabulary knowledge. As teachers increase their knowledge of CCSSM, create detailed lesson plans that integrate the Common Core math standards, and create meaningful math vocabulary activities that can enhance students learning, their ability to provide effective mathematical word problem-solving instruction may directly increase students'ability to meet proficient or advanced on state, county, and curriculum math word problem-solving assessments.

The PD project may also be used to promote positive social change by increasing teachers' math problem-solving pedagogy. The expanded word problem-solving knowledge that students will gain from their teachers' math problem-solving pedagogy should increase students' word problem-solving achievement within the study school district. Additionally, students will benefit from the word problem-solving instruction because, as students transition from elementary to secondary school, then preferably to college, they will have a more in-depth and developed level of understanding of how to solve word problems and increase their achievement in math and other academic subject areas.

Conclusion

A 3-day *Learning to Word Problem Solve PD* workshop for schools identified in this study was developed and implemented, with the goal of educating teachers to understand Common Core math standards, incorporate the standards in lesson plans and develop standards-based lesson plans for instruction, and create math vocabulary activities to help students with solving word problems. This workshop was developed as a result of a larger investigation that used qualitative data to examine teachers' perceptions about instructing underachieving K-5 students on mathematical word problem-solving. Findings showed that teachers needed training on the CCSSM, creating detailed standards-based lesson plans, and developing pedagogical strategies that strengthen students' math vocabulary. The PD workshop will show that teachers have enhanced their understanding of CCSSM, incorporating standards into lesson plans, using resources, and working collaboratively in creating math vocabulary activities.

In Section 4, I will review the strengths and limitations of my overall project study, my recommendations for alternative approaches, my self-analysis as a scholar, project developer, and practitioner. I also will discuss the importance of the work and what I have learned from conducting this case study. Lastly, I will discuss social change and implications for future research.

Section 4: Reflections and Conclusion

The purpose of this study was to investigate teachers' perceptions about instructing underachieving students on mathematical word problem-solving. Instruction of mathematical word problem-solving is important for the completion of word problem tasks by students in elementary grade levels (Root, Browder, Saunders, & Lo, 2017). To increase students' math achievement, teachers need to be knowledgeable about math curricular content, CCSSM, and pedagogy (Hurrell, 2013).

Eight teachers from five elementary schools in an urban school district were selected for this study. Data were collected and analyzed from the interviews and from the written responses to interview questions. The analysis of the collected data indicated that teachers are confident in teaching students mathematical word problem-solving even though they experience personal and instructional challenges. These challenges included their need for learning CCSSM, developing standards-based lesson plans, and creating math vocabulary activities. I developed a 3-day PD to address teachers' responses and increase teacher's knowledge and understanding of Common Core math standards, math vocabulary strategies, and lesson planning, all of which are reflective in their mathematical word problem-solving instruction.

This section includes the projects' strengths, limitations, and recommendations for alternative approaches to the problem. I also include a discussion about the project development, my learning, the importance of the work, implications, applications, and directions for future research.

Project Strengths and Limitations

An important strength of this project lies in the use of qualitative data to uncover the participants's concerns related to knowledge of the CCSSM for standards-based lesson plans and strategies to enhance students' math vocabulary. Another strength of the project relates to the findings from participants. Teachers revealed that they are confident in their instructional capabilities but recognized that they could benefit from more PD activities designed to enhance their understanding of standards-based lesson plans, CCSSM, and math vocabulary activities. Thus, a third strength of the project was the development of the professional development workshop titled, "Learning to Word Problem Solve PD" based on the findings.

The limitation of this project is the time span for conducting the PD workshop. The PD spans over 3 consecutive days and may not provide an adequate amount of time for teachers to process and understand the information presented. Research has shown that for teachers to transfer their PD learning to their teaching practice requires multiple opportunities for teachers to collaborate and engage in learning (Darling-Hammond, Hyler, & Gardner, 2017; Lauer, Christopher, Firpo-Triplett, & Buchting, 2014).

One recommendation would be to provide monthly PD sessions throughout the school year. Monthly PD will allow teachers to engage frequently in collaboration and reflection (Darling-Hammond et al., 2017), as teachers share teaching practices and experiences, problem-solving success and challenges, and ideas and instruction for teaching mathematical word problem-solving strategies (Forte & Flores, 2014).

Collaboration and reflection provide teachers with the support they can use to strengthen or improve their area of weakness.

Recommendations for Alternative Approaches

An alternative approach to addressing the problem of students' low achievement in mathematics word problem-solving would be to conduct classroom observations as a data collection method. Classroom observations can provide an in-depth understanding of teaching styles and strategies teachers use during math word problem-solving instruction (Oleson, & Hora, 2014; Van Beek, De Jong, Minnaert, & Wubbels, 2014). Classroom observations could also be beneficial for observing students' learning and emotional behavior during instruction. Knowing how students learn based on their learning styles can provide teachers with insight about the students, allowing teachers to know better how to address students' learning needs.

Another approach to the study problem would be to conduct an experimental study to examine the effect of math vocabulary instruction on students' mathematical word problem-solving achievement. The study would use students' mathematical word problem-solving assessments scores before and after instruction. One teacher would teach vocabulary instruction (control group) and the other teacher would teach as usual. The study could reveal whether math vocabulary instruction provides students with the vocabulary skills and strategies that they need to engage in mathematical word problem-solving.

Scholarship, Project Development, and Leadership and Change

As a scholar who conducted this qualitative case study, I have learned valuable information about different research designs, collecting and analyzing data, and presenting findings, all of which has prepared me to conduct research. During this doctoral process, I learned how to conduct qualitative research which was a challenge for me. I learned that conducting qualitative research is a rigorous process which requires a deep dive into understanding a problem. I have also learned the importance of using the research findings to develop a project. Now that I have some experience in qualitative research, the knowledge I have acquired will help me in the future to conduct research on teaching practices in my district.

Creating a PD project that can help teachers improve their math instruction was important to me. The process from the beginning to end helped me to realize the overall importance of conducting research. The data collected and analyzed from the teacher interviews led to the development of the PD workshop. The literature review was vital in helping me identify and understand the best PD practices for math teachers. The PD workshop that I developed provided teachers the opportunity to work closely together with other teachers to learn about CCSSM, develop standards-based lesson plans, and create math vocabulary activities.

I decided to take this doctoral journey to further my education to develop my skills and increase my instructional and theoretical knowledge so that I can later use these experiences to help other teachers as they enter into the teaching profession. During my journey, I realized the importance of being a practitioner who can bring about effective change in my classroom, school, and community.

Reflection on the Importance of the Work

The purpose of this study was to investigate teachers' perceptions of instructing underachieving K-5 students on mathematical word problem-solving. This study is important because the findings showed the need for PD. I have interviewed teachers, obtained, and analyzed data, and written up findings in order to develop an understanding of underachieving students mathematical word problem-solving issues. This study could assist teachers in providing instruction for students that are based on CCSSM, preparing, and implementing standards-based lesson, and creating activities that can increase students' math vocabulary.

As I reflect upon my work for this project, I realize that teachers' knowledge and understanding of Common Core math standards are foundational for teachers to be able to develop instructional math lessons which can provide essential instruction to students. I also realize that by allowing teachers' time to collaborate and develop math lessons through the PD training, I will be providing them with needed opportunities to examine, understanding, and reflect upon Common Core standards and the importance of the standards for implementation when providing mathematical word problem-solving instruction to underachieving students. When I reflect upon the importance of this study, I imagine elementary teachers across districts providing students with standards-based lessons that will increase students understanding of word problem-solving as well as increase students' achievement on county and state assessments. Additionally, as a result of my work on this project, I see myself becoming a lifelong learner who appreciates the experiences and will be willing to share learned knowledge with others. As long as math education is part of the everyday curriculum, there will be a need for teachers to provide effective instruction.

Implications, Applications, and Directions for Future Research

The project was designed to address elementary teachers' concerns about instructing underachieving students about mathematical word problem-solving. Findings from my project study revealed that teachers had a desire to improve students' learning of mathematics word problem-solving but faced challenges with Common Core math standards, creating standards-based lesson plans, and creating activities that will enhance students' math vocabulary. These findings have implications for teachers, administrators, and other district stakeholders. The stakeholders may use the project to improve teachers' math word problem-solving instruction, which may lead to social change. Positive social change can occur as teachers improve their effectiveness in instruction to enhance students' math achievement in lower grades. This process may lead to students advancing in problem-solving and critical thinking skills through secondary grades and beyond.

The offering of the *Learning to Word Problem Solve PD* workshop within the district is intended to affect teachers' mathematical word problem-solving instruction positively. The improvement of teachers' ability to implement Common Core math standards lessons and math vocabulary activities should provide a positive effect on students' word problem-solving ability.

A recommendation for future research is to conduct a quantitative experimental study to evaluate the effectiveness of PD workshop, on teachers' word problem-solving instruction before and after teachers have received problem-solving PD. The study would compare students' mathematical word problem-solving assessments scores before teachers engage in PD training and after an intensive PD training. The study could reveal whether PD provides teachers with the necessary skills and strategies they need to implement effective mathematical word problem-solving instruction to students. The study could include classroom observations of teacher instruction and students' learning behavior during instruction. The data collected for this study could come from teacher surveys that address self-efficacy and teaching pedagogies, observation protocols, teacher interviews, and classroom observations. According to Shaha, Glassett, & Ellsworth (2015), PD that focuses on specific instructional practices and linked to classroom instruction increases teachers' use of those practices in the classroom.

Conclusion

This study investigated teachers' perceptions of word problem-solving instruction for underachieving K-5 students. From the study findings, I developed a three-day PD workshop that focused on teachers knowing and understanding Common Core math standards, developing standards-based lesson planning and creating math vocabulary activities. The PD workshop focused on helping teachers to become about knowledgeable of Common Core math standards, developing and implementing standards-based lesson plans, and creating activities that enhance students math vocabulary.

As a result of this project study and PD workshop, I have learned to appreciate the amount of work required for conducting qualitative research. I have also seen myself grow personally and professionally and I have developed a profound acceptance of the research process and the skills needed that would move me from a novice to the expert qualitative researcher.

References

Akkus, M. (2016). The common core state standards for mathematics. *International Journal of Research in Education and Science, 2*(1), 49-54. doi:10.21890/ijres.61754

Akyuz, D., Dixon, J. K., & Stephan, M. (2013). Improving the quality of mathematics teaching with effective planning practices. *Teacher Development*, *17*(1), 92-106. doi:10.1080/13664530.2012.753939

Alt, M., Arizmendi, G. D., Beal, C. R., & Hurtado, J. S. (2013). The effect of test translation on the performance of second grade English learners on the KeyMath-3. *Psychology in the Schools, 50*(1), 27-36. doi:10.1002/pits.21656

Avalos, B. (2011). Review: Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education, 27,* 10-20. doi:10.1016/j.tate.2010.08.007

Ball, J., Paris, S. G., & Govinda, R. (2014). Literacy and numeracy skills among children in developing countries. In D. A. Wagner (Ed.), *Learning and education in developing countries: Research and policy for the post-2015 UN development goals* (pp. 26-41). doi:10.1057/9781137455970_2

Baroody, A. J. (2017). The use of concrete experiences in early childhood mathematics instruction. *Advances in Child Development and Behavior, 53*(1), 43-94. doi:10.1016/bs.acdb.2017.03.001

Bayar, A. (2014). The components of effective professional development activities in terms of teachers' perspective. *International Online Journal of Educational*

Sciences, 6(2), 319-327. doi:10.15345/iojes.2014.02.006

Bayazit, I. (2013). An investigation of problem-solving approaches, strategies, and models used by the 7th and 8th-grade students when solving real-world problems. *Educational Sciences: Theory & Practice, 13*(3), 1920-1927. doi:10.12738/estp.2013.3.1419

Beck, I. L., McKeown, M. G., & Kucan, L. (2013). Introducing word meaning. In *Bringing words to life: Robust vocabulary instruction* (2nd ed., pp. 40-54). doi:10.1177%2F0261429415596306

Bender, W. N. (2013). Strategies for differentiating early math instruction. In *Differentiating math instruction: K-8 common core mathematics in the 21st century* (3rd ed., pp. 105-153). doi:10.4135/9781483387925

Björn, P., Aunola, K., & Nurmi, J. (2016). Primary school text comprehension predicts mathematical word problem-solving skills in secondary school. *Educational Psychology, 36*(2), 362-377. doi:10.1080/01443410.2014.992392

Bloomberg, L. D., & Volpe, M. (2015). Presenting methodology and research approach. In *Completing your qualitative dissertation: A road map from beginning to end*. (2nd ed., pp 100-128). Thousand Oaks, CA: Sage.

Bonny, J. W., & Lourenco, S. F. (2013). The approximate number system and its relation to early math achievement: Evidence from the preschool years. *Journal of Experimental Child Psychology, 114*(3), 375-388. doi:10.1016/j.jecp.2012.09.015

Boonen, A., & Jolles, J. (2015). Second grade elementary school students' differing performance on combine, change, and compare word problems. *International*

Journal of School and Cognitive Psychology, 2(122), 1-6. doi:10.4172/ijscp.1000122

Boonen, A., Koning, B., Jolles, J., & van der Schoot, M. (2016). Word problem solving in contemporary math education: A plea for reading comprehension skills training. *Frontiers in Psychology, 7*(191), 1-10. doi:10.3389/fpsyg.2016.00191

Bostic, J., & Matney, G. (2013). Overcoming a common storm: Designing professional development for teachers implementing the common core. *Ohio Journal of School Mathematics, 67*(1), 12-19. Retrieved from https://kb.osu.edu/bitstream/handle/1811/78176/OJSM_67_Spring2013_12.pdf

Boston, M., Bostic, J., Lesseig, K., & Sherman, M. (2015). A comparison of mathematics classroom observation protocols. *Mathematics Teacher Educator, 3*(2), 154-175. doi:10.5951/mathteaceduc.3.2.0154

Bouck, E. C., Satsangi, R., Doughty, T. T., & Courtney, W. T. (2014). Virtual and concrete manipulatives: A comparison of approaches for solving mathematics problems for students with autism spectrum disorder. *Journal of Autism and developmental disorders, 44*(1), 180-193. doi:10.1007/s10803-013-1863-2

Bradley-Levine, J. (2012). Developing critical consciousness through teacher leader preparation. *Journal of School Leadership, 22*(4), 751-770. doi:10.1353/tip.2003.0029

Burke, M. A., & Sass, T. R. (2013). Classroom peer effects and student achievement. *Journal of Labor Economics, 31*(1), 51-82. doi:10.1086/666653pl

Cai, J., & Lester, F. (2010). Why is teaching with problem solving important to student learning. *National Council of Teachers of Mathematics*, 1-6. Retrieved from https://www.nctm.org

Carifio, J. (2015). Updating, modernizing, and testing Polya's theory of [Mathematical] problem solving in terms of current cognitive, affective, and information processing theories of learning, emotions, and complex performances. *Journal of Education and Human Development*, *4*(3), 105-117. doi:10.15640/jehd.v4n3a12

Chapman, C., & Muijs, D. (2014). Does school-to-school collaboration promote school improvement? A study of the impact of school federations on student outcomes. *School Effectiveness and School Improvement*, *25*(3), 351-393. doi:10.1080/09243453.2013.840319

Chen, S., & Herron, S. (2014). Going against the grain: Should differentiated instruction be a normal component of professional development. *International Journal of Technology in Teaching and Learning*, *10*(1), 14-34. Retrieved from https://sicet.org/main/wp-content/uploads/2016/11/ijttl-14-01-2_Sherry_Herron.pdf

Chipman, S., & Segal, J. (2013). Higher cognitive goals for education: An introduction. In S. Chipman, J. Segal, & R. Glaser (Eds.), *Thinking and learning skills: Volume 2: Research and open questions* (pp. 1-18). Mahwah, NJ: Lawrence Erlbaum Associates.

Common Core State Standard Initiative. (2016a). Implementing the common core state standards. Retrieved from http://www.corestandards.org/

Common Core State Standard Initiative. (2016b). Standards for mathematical practice.

Retrieved from http://www.corestandards:math/

Connor, C. M., Spencer, M., Day, S. L., Giuliani, S., Ingebrand, S. W., McLean, L., & Morrison, F. J. (2014). Capturing the complexity: Content, type, and amount of instruction and quality of the classroom learning environment synergistically predict third graders' vocabulary and reading comprehension outcomes. *Journal of Educational Psychology, 106*(3), 762. doi:10.1037/a0035921

Creswell, J. W. (2012). *Educational research: Planning conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston, MA: Pearson.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed.). Thousand Oaks CA: Sage.

Csíkos, C., Szitányi, J., & Kelemen, R. (2012). The effects of using drawings in developing young children's mathematical word problem solving: A design experiment with third-grade Hungarian students. *Educational studies in mathematics, 81(1),* 47-65. doi:10.1007/s10649-011-9360-z

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). Effective teacher professional development. Retrieved from https://learningpolicyinstitute.org

David, M, & Tomaz, V. S. (2012). The role of visual representations for structuring classroom and mathematical activity. *Educational Studies in Mathematics, 80*(3), 413-431. doi:10.1007/s10649-011-9358-6

DeFilippis, C. L. (2015). *Perceptions of teachers on instructing remedial mathematics students* (Doctoral dissertation). Retrieved from https://www.scribd.com

DeMonte, J. (2013). Professional development and learning to teach the common core state standards. In *High-Quality Professional Development for Teachers: Supporting Teacher Training to Improve Student Learning* (pp. 16-18). Retrieved from http://www.americanprogress.org

Desimone, L., Smith, T. M., & Phillips, K. (2013). Linking student achievement growth to development participation and changes in instruction: A longitudinal study of elementary students and teachers in Title I schools. *Teachers College Record, 115*(5), 1-46. Retrieved from https://scholar.google.com/scholar?hl=en&as_sdt=0%2C21&q=Linking+student+achievement+growth++to+development+participation+and+changes+in+instruction%3A+A+longitudinal+study+of+elementary+students+and+teachers+in+Title+I+schools&btnG=

de Vries, S., Jansen, E. P., & van de Grift, W. J. (2013). Profiling teachers' continuing professional development and the relation with their beliefs about learning and teaching. *Teaching and Teacher Education, 33*, 78-89. doi:10.1016/j.tate.2013.02.006

Dewolf, T., van Dooren, W., Ev Cimen, E., & Verschaffel, L. (2014). The impact of illustrations and warnings on solving mathematical word problems realistically. *The Journal of Experimental Education, 82(1),* 103-120. doi:10.1080/00220973.2012.745468

DiDonato, N. (2013). Effective self- and co-regulation in collaborative learning groups: An analysis of how students regulate problem solving of authentic interdisciplinary tasks. *Instructional Science, 41*(1), 25-47. doi:10.1007/s11251-

012-9206-9

Dixon, F. A., Yssel, N., McConnell, J. M., & Hardin, T. (2014). Differentiated instruction, professional development, and teacher efficacy. *Journal for the Education of the Gifted*, *37*(2), 111-127. doi:10.1177/0162353214529042

Dixon, F. A., Yssel, N., McConnell, J. M., & Hardin, T. (2014). Differentiated instruction, professional development, and teacher efficacy. *Journal for the Education of the Gifted, 37*(2), 111-127. doi:10.1177/0162353214529042

Donaldson, S. (2011). *Teaching through problem solving: Practices of four high school mathematics teachers.* (Doctoral dissertation, University of Georgia). Retrieved from http://getd.libs.uga.edu/pdfs/donaldson_sarah_e_201105_phd.pdf

Dostal, J. (2015) The theory of problem solving. *Procedia- Social and Behavioral Sciences 174*, 2798–2805. doi:10.1016/j.sbspro.2015.01.970

Edens, K., & Potter, E. (2008). How students “unpack” the structure of a word problem: Graphic representations and problem solving. *School Science and Mathematics, 108*(5), 184-196. doi:10.1111/j.1949-8594.2008.tb17827.x

Forte, A. M., & Flores, M. A. (2014). Teacher collaboration and professional development in the workplace: A study of Portuguese teachers. *European Journal of Teacher Education*, *37*(1), 91-105. doi:10.1080/02619768.2013.763791

Gallagher, S., & Zahavi, D. (2012). Introduction: Philosophy of mind, cognitive science, and phenomenology. In *The phenomenological mind* (2nd ed., pp. 1-11). New York, NY: Routledge. doi:10.4324/9780203086599

Garet, M. S., Porter, A. C., Desimone, L. M., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915–945. doi:10.3102/00028312038004915

Gottfried, M. (2018). Teacher's aides in kindergarten: Effects on achievement for students with disabilities. *The Journal of Educational Research*, 111(5), 620-630. doi:10.1080/00220671.2017.1354174

Gregor, S., & Hevner, A. R. (2013). Positioning and presenting design science research for maximum impact. *Management Information Systems Quarterly, 37*(2), 1-26. doi:10.25300/MISQ/2013/37.2.01

Guskey, T. R. (2014). Planning professional learning. *Educational Leadership*, *71*(8), 10. doi:10.25300/MISQ/2013/37.2.01

Haager, D., & Vaughn, S. (2013). The common core state standards and reading: Interpretations and implications for elementary students with learning disabilities. *Learning Disabilities Research & Practice*, *28*(1), 5-16. doi:10.1111/ldrp.12000

Haghverdi, M., Semnani, A., & Seifi, M. (2012). The relationship between different kinds of students' errors and the knowledge required to solve mathematics word problems. *Bolema, Rio Claro (SP), 26*(42b), 649-666. doi:10.1590/S0103-636X2012000200012

Hirsch, E. D. (2003). Reading comprehension requires knowledge of words and the world. *American Educator*, *27*(1), 10-13. Retrieved from https://www.aft:our-news/periodicals/american-educator

Hochberg, E. D., & Desimone, L. M. (2010). PD in the accountability context: Building capacity to achieve standards. *Educational Psychologist*, *45*(2), 89-106. doi:10.1080/00461521003703052

Horn, I., & Kane, B. (2015). Opportunities for professional learning in mathematics teacher workgroup conversations: Relationships to instructional expertise. *Journal of the Learning Sciences, 24*(3), 373-418. doi:10.1080/10508406.2015.1034865

Houghton, C., Casey, D., Shaw, D., & Murphy, K. (2013). Rigour in qualitative case-study research. *Nurse Researcher, 20*(4), 12-17. doi:10.7748/nr2013.03.20.4.12.e326

Huang, T., Liu, Y., & Chang, H. (2012). Learning achievement in solving word-based mathematical questions through a computer-assisted learning system. *Educational Technology & Society, 15*(1), 248-259. Retrieved from http://www.j-ets.net/ETS/journals/15_1/22.pdf

Hughes, E. M., Witzel, B. S., Riccomini, P. J., Fries, K. M., & Kanyongo, G. Y. (2014). A meta-analysis of Algebra interventions for learners with disabilities and struggling learners. *Journal of the International Association of Special Education*, *15*(1), 36-47. Retrieved from http://www.iase.org/Publications/JIASE%202014%20.

Hurrell, D. P. (2013). What teachers need to know to teach mathematics: An argument for a reconceptualised model. *Australian Journal of Teacher Education*, *38*(11), 54-64. doi:10.14221/ajte.2013v38n11.3

Irvine, A., Drew, P., & Sainsbury, R. (2013). ‘Am I not answering your questions properly?’ Clarification, adequacy, and responsiveness in semi-structured telephone and face-to-face interviews. *Qualitative Research*, *13(*1), 87-106. doi:10.1177/1468794112439086

Jennings, J. (2012). *Reflections on a half-century of school reform: Why have we fallen short and where do we go from here? Center on Education Policy*. 1-12. Retrieved from https://files.eric.ed.gov/fulltext/ED528905.pdf

Jitendra, A., DiPipi, C. M., & Perron-Jones, N. (2002). An exploratory study of schema-based word-problem-solving instruction for middle school students with learning disabilities an emphasis on conceptual and procedural understanding. *The Journal of Special Education*, *36*(1), 23-38. doi:10.1177/00224669020360010301

Kablan, Z. (2016). The effect of manipulatives on mathematics achievement across different learning styles. *Educational Psychology*, *36*(2), 277-296. doi:10.1080/01443410.2014.946889

Kajamies, A., Vauras, M., & Kinnunen, R. (2010). Instructing low-achievers in mathematical word problem-solving. *Scandinavian Journal of Educational Research, 54*(4), 335-355. doi:10.1080/0031831.2010.493341.

Karatas, I., & Baki, A. (2013). The effect of learning environments based on problem solving on students' achievements of problem solving. *International Electronic Journal of Elementary Education, 5*(3), 249-268. Retrieved from http://iejee.com/index.php/IEJEE/article/view/25/23

Kaya, D., Izgiol, D., & Kesan, C. (2014). The investigation of elementary mathematics teachers' candidates' problem solving skills according to various variables. *International Electronic Journal of Elementary Education*, *6*(2), 295-314.

Retrieved from http://iejee.com/index.php/IEJEE/article/view/46/44

Kober, N., & Rentner, D. S. (2012). Year two of implementing the common core state standards: States' progress and challenges. *Center on Education Policy, 1-13*. Retrieved from https://files.eric.ed.gov/fulltext/ED528907.pdf

Krawec, J., & Montague, M. (2014). The role of teacher training in cognitive strategy instruction to improve math problem solving. *Learning Disabilities Research & Practice*, *29*(3), 126-134. doi:10.1111/ldrp.12034

Krawec, J., Huang, J., Montague, M., Kressler, B., & Melia de Alba, A. (2012). The effects of cognitive strategy instruction on knowledge of math problem-solving processes of middle school students with learning disabilities. *Learning Disability Quarterly*, *36*(2), 80-92. doi:10.1177/0731948712463368

Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T., & Hachfeld, A. (2013). Professional competence of teachers: Effects on instructional quality and student development. *Journal of Educational Psychology*, *105*(3), 805-820.doi:10.1037/a0032583

Lampert, M. (1985). How do teachers manage to teach? Perspectives on problems in practice. *Harvard Educational Review*, *55*(2), 178-195. doi:10.17763/haer.55.2.56142234616x4352

Lattuca, L. R., Bergom, I., & Knight, D. B. (2014). Professional development, departmental contexts and use of instructional strategies. *Journal of Engineering Education*, *103*(4), 549-572. doi:10.1002/jee.20055

Lauer, P. A., Christopher, D. E., Firpo-Triplett, R., & Buchting, F. (2014). The impact of short-term professional development on participant outcomes: a review of the literature. *Professional Development in Education, 40*(2), 207-227. doi:10.1080/19415257.2013.776619

Lodico, M., Spaulding, D., & Voegtle, K. (2010). *Methods in educational research: From theory to practice.* San Francisco, CA: Jossey-Bass.

Lui, A., & Bonner, S. (2016). Preservice and inservice teachers' knowledge, beliefs, and instructional planning in primary school mathematics. *Teaching and Teacher Education, 56*, 1-13. doi:10.1016/j.tate.2016.01.015

Marchis, I. (2011). How mathematics teachers develop their pupils' self-regulated learning skills. *E-Acta Didactica Napocensia, 4*(2-3), 9-14. Retrieved from http://adn.teaching.ro/

Marrongelle, K., Sztajn, P., & Smith, M. (2013). Scaling up professional development in an era of common state standards. *Journal of Teacher Education, 64*(3), 202–211. doi:10.1177/0022487112473838

Martin, S., Shaw, E., & Daughenbaugh, L. (2014). Using smart boards and manipulatives in the elementary science classroom. *Techtrends: Linking Research & Practice to Improve Learning, 58*(3), 90-96. doi:10.1007/s11528-014-0756-3

Maryland State Department of Education. (2014). Programs: Common core state standards. Retrieved from http://mdk12.msde.maryland.gov/instruction/curriculum/mathematics/index.html

Maryland State Department of Education. (2015a). The fact book 2014-2015: A statistical handbook. Retrieved from http://marylandpublicschools.org/about/Documents/DBS/FactBook/FactBook20142015.pdf

Maryland State Department of Education. (2015b). School improvements in Maryland. Retrieved from http://mdk12.msde.maryland.gov/instruction/curriculum/mathematics/index.html

Maryland State Department of Education. (2016). School systems. Retrieved from http://reportcard.msde.maryland.gov/SchoolsList/index

Maryland State Department of Education. (2017). School systems. Retrieved from http://reportcard.msde.maryland.gov/SchoolsList/index

McDonough, A., & Sullivan, P. (2014). Seeking insights into young children's beliefs about mathematics and learning. *Educational Studies in Mathematics*, *87*(3), 279-296. doi:10.1007/s10649-014-9565-z

McDonnell, L. M., & Weatherford, M. S. (2013). Evidence use and the common core state standards movement: From problem definition to policy adoption. *American Journal of Education*, *120*(1), 1-25. doi:10.1086/673163

McGee, J. R., Wang, C., & Polly, D. (2013). Guiding teachers in the use of a standards-based mathematics curriculum: Teacher perceptions and subsequent instructional practices after an intensive professional development program. *School Science and Mathematics*, *113*(1), 16-28. doi:10.1111/j.1949-8594.2012.00172.x

McNeill, K. L., & Knight, A. M. (2013). Teachers' pedagogical content knowledge of scientific argumentation: The impact of professional development on K–12 teachers. *Science Education*, *97*(6), 936-972. doi:10.1002/sce.21081

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass.

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). San Francisco, CA: Jossey-Bass.

Miles, M. B., Huberman, A. M., & Saldana, J. (2013). Research design and management. In *Qualitative data analysis: A methods sourcebook* (3rd ed., pp. 17-55). Thousand Oaks, CA: SAGE.

Motlhabane, A. (2013). Reflective practice through reflecting writing: A case involving mathematics and science teachers. *Mediterranean Journal of Social Sciences, 4*(14), 263-268. doi:10.5901/mjss.2013.v4n14p263

Moyer-Packenham, P. S., Salkind, G., & Bolyard, J. J. (2008). Virtual manipulatives used by K-8 teachers for mathematics instruction: Considering mathematical, cognitive, and pedagogical fidelity. *Contemporary Issues in Technology and Teacher Education, 8*(3), 202-218. doi:10.1177/1053451216644830

National Assessment of Educational Progress. (2015). *The nation's report card: Mathematics at Grades 4 and 8*. Retrieved from http://www.nationsreportcard.gov/glossary.aspx

National Center for Education Statistics. (2012). *The condition of education 2012.* (NCES 2011-045). Washington, DC: U.S. Department of Education. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2012045

National Center for Education Statistics. (2016). *The condition of education 2016*. (NCES 2015-144). Washington, DC: U.S. Department of Education. Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2016144

National Center for Education Statistics. (2017). *The condition of education 2017*. (NCES 2016-144). Washington, DC: U.S. Department of Education. Retrieved from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2017144

National Council of Teachers of Mathematics. (2013). Principles to action: Executive summary. Retrieved from https://www.nctm.org/uploadedFiles/Standards_and_Positions/PtAExecutiveSummary.pdf

Neuman, S. B., & Roskos, K. (2013). Why Common Core matters: What parents need to know. *The reading teacher*, *67*(1), 9-11. doi:10.1002/TRTR.1186

Nieveen, N., & Folmer, E. (2013). Formative evaluation in educational design research. In T. Plomp & N. Nieveen (Eds.), *Educational Design Research* (pp. 152-169). Retrieved from http://downloads.slo.nl/Documenten/educational-design-research-part-a.pdf

Nguyen, T., Watts, T., Duncan, G. J., Clements, D. H., Sarama, J. S., Wolfe, C., & Spitler, M. E. (2016). Which preschool mathematics competencies are most predictive of fifth grade achievement? *Early Childhood Research Quarterly*, *36*, 550-560. doi:10.1016/j.ecresq.2016.02.003

Oleson, A., & Hora, M. T. (2014). Teaching the way they were taught? Revisiting the sources of teaching knowledge and the role of prior experience in shaping faculty teaching practices. *Higher Education*, *68*(1), 29-45. doi:10.1007/s10734-013-9678-9

Palmer, J., Boon, R., & Spencer, V. (2014) Effects of concept mapping instruction on the vocabulary acquisition skills of seventh-graders with mild disabilities: A replication study. *Reading & Writing Quarterly, 30*(2), 165-182. doi:10.1080/10573569.2013.818890

Pape, S. J. (2004). Middle school children's problem-solving behavior: A cognitive analysis from a reading comprehension perspective. *Journal for Research in Mathematics Education*, *35*(3), 187-219. doi: 10.2307/30034912

Parsons, P., & Sedig, K. (2014). Distribution of information processing while performing complex cognitive activities with visualization tools. In W. Huang (Ed.), *Handbook of human centric visualization* (pp. 693-715). New York, NY: Springer. doi:10.1007/978-1-4614-7485-2_28

Passolunghi, M. C., & Cornoldi, C. (2008). Working memory failures in children with arithmetical difficulties. *Child Neuropsychology*, *14*(5), 387-400. doi:10.1080/09297040701566662

Pearce, D., Bruun, F., Skinner, K., & Lopez-Mohler, C. (2014). What teachers say about student difficulties solving mathematical word problems in grade 2-5. *International Electronic Journal of Mathematical Education, 8*(1), 3-19. Retrieved from http://www.iejme.com/download/what-teachers-say-about-student-difficulties-solving-mathematical-word-problems-in-grades-2-5.pdf

Pierce, M. E., & Fontaine, L. M. (2009). Designing vocabulary instruction in mathematics. *The Reading Teacher*, *63*(3), 239-243. doi:10.1598/RT.63.3.7

Programme for International Student Assessment. (2015). *Collaborative problem-solving* *skills of 15-year-olds: Results from PISA 2015*. Retrieved from http://nces.ed.gov/pubs2017/2017249.pdf

Poison, P. G., & Jeffries, R. (2014). Instruction in general problem-solving skills: An analysis of four approaches. In J. Segal, S. Chipman, & R. Glaser (Eds.), *Thinking and learning skills: Volume 1: Relating instruction to research* (pp. 417-458). New York, NY: Routledge.

Polly, D., McGee, J. R., Wang, C., Lambert, R. G., Pugalee, D. K., & Johnson, S. (2013). The association between teachers' beliefs, enacted practices, and student learning in mathematics. *Mathematics Educator*, *22*(2), 11-30. Retrieved from http://tme.journals.libs.uga.edu/index.php/tme/article/view/253/240

Polly, D., Neale, H., & Pugalee, D. K. (2014). How does ongoing task-focused mathematics professional development influence elementary school teachers' knowledge, beliefs, and enacted pedagogies? *Early Childhood Education Journal*, *42*(1), 1-10. doi:10.1007/s10643-013-0585-6

Polya, G. (1957). In the classroom. In *How to solve it: A new aspect of mathematical method* (2nd ed., pp. 1-29). Princeton, NJ: Princeton University Press.

Powell, S. R., Fuchs, L. S., & Fuchs, D. (2013). Reaching the mountaintop: Addressing the common core standards in mathematics for students with mathematics difficulties. *Learning Disabilities Research & Practice*, *28*(1), 38-48. doi:10.1111/ldrp.12001

Pungut, M. H. A., & Shahrill, M. (2014). Students' English language abilities in solving mathematics word problems. *Mathematics Education Trends and Research*, *2014*(48), 1-11. doi:10.5899/2014/metr-00048

Riccomini, P. J., Smith, G. W., Hughes, E. M., & Fries, K. M. (2015). The language of mathematics: The importance of teaching and learning mathematical vocabulary. *Reading & Writing Quarterly, 31*(3), 235-252. doi:10.1080/10573569.2015.1030995

Rode, C., Robson, R., Purviance, A., Geary, D., & Mayr, U. (2014). Is working memory training effective? A Study in a school setting. *PLoS ONE, 9*(8), 1-8. doi:10.1371/journal.pone.0104796

Ronfeldt, M., Farmer, S. O., McQueen, K., & Grissom, J. A. (2015). Teacher collaboration in instructional teams and student achievement. *American Educational Research Journal*, *52*(3), 475-514. doi:10.3102%2F0002831215585562

Root, J., Browder, D., Saunders, A., & Lo, Y. (2017). Schema-based instruction with concrete and virtual manipulatives to teach problem-solving to students with autism. *Remedial and Special Education*, *38*(1), 42-52. doi:10.1177%2F0741932516643592

Sakshaug, L. E., & Wohlhuter, K. A. (2010). Journey toward teaching mathematics through problem-solving. *School Science and Mathematics, 110*(8), 397-409. doi:10.1111/j.1949-8594.2010.00051.x

Samson, J. F., & Collins, B. A. (2012). Growing numbers of ELL students in the United States. In *Preparing all teachers to meet the needs of English language learners: Applying research to policy and practice for teacher effectiveness* (pp. 4-8).

Retrieved from https://cdn.americanprogress.org/wp-content/uploads/issues/2012/04/pdf/ell_report.pdf

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.), *Handbook for research on mathematics teaching and learning* (pp. 334-370). New York, NY: MacMillan.

Shaha, S. H., Glassett, K. F., & Ellsworth, H. (2015). Long-term impact of on-demand professional development on student performance: A longitudinal multi-state study. *Journal of International Education Research, 11*(1), 29-34. doi:10.19030/jier.v11i1.9096

Shin, M., Bryant, D. P., Bryant, B. R., McKenna, J. W., Hou, F., & Ok, M. W. (2017). Virtual manipulatives: Tools for teaching mathematics to students with learning disabilities. *Intervention in School and Clinic, 52*(3), 148-153. doi:10.1177%2F1053451216644830

Singer, F., & Voica, C. (2013). A problem-solving conceptual framework and its implications in designing problem-posing tasks. *Educational Studies in Mathematics, 83*(1), 9-26. doi:10.1007/s10649-012-9422

Stevens, T., Aguirre-Munoz, Z., Harris, G., Higgins, R., & Liu, X. (2013). Middle-level mathematics teachers' self-efficacy growth through professional development: Differences based on mathematical background. *Australian Journal of Teacher Education (Online), 38*(4), 144. doi:10.14221/ajte.2013v38n4.3

Stewart, C. (2014). Transforming professional development to professional learning.

Journal of Adult Education, *43*(1), 28-33. Retrieved from http://files.eric.ed.gov/fulltext/EJ1047338.pdf

Sun, M., Penuel, W. R., Frank, K. A., Gallagher, H. A., & Youngs, P. (2013). Shaping professional development to promote the diffusion of instructional expertise among teachers. *Educational Evaluation and Policy Analysis, 35*(3), 344–369. doi:10.3102%2F0162373713482763

Swanson, H. (2015). Cognitive strategy interventions improve word problem solving and working memory in children with math disabilities. *Frontiers in Psychology, 6*(1099), 1-13. doi:10.3389/fpsyg.2015.01099

Swanson, H., Moran, A., Lussier, C., & Fung, W. (2014). The effect of explicit and direct generative strategy training and working memory on word problem-solving accuracy in children at risk for math difficulties. *Learning Disability Quarterly*, *37*(2), 11-123. doi:10.1177%2F0731948713507264

Taton, J. A. (2015). Much more than it's cooked-up to be: Reflections on doing math and teachers' professional learning. *Penn GSE Perspectives on Urban Education*, *12*(1), 1-14. Retrieved from http://www.urbanedjournal.org

Tienken, C. H., & Mullen, C. A. (2014). The curious case of international student assessment: Rankings and realities in the innovation economy. In S. Harris & J. Mixon (Eds.), *Building cultural community through global educational leadership (pp.* 146-164). Beaumont, TX: NCPEA..

Tzohar-Rozen, M., & Kramarski, B. (2014). Metacognition, motivation, and emotions: Contribution of self-regulated learning to solving mathematical problems. *Global*

Education Review, 1(4). 76-95. Retrieved from http://ger.mercy.edu/index.php/ger/issue/view/15

Van Beek, J. A., De Jong, F. P. C. M., Minnaert, A. E. M. G., & Wubbels, T. (2014). Teacher practice in secondary vocational education: Between teacher-regulated activities of student learning and student self-regulation. *Teaching and Teacher Education*, *40*, 1-9. doi:10.1016/j.tate.2014.01.005

Verschaffel, L., & De Corte, E. (1997). Word problems: A vehicle for promoting authentic mathematical understanding and problem solving in the primary school? In T. Nunes & P. Bryant (Eds.), *Learning and teaching mathematics: An international perspective* (pp. 69-97). Hove, England: Psychology Press/Erlbaum (UK) Taylor & Francis.

Verzosa, D. B., & Mulligan, J. (2013). Learning to solve addition and subtraction word problems in English as an imported language. *Educational Studies in Mathematics, 82*(2), 223-244. doi:10.1007/s10649-012-9420-z

Vesel, J., & Robillard, T. (2013). Teaching mathematics vocabulary with an interactive signing math dictionary. *Journal of Research on Technology in Education, 45*(4), 361-389. doi:10.1080/15391523.2013.10782610

Voyer, D. (2011). Performance in mathematical problem solving as a function of comprehension and arithmetic skills. *International Journal of Science and Mathematics Education, 9*(5), 1073-1092. doi:10.1007/s10763-010-9239-y

Vula, E., Avdyli, R., Berisha, V., Saqipi, B., & Elezi, S. (2017). The impact of metacognitive strategies and self-regulating processes of solving math word problems. *International Electronic Journal of Elementary Education*, *10*(1), 49-59. doi:10.26822/iejee.2017131886

Witt, M. (2010). Cognition in children's mathematical processing: bringing psychology to the classroom. *Electronic Journal of Research in Educational Psychology*, *8*(3), 945-970. doi:10.25115/ejrep.v8i22.1454

Wright, T. S., & Neuman, S. B. (2014). Paucity and disparity in kindergarten oral vocabulary instruction. *Journal of Literacy Research*, *46*(3), 330-357. doi:10.1177%2F1086296X14551474

Yee, S., & Bostic, J. (2014). Developing a contextualization of students' mathematical problem solving. *The Journal of Mathematical Behavior*, *36*, 1-19. doi:10.1016/j.jmathb.2014.08.002

Yin, R. K. (2011). *Qualitative research from start to finish* (2nd ed.) New York, NY: Guilford Press.

Zhang, S. (2014). New teachers' implementation of the common core state standards. *Action in Teacher Education*, *36*(5-6), 465-479. doi:10.1080/01626620.2014.977745

Zhu, N. (2015). Cognitive strategy instruction for mathematical word problem solving of students with mathematics disabilities in China. *International Journal of Disability, Development, and Education*, *62*(6), 608-627. doi:10.1080/1034912X.2015.1077935

Appendix A: The Project

Implementing the 3-Day Professional Development Training for Elementary Educators

The 3-day PD project focusses on increasing teachers' knowledge of Common Core math standards, improving standards-based lesson planning, and ways of enhancing students' math vocabulary. The goal of the project is to educate teachers on Common Core math standards, provide guidance in developing detailed standards-based lesson plans, and to create activities and lessons that will increase students' math vocabulary knowledge, which can help to increase underachieving students' word problem-solving ability.

Purpose

The purpose of the PD training is to provide elementary math teachers with Common Core math standards and best practices to use in developing lesson plans and activities that can increase students' math vocabulary knowledge. Participants will learn how to create lesson plans to use during the academic school year. The lesson plans will be used as a guide for math instruction that will help to increase students who struggle with understanding how to solve word problems.

Target Audience

The target audience for this PD training is elementary teachers. Participants are classroom math general education or special education teachers and other support teachers who teach from Grades K-5.

Goals for Professional Development Training

1. Increase teachers' understanding of the CCSSM;
2. Enhance teachers' effectiveness in developing CCSSM lesson plans; and
3. Increase teachers' effectiveness in developing math vocabulary activities using various types of resources.

Learning Outcomes

The learning outcomes for this PD training enables participants to understand the Common Core math standards, create math vocabulary learning activities, and develop standards-based math lesson plans. Teachers will have the opportunity to achieve an in-depth understanding of what Common Core math standards are and how to address the standards in their teaching. These outcomes are critical for ensuring that teachers can conduct standards-based instructional lessons to increase students' word problem-solving learning. Additionally, the resources, strategies, and planning session presented during the PD will grant teachers the opportunity to create math vocabulary lessons and activities which can be used collectively or independently by teachers during the academic school year.

Timeline

The timeline for this PD is three consecutive days during summer break. The workshop will take place from 8:30-3:30 each day. Lunch and unscheduled breaks are provided. Each day participants engage in whole group and small group sessions. Small groups sessions are grade-level specific. During Day 1, teachers will engage in learning the importance of mathematical word problem-solving. The teachers will learn about the researcher's study, strategies for completing a Problems-Solving pretest, problem-solving instruction and students performance through the use of an article reading and discussion, and completing an Exit Ticket evaluation. During Day 2, teachers will engage in learning about math vocabulary resources and strategies, and the CCSSM. The teachers will learn how to locate and use math vocabulary resources, Common Core math standards, various strategies to complete a problem-solving posttest, and engage in collaborative discussion of the day's learning, and complete an Exit Ticket evaluation. During Day 3 teachers will learn how to work collaboratively to develop standards-based instructional lesson plans. The teachers will learn the importance of implementing the best strategy for solving word problems based on the problem-solving pretest and posttest results, selecting and using math standards to develop math lesson plans, discussing the day's learning, and completing the PD evaluation.

3-Day *Learning to Word Problem-Solve* Professional Development Training

Day 1: Problem-Solving

8:30- 9:00: Facilitator and participants introduce themselves. Participants will independently complete and Ice Breaker activity, using a marker and index card to list two ways they teach students to solve word problems.

Facilitator Notes: Please use participants responses on this activity as the discussion for Day 1, Activity 3.

9:00-10:00: Activity 1: Facilitator introduces her research study, the study findings, and the need for PD training for elementary teachers.

10:00-10:45: Activity 2: Math word problem-solving pretest administered by the facilitator.

Facilitator Notes: After teachers complete the test, discuss with participants the reasons for administering the test and what they experienced while completing the pretest. The test results are discussed during Day 3, Activity 1.

10:45-12:15 Activity 3: County math presenter will present on the following topics: what is math word problem-solving, types of word problems, and strategies used to solve word problems. The presenter will show three short videos throughout the presentation.

- Types of Problems & Problem-Solving Strategies Free Educational Psychology Video https://www.youtube.com/watch?v=ftgtzFaHFGE (8:42)
- Problem-Solving Strategies https://www.youtube.com/watch?v=m3ZwlLTiNrI (8:51)
- Increasing Students' Math Problem-Solving, Grades 3-6, Part I: Core Problem-Solving Strategies https://www.youtube.com/watch?v=njdi5osKwmo (1:17)

Facilitator Notes: The presenter will provide participants with time to ask questions that may have surfaced during the day's activity, and time to discuss participants responses to the Ice Breaker activity.

12:15-1:15 Lunch (On your own)

1:15-3:00 Activity 4: Breakout session. The facilitator will instruct participants to break into small groups K-2 and 3-5. Each group will read and discuss a different article.

- Grade levels K-2 will read *A Meta-Analysis of Schema Instruction on the Problem-Solving Performance of Elementary School Students.*
- Grade levels 3-5 participants will read *The Impact of Metacognitive Strategies and Self-regulating Processes of Solving Math Word Problems*.

Each group of participants will present the findings of the article to the whole group. Teachers will be instructed to do the following:

- In your group, discuss the following questions. Use chart paper and markers provided to display your answers.
    - How does the author define problem-solving?
    - How does the information presented in the article prepare teachers for problem-solving instruction?
    - What types of instructional strategies did teachers implement during problem-solving instruction?
    - What are three ideas you can take away from the article that can aid you in word problem-solving instruction?

Facilitator Notes: Participants will be reminded to revisit the information (i.e., what is math word problem-solving, types of word problems, and strategies used to solve word problems) presented on Day 1 Activity Three, as a reference when answering the above questions. Also, the information that teachers present from these articles will be an introduction for Day 3 lesson planning.

3:00-3:30 Exit Ticket: Complete formative evaluation

Facilitators Notes: Before completing the evaluation, participants and presenters will discuss teachers' learning from the day's activities.

Day 2: Math Vocabulary and Math Common Core Standards

8:30- 10:30 Activity 1: County math presenter will discuss strategies teachers can use when teaching students math vocabulary words. The presenter will also discuss and provide teachers with resources they can use to create lessons, activities, and games students can use to help enhance students' math vocabulary math.

The presenter will show a short video during the presentation.

- Literacy in Mathematics: Building Math Vocabulary and Word Problem Strategies (Virtual Tour) https://www.youtube.com/watch?v=epLd_mK2Oic (2:37)

Facilitator Notes: The presenter will provide participants with time to ask questions that may arise during the presentation.

10:30-12:00 Activity 2: Participants will break into groups based on grade level. Each group will create two math vocabulary activities, lessons, or games that students can use independently or in a small group.

Facilitator Notes: Include time for teachers to present their math vocabulary activity to the whole group for constructive feedback and new ideas.

12:00-1:00 Lunch (On your own)

1:00-2:30 Activity 3: Introduce the Common Core math standards. The county math coach (CMC) will discuss the purpose of CCSSM, and how to incorporate the standards into instructional lessons when creating lesson plans.

Videos include

- Common Core Math
  https://www.youtube.com/watch?v=k5p5pHi3Lwg (2:46)
- Three-Minute Video Explaining the Common Core State Standards
  https://www.youtube.com/watch?v=5s0rRk9sER0 (3:10)

The CMC will also discuss the eight teaching practices that should be a part of every math lesson.

- Establish mathematics goals to focus on student learning.
- Implement tasks that promote student reasoning and problem-solving.
- Use and connect mathematical representations.
- Facilitate meaningful mathematical discourse.
- Pose purposeful questions.
- Build procedural fluency from conceptual understanding.
- Support productive struggle in learning mathematics.

- Elicit and use evidence of student thinking.

Facilitator Notes: The presenter will provide participants with time to ask the questions surfaced during the session presentation.

2:30-3:00 Activity Four: Math Word Problem-Solving Posttest.

Facilitator Notes: After teachers complete the test, discuss with participants the reasons for administering the posttest and whether their experience changed from the pretest to the posttest. The test results are discussed during Day Three, Activity One.

3:00-3:30 Exit Ticket: Complete the Evaluation

Before completing the evaluation, participants and presenters will discuss what was learned from the day's activities.

Day 3: Lesson Planning

8:30-9:15 Activity One: Facilitator and participants will discuss the pretest and posttest results.

Facilitator Notes: Discuss the purpose of presenting these findings with the participants. Inform the participants that the purpose of the pretest and posttest discussion is to show whether the information presented during the sessions have contributed to improving teachers knowledge of implementing the appropriate problem-solving strategies to solve word problems.

9:15-11:00 Continuation from Day 2, Activity 3

Activity 2: Participants will break into groups K-2 and 3-5 to review Common Core math standards. Participants will choose and analyze three math standards covered during the school year for which they would like to create lesson plans to address. While in their groups, participants will discuss various problem-solving strategies they can use to incorporate into their Common Core lesson plans.

Facilitator Notes: Presenter will discuss with participants the need for using the county provided Curriculum Instructional Map (CIM) to identify the math areas that must be taught during the school year to prepare students for Partnership for Assessment of Readiness for College and Careers (PARCC) testing.

11:00-12:00 Lunch (On your own)

12:00-2:00 Activity 3: Participants will divide into groups based on their grade level to create 3 to 4 math lesson plans.

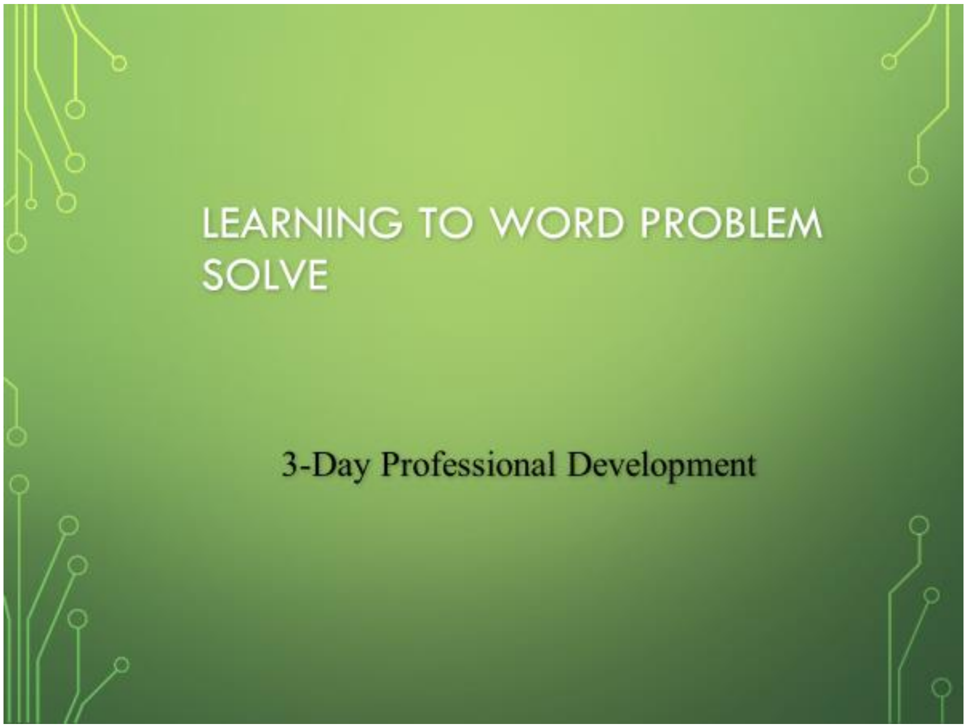
Facilitator Notes: Lesson plans must include various word problem-solving strategies, the eight teaching practices, and a math vocabulary activity. Participants will use what they learned from Day 2 Activity 4 to help them create their lesson plans.

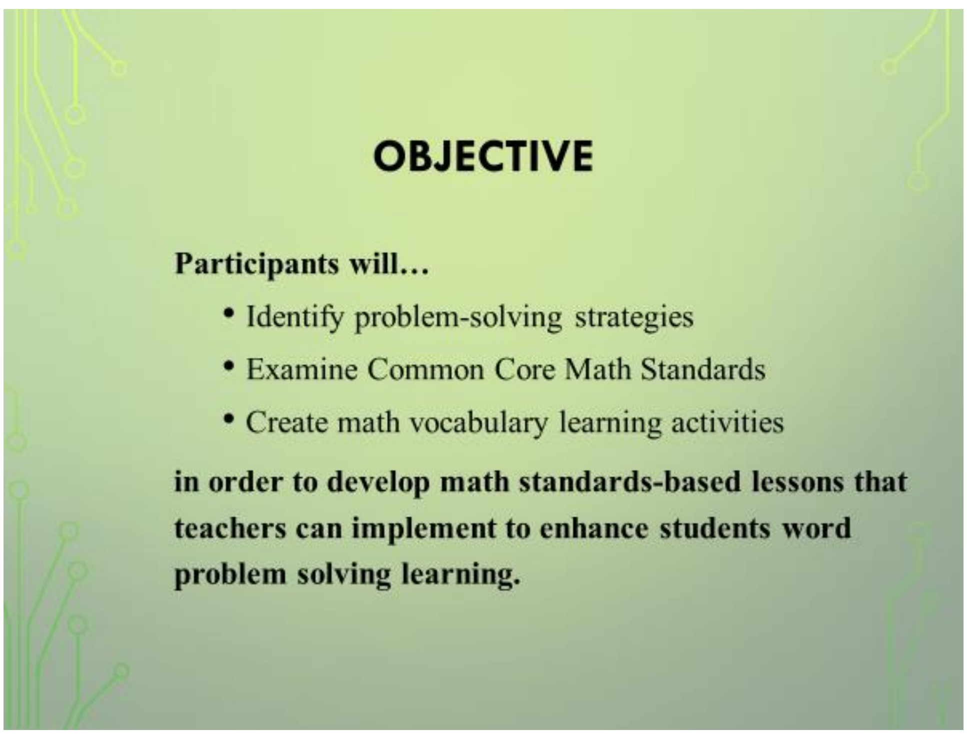
2:00-3:00 Activity 4: Participants return to a whole group setting. Each grade level group will present one lesson activity to the whole group.

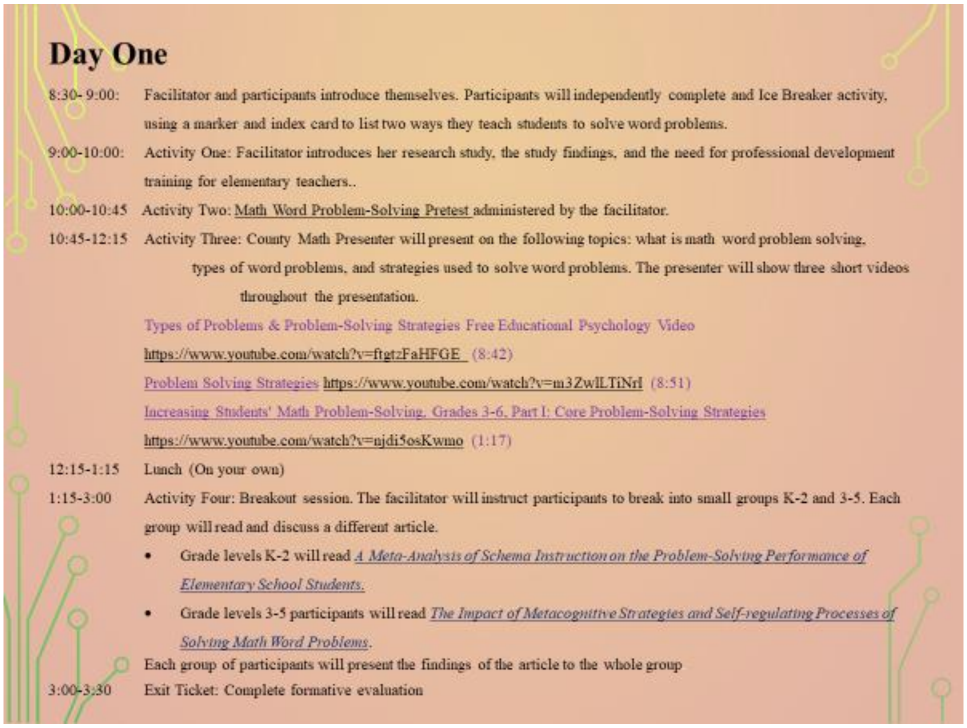
Facilitator Notes: Participants will comment and make constructive suggestions for improving the lesson.

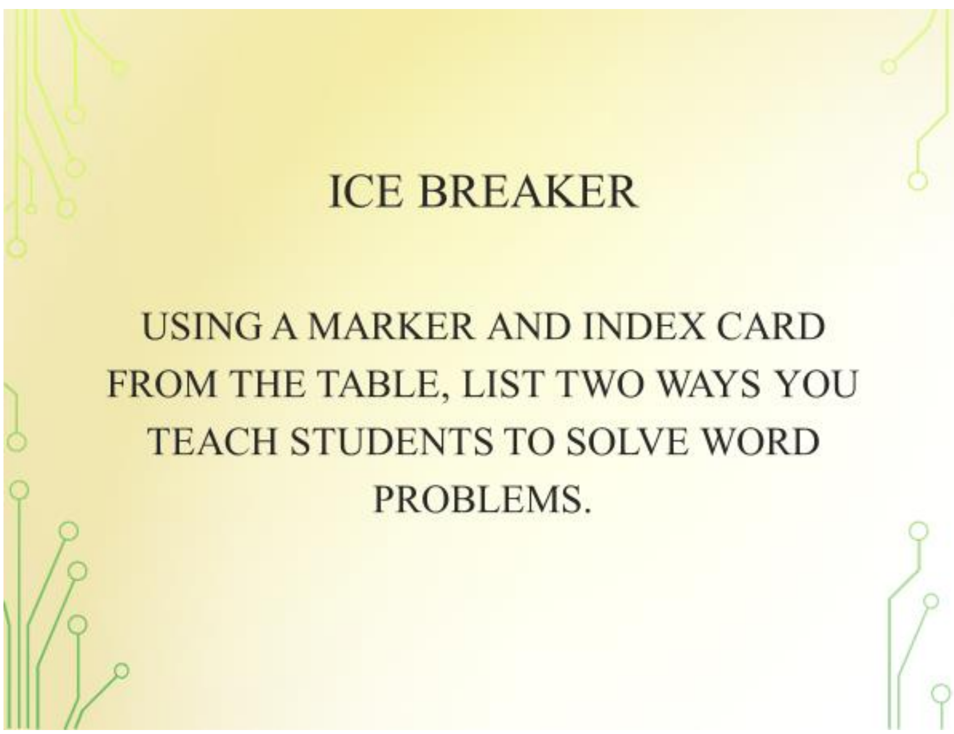
3:00-3:30 Exit Ticket: Complete the Evaluation

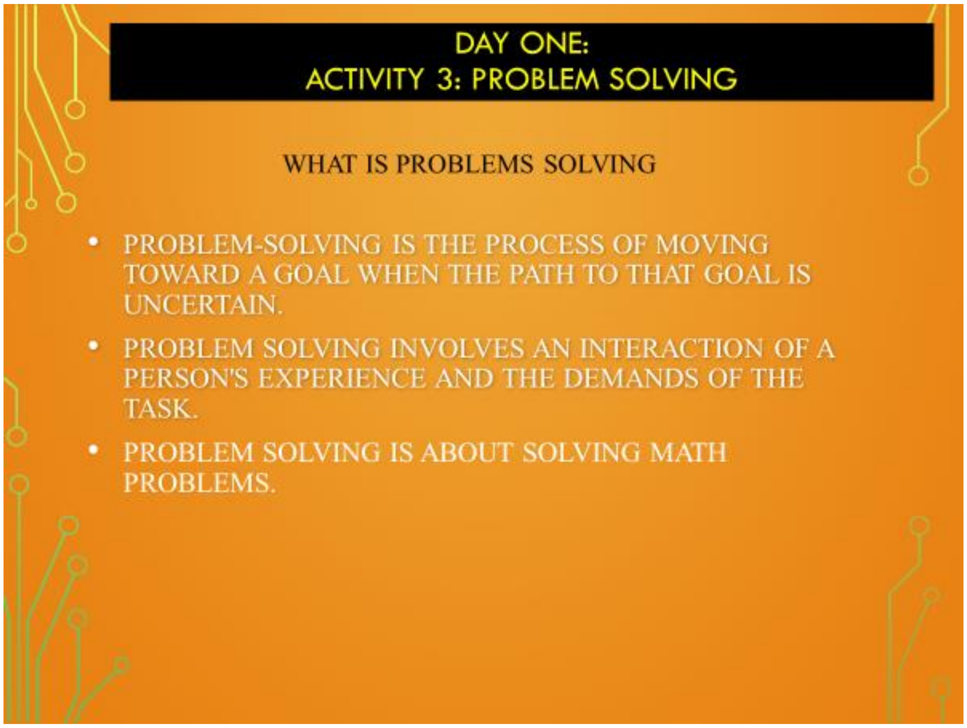
Facilitator Notes: Before completing the evaluation, participants and presenters will discuss what teachers learned from the day’s activities.

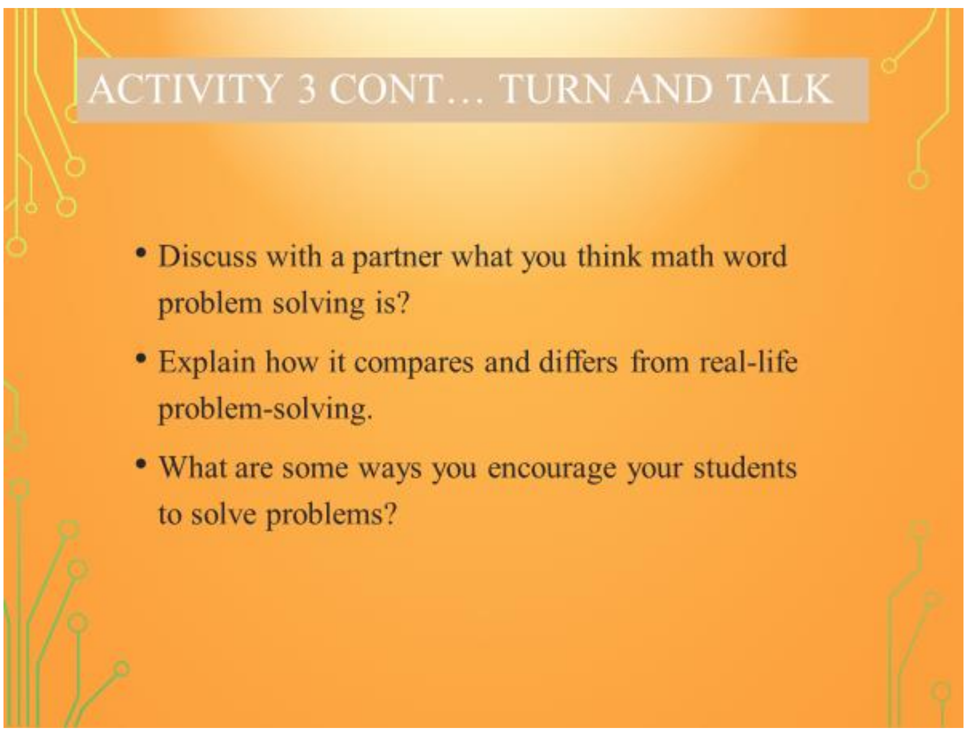

LEARNING TO WORD PROBLEM SOLVE
3-Day Professional Development

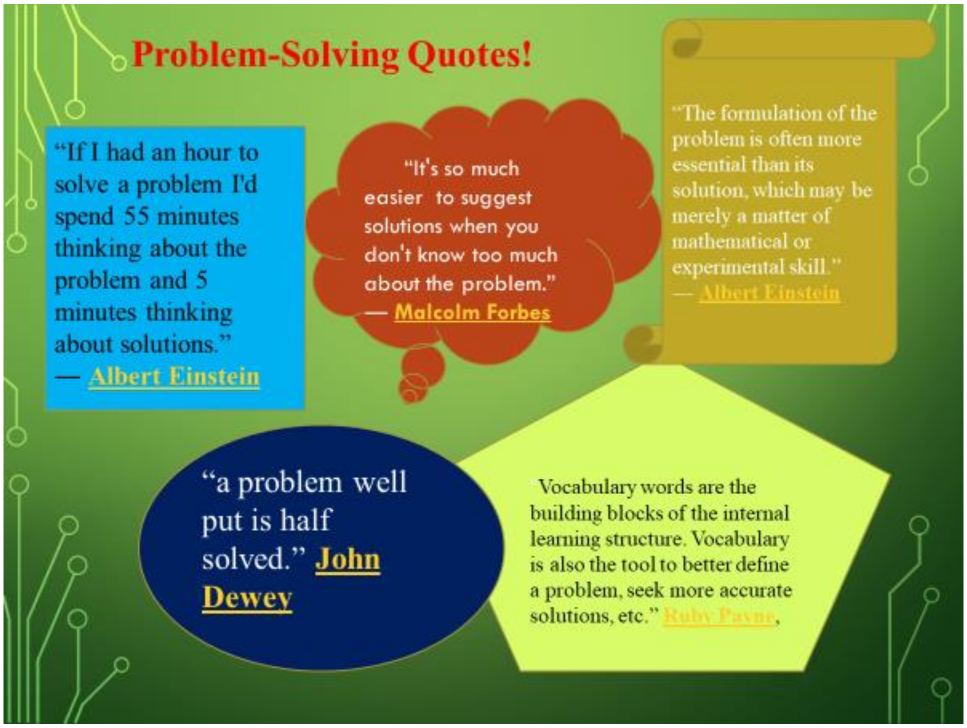

OBJECTIVE
Participants will…
• Identify problem-solving strategies
• Examine Common Core Math Standards
• Create math vocabulary learning activities
in order to develop math standards-based lessons that teachers can implement to enhance students word problem solving learning.

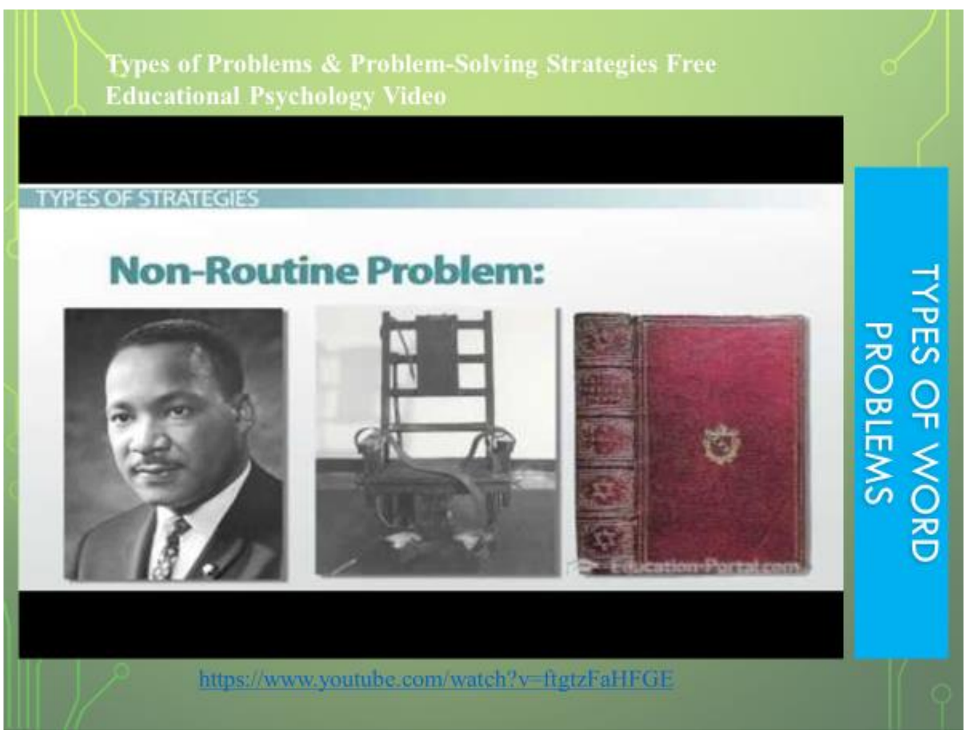

Day One
8:30- 9:00: Facilitator and participants introduce themselves. Participants will independently complete and Ice Breaker activity, using a marker and index card to list two ways they teach students to solve word problems.
9:00-10:00: Activity One: Facilitator introduces her research study, the study findings, and the need for professional development training for elementary teachers..
10:00-10:45 Activity Two: Math Word Problem-Solving Pretest administered by the facilitator.
10:45-12:15 Activity Three: County Math Presenter will present on the following topics: what is math word problem solving, types of word problems, and strategies used to solve word problems. The presenter will show three short videos throughout the presentation.
Types of Problems & Problem-Solving Strategies Free Educational Psychology Video
https://www.youtube.com/watch?v=ftgtzFaHFGE (8:42)
Problem Solving Strategies https://www.youtube.com/watch?v=m3ZwlLTiNrI (8:51)
Increasing Students' Math Problem-Solving, Grades 3-6, Part I: Core Problem-Solving Strategies
https://www.youtube.com/watch?v=njdi5osKwmo (1:17)
12:15-1:15 Lunch (On your own)
1:15-3:00 Activity Four: Breakout session. The facilitator will instruct participants to break into small groups K-2 and 3-5. Each group will read and discuss a different article.
• Grade levels K-2 will read A Meta-Analysis of Schema Instruction on the Problem-Solving Performance of Elementary School Students.
• Grade levels 3-5 participants will read The Impact of Metacognitive Strategies and Self-regulating Processes of Solving Math Word Problems.
Each group of participants will present the findings of the article to the whole group
3:00-3:30 Exit Ticket: Complete formative evaluation

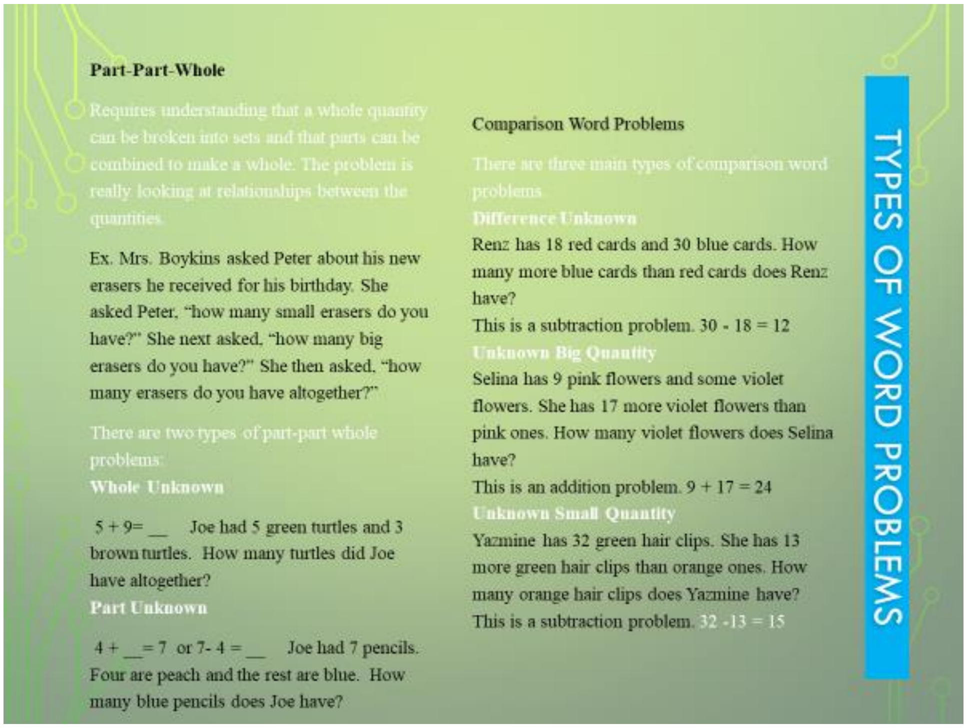

ICE BREAKER
USING A MARKER AND INDEX CARD FROM THE TABLE, LIST TWO WAYS YOU TEACH STUDENTS TO SOLVE WORD PROBLEMS.

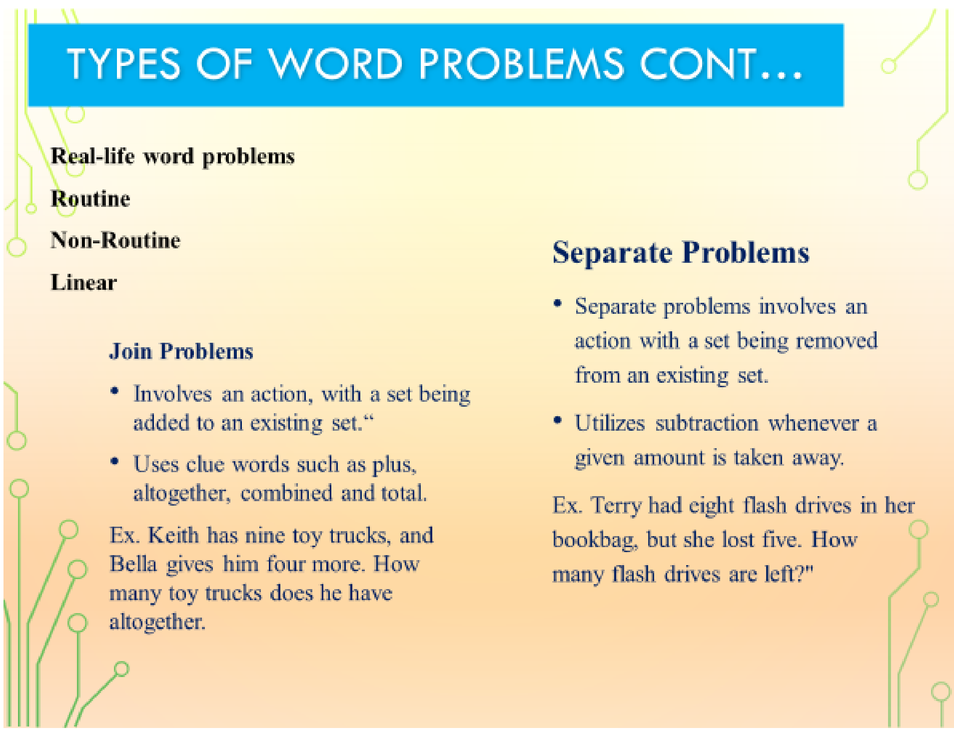

DAY ONE:
ACTIVITY 3: PROBLEM SOLVING
WHAT IS PROBLEMS SOLVING
• PROBLEM-SOLVING IS THE PROCESS OF MOVING TOWARD A GOAL WHEN THE PATH TO THAT GOAL IS UNCERTAIN.
• PROBLEM SOLVING INVOLVES AN INTERACTION OF A PERSON'S EXPERIENCE AND THE DEMANDS OF THE TASK.
• PROBLEM SOLVING IS ABOUT SOLVING MATH PROBLEMS.

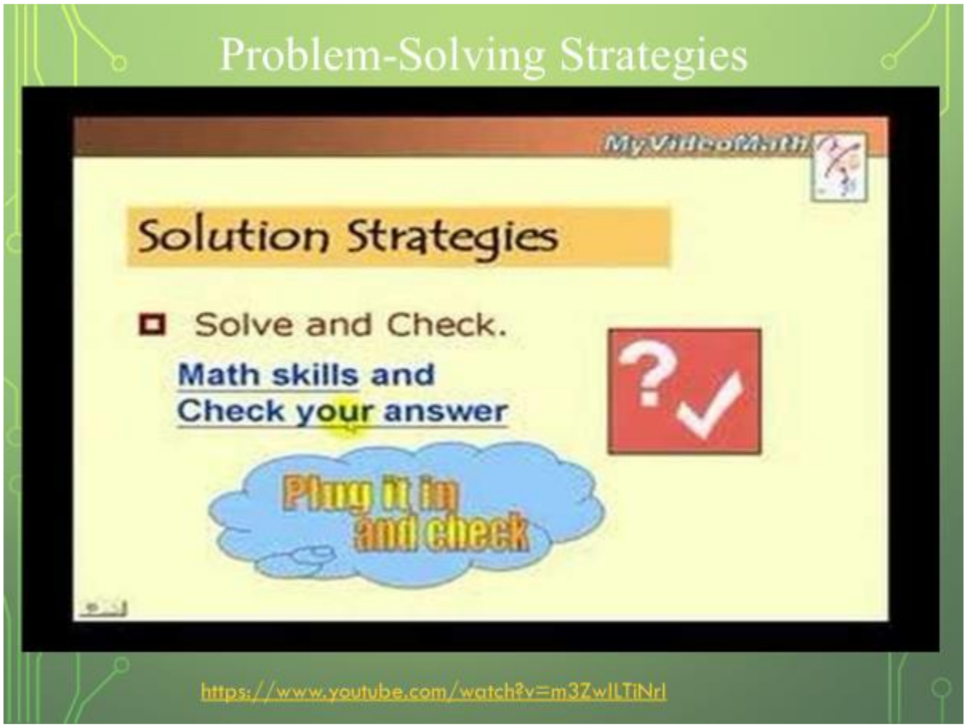

ACTIVITY 3 CONT… TURN AND TALK
• Discuss with a partner what you think math word problem solving is?
• Explain how it compares and differs from real-life problem-solving.
• What are some ways you encourage your students to solve problems?

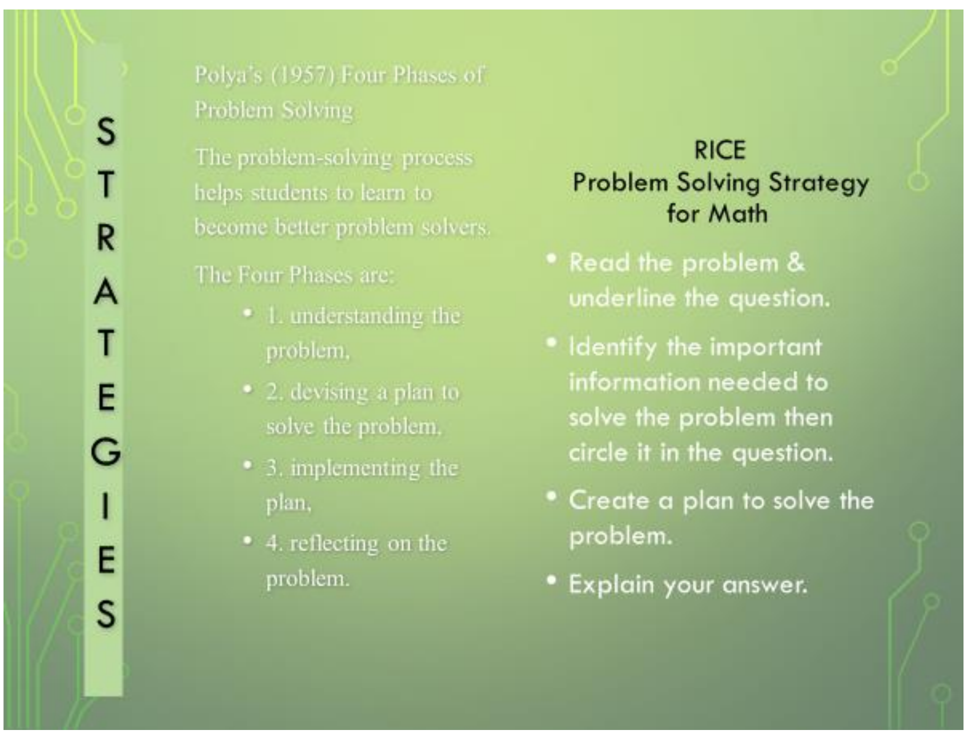

Problem-Solving Quotes!
"If I had an hour to solve a problem I'd spend 55 minutes thinking about the problem and 5 minutes thinking about solutions." — Albert Einstein
"It's so much easier to suggest solutions when you don't know too much about the problem." — Malcolm Forbes
"The formulation of the problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill." — Albert Einstein
"a problem well put is half solved." John Dewey
Vocabulary words are the building blocks of the internal learning structure. Vocabulary is also the tool to better define a problem, seek more accurate solutions, etc." Ruby Payne,

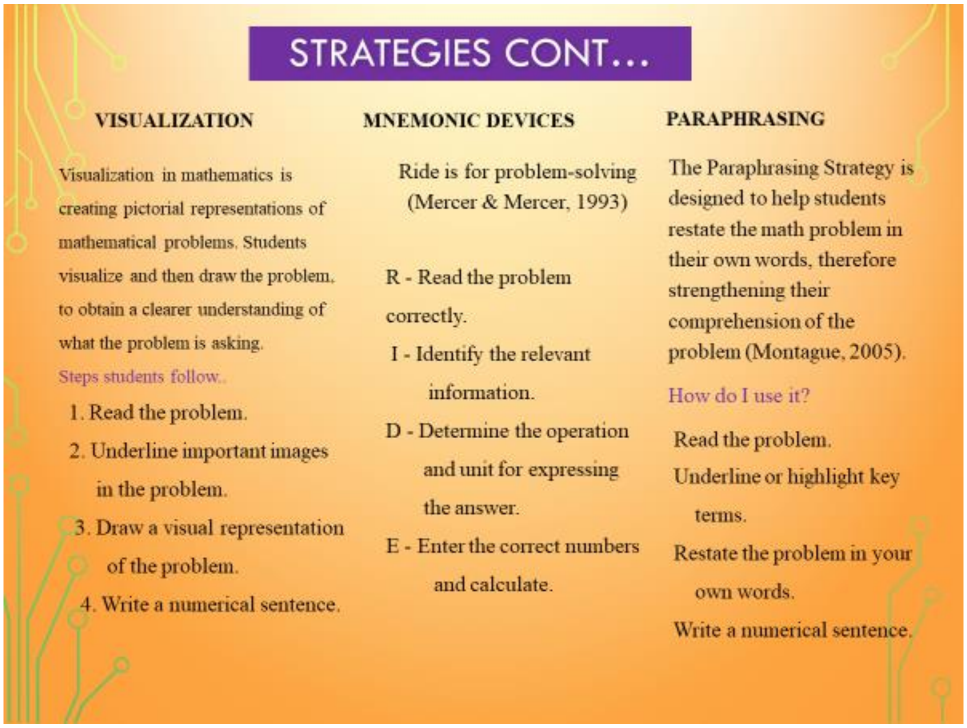

Types of Problems & Problem-Solving Strategies Free Educational Psychology Video
TYPES OF STRATEGIES
Non-Routine Problem:
Education-Portal.com
TYPES OF WORD PROBLEMS
https://www.youtube.com/watch?v=ftgtzFaHFGE

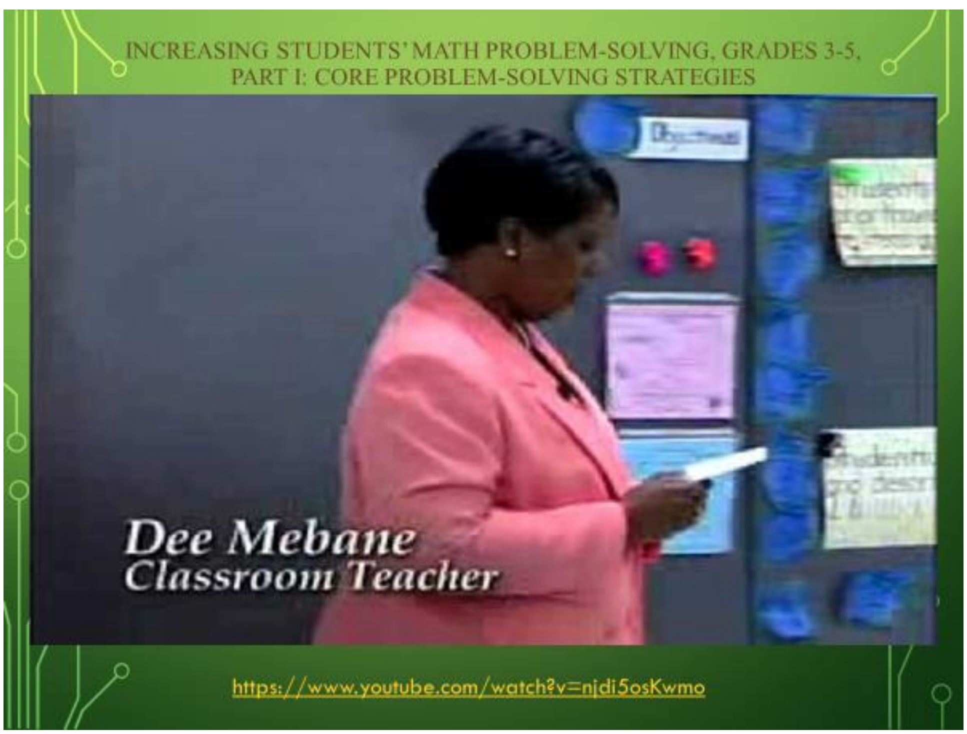

TYPES OF WORD PROBLEMS
Part-Part-Whole
Requires understanding that a whole quantity can be broken into sets and that parts can be combined to make a whole. The problem is really looking at relationships between the quantities.
Ex. Mrs. Boykins asked Peter about his new erasers he received for his birthday. She asked Peter, "how many small erasers do you have?" She next asked, "how many big erasers do you have?" She then asked, "how many erasers do you have altogether?"
There are two types of part-part whole problems:
Whole Unknown
5 + 9= __ Joe had 5 green turtles and 3 brown turtles. How many turtles did Joe have altogether?
Part Unknown
4 + __ = 7 or 7- 4 = __ Joe had 7 pencils. Four are peach and the rest are blue. How many blue pencils does Joe have?
Comparison Word Problems
There are three main types of comparison word problems.
Difference Unknown
Renz has 18 red cards and 30 blue cards. How many more blue cards than red cards does Renz have?
This is a subtraction problem. 30 - 18 = 12
Unknown Big Quantity
Selina has 9 pink flowers and some violet flowers. She has 17 more violet flowers than pink ones. How many violet flowers does Selina have?
This is an addition problem. 9 + 17 = 24
Unknown Small Quantity
Yazmine has 32 green hair clips. She has 13 more green hair clips than orange ones. How many orange hair clips does Yazmine have?
This is a subtraction problem. 32 -13 = 15


TYPES OF WORD PROBLEMS CONT…
Real-life word problems
Routine
Non-Routine
Linear
Join Problems
• Involves an action, with a set being added to an existing set."
• Uses clue words such as plus, altogether, combined and total.
Ex. Keith has nine toy trucks, and Bella gives him four more. How many toy trucks does he have altogether.
Separate Problems
• Separate problems involves an action with a set being removed from an existing set.
• Utilizes subtraction whenever a given amount is taken away.
Ex. Terry had eight flash drives in her bookbag, but she lost five. How many flash drives are left?"


Problem-Solving Strategies
MyVideoMath
Solution Strategies
Solve and Check.
Math skills and
Check your answer
Plug it in
and check
https://www.youtube.com/watch?v=m3ZwILTiNrI


STRATEGIES
Polya's (1957) Four Phases of Problem Solving
The problem-solving process helps students to learn to become better problem solvers.
The Four Phases are:
1. understanding the problem,
2. devising a plan to solve the problem,
3. implementing the plan,
4. reflecting on the problem.
RICE
Problem Solving Strategy
for Math
Read the problem & underline the question.
Identify the important information needed to solve the problem then circle it in the question.
Create a plan to solve the problem.
Explain your answer.


STRATEGIES CONT…
VISUALIZATION
Visualization in mathematics is creating pictorial representations of mathematical problems. Students visualize and then draw the problem, to obtain a clearer understanding of what the problem is asking.
Steps students follow..
1. Read the problem.
2. Underline important images in the problem.
3. Draw a visual representation of the problem.
4. Write a numerical sentence.
MNEMONIC DEVICES
Ride is for problem-solving (Mercer & Mercer, 1993)
R - Read the problem correctly.
I - Identify the relevant information.
D - Determine the operation and unit for expressing the answer.
E - Enter the correct numbers and calculate.
PARAPHRASING
The Paraphrasing Strategy is designed to help students restate the math problem in their own words, therefore strengthening their comprehension of the problem (Montague, 2005).
How do I use it?
Read the problem.
Underline or highlight key terms.
Restate the problem in your own words.
Write a numerical sentence.


INCREASING STUDENTS' MATH PROBLEM-SOLVING, GRADES 3-5, PART I: CORE PROBLEM-SOLVING STRATEGIES
Dee Mebane
Classroom Teacher
https://www.youtube.com/watch?v=njdi5osKwmo

STRATEGIES

SQR?

The SQR strategy involves expansion and discussion between teacher and students. These discussions often lead to a better student understanding of the problem. This strategy was developed to help students arrive at their own solutions through rich discussion.

- How do I use SQR?

Survey

Read the problem

Paraphrase in your own words Question

Question the purpose of the problem

What is being asked?

What are you ultimately trying to determine?

Read

Reread the question

Determine the exact information you are looking for

Eliminate unnecessary information

Prepare to devise a plan for solving the problem

DAY ONE: ACTIVITY 4: SMALL GROUP SESSION

GRADE LEVELS K-2 WILL READ A META-ANALYSIS OF SCHEMA INSTRUCTION ON THE PROBLEM-SOLVING PERFORMANCE OF ELEMENTARY SCHOOL STUDENTS.

GRADE LEVELS 3-5 PARTICIPANTS WILL READ THE IMPACT OF METACOGNITIVE STRATEGIES AND SELF-REGULATING PROCESSES OF SOLVING MATH WORD PROBLEMS.

IN YOUR GROUP, DISCUSS THE FOLLOWING QUESTIONS. USE CHART PAPER AND MARKERS PROVIDED TO DISPLAY YOUR ANSWERS

IN YOUR GROUP, DISCUSS THE FOLLOWING QUESTIONS. USE CHART PAPER AND MARKERS PROVIDED TO DISPLAY YOUR ANSWERS.

- How does the author define problem-solving?
- How does the information presented in the article prepare teachers for problem-solving instruction?
- What types of instructional strategies did teachers implement during problem solving instruction?
- What are three ideas you can take away from the article that can aid you in word problem solving instruction?

AGENDA: DAY TWO

Math Vocabulary and Math Common Core Standards

8:30- 10:30 Activity One: County Math Presenter will discuss strategies teachers can use when teaching students math vocabulary words. The presenter will also discuss and provide teachers with resources they can use to create lessons, activities, and games students can use to help enhance students' math vocabulary math.

The presenter will show a short video during the presentation.

Literacy in Mathematics: Building Math Vocabulary and Word Problem Strategies (Virtual Tour)

https://www.youtube.com/watch?v=epLd_mK2Oic (2:37)

10:30-12:00 Activity Two: Participants will break into groups based on grade level. Each group will create two math vocabulary activities, lessons, or games that students can use independently or in a small group.

12:00-1:00 Lunch (On your own)

1:00-2:30 Activity Three: Introduce the Common Core Math Standards. The CMC will discuss the purpose of CCSSM, and how to incorporate the standards into instructional lessons when creating lesson plans. The CMC will also discuss the NCTM eight teaching practices that should be a part of every math lesson.

Videos include

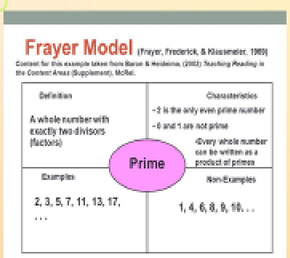
Common Core Math https://www.youtube.com/watch?v=k5p5pHi3Lwg (2:46)

Three-Minute Video Explaining the Common Core State Standards https://www.youtube.com/watch?v=5s0rRk9sER0 (3:10)

2:30-3:00 Activity Four: Math Word Problem Solving Posttest.

3:00-3:30 Exit Ticket: Complete the Evaluation

VOCABULARY STRATEGIES



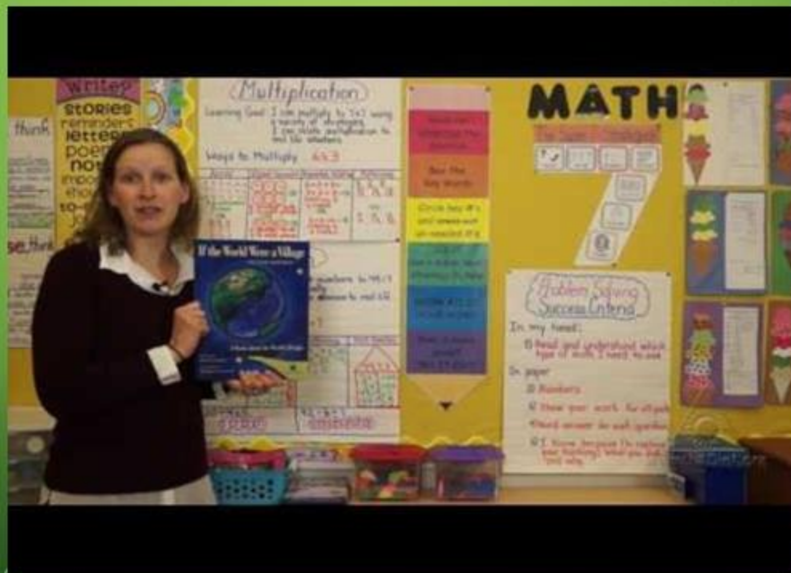
(Frayer, Frederick, & Klauseier, 1969)

Frayer Vocabulary Model

The Frayer model is a concept map which enables students to make relational connections with vocabulary words.

- How do you use it?
  - 1. Identify concept/vocabulary word.
  - 2. Define the word in your own words.
  - 3. List characteristics of the word.
  - 4. List or draw pictures of examples and non-examples of the word.

LITERACY IN MATHEMATICS: BUILDING MATH VOCABULARY AND WORD PROBLEMS STRATEGIES (2:37)



https://www.youtube.com/watch?v=epLd_mK2Oic

MATH VOCABULARY RESOURCES

http://www.math-play.com/Math-Vocabulary-Games.html

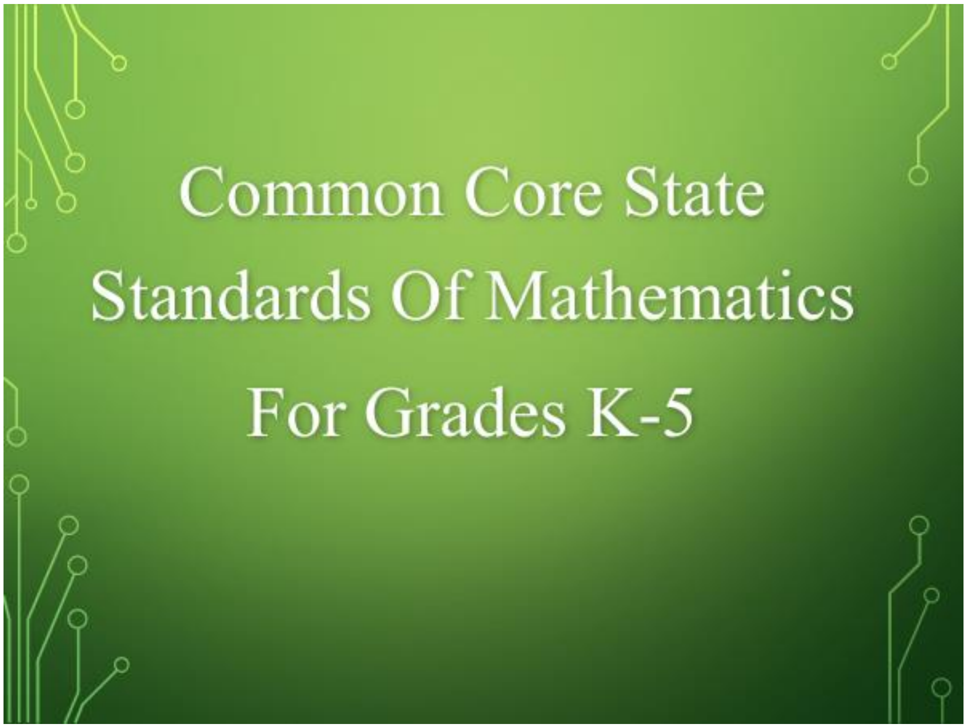
https://www.mathnook.com/math/skill/mathvocabularygames.php

https://www.spellingcity.com/math-vocabulary.html

https://www.nctm.org/Classroom- Resources/Illumination/Lessons/Math-Vocabulary-Bingo/

https://www.sadlier.com/school/mathematics/math-problem-solving-series

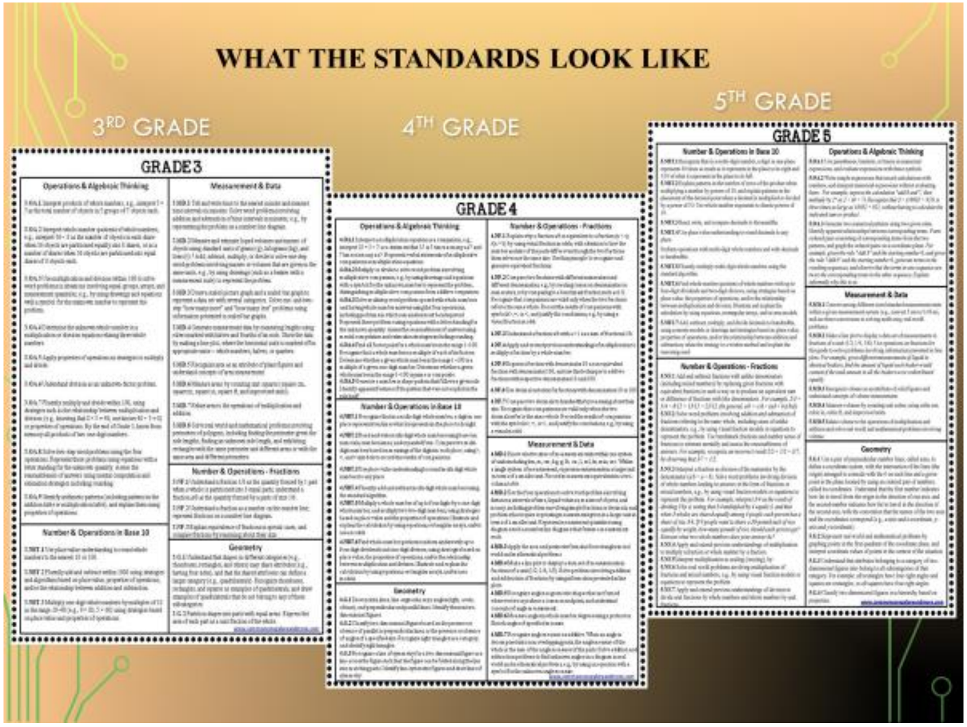
https://www.math4childrenplus.com/topics/vocabulary/


Common Core State
Standards Of Mathematics
For Grades K-5


CCSSM PURPOSE
https://www.youtube.com/watch?v=5s0rRk9sER0 (3:10)

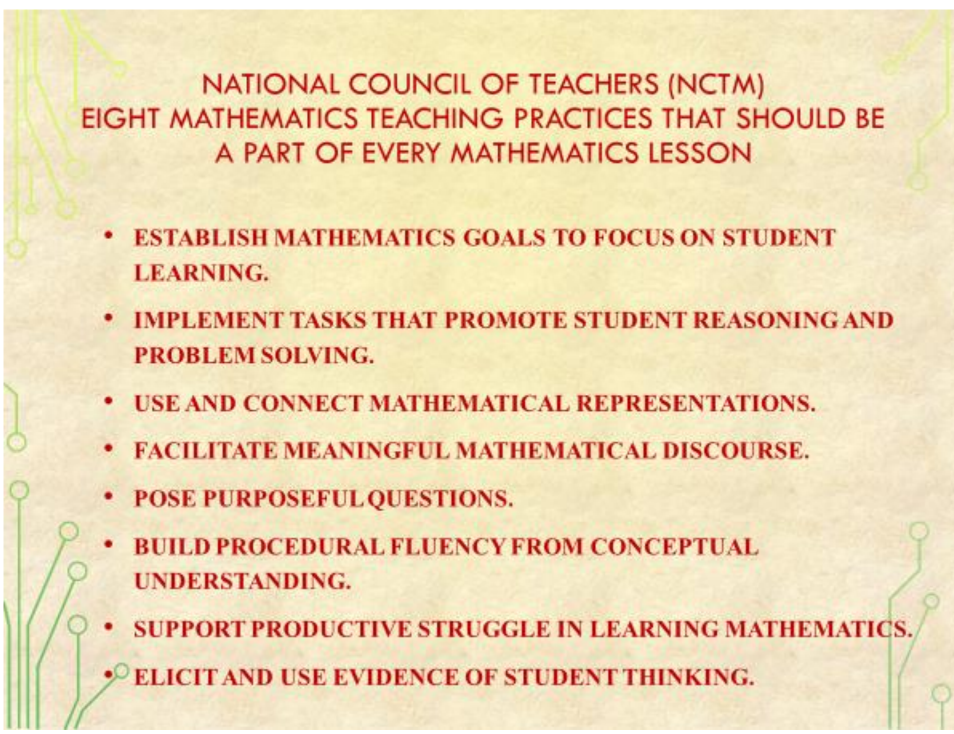

WHAT ARE THEY?
PURPOSE
MATH STANDARDS
The Common Core State Standards Initiative, known as Common Core, is a set of academic quality standards in mathematics and English language arts. Common Core outlines what students should know at the completion of each K-12 grade year
The purpose was to create a set of clear, consistent guidelines to help prepare students for college or a career upon graduation from high school. While the definition of Common Core is nationwide, the implementation of Common Core is done at state and local levels.
The math standards of Common Core strive to provide conceptual understanding of key ideas while continually returning to topics of organizing principles, such as place value. The standards build upon math standards from across the United States and international models
CCSSM PURPOSE CONT….

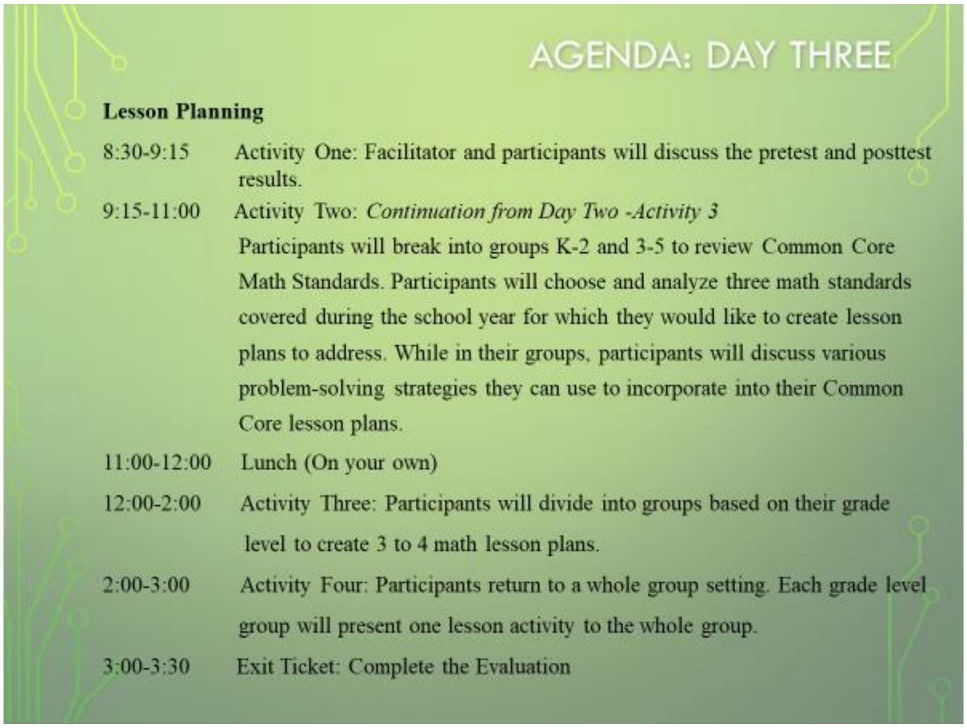

CCSSM: WHERE THEY CAN BE FOUND
www.corestandards.org
http://mdk12.msde.maryland.gov/instruction/commoncore/index.html
www.corecommonstandards.com

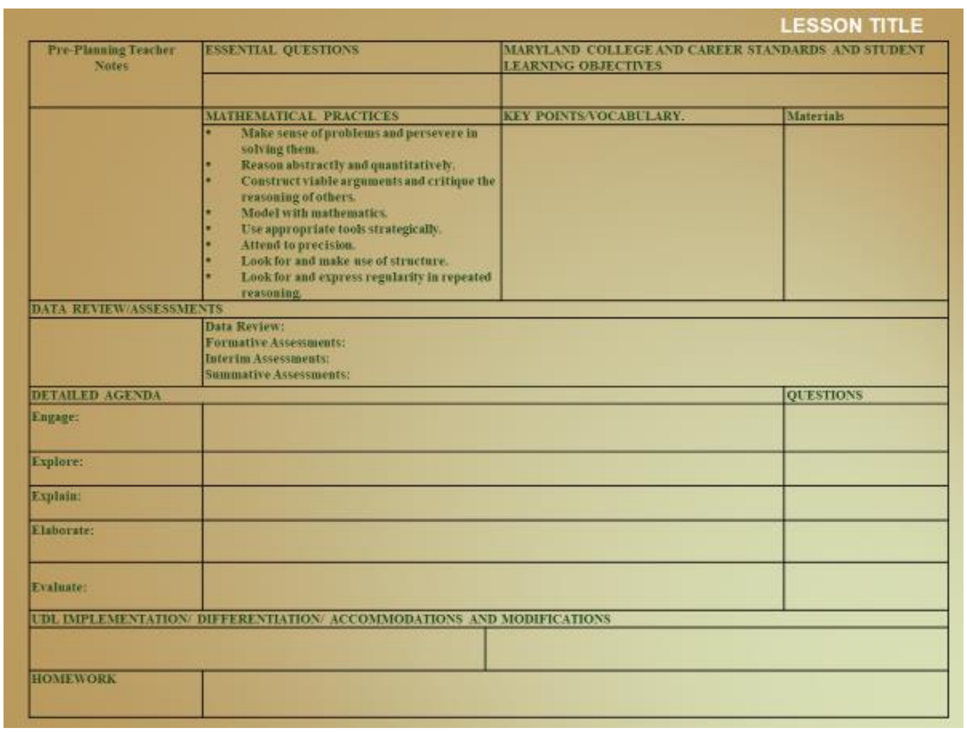

WHAT THE STANDARDS LOOK LIKE
3RD GRADE
4TH GRADE
5TH GRADE
GRADE 3
Operations & Algebraic Thinking
Measurement & Data
Number & Operations - Fractions
Number & Operations in Base 10
Geometry
GRADE 4
Operations & Algebraic Thinking
Number & Operations - Fractions
Number & Operations in Base 10
Measurement & Data
Geometry
GRADE 5
Number & Operations in Base 10
Operations & Algebraic Thinking
Measurement & Data
Number & Operations - Fractions
Geometry


CCSSM HOW IT'S DONE!
Show how you did it
with a picture.
https://www.youtube.com/watch?v=k5p5pHi3Lwg (2:46)


Common Core: TOP TEN
Top Ten Things You Need To Know About Common Core:
10. Your child is unique
Your community is unique.
Common Core is one size fits all.
9. Created by special interest groups with math and language arts experts refusing to endorse.
8. State boards of education approved Common Core...NO legislatve vote.
7. Higher testing costs and additional expenses for many districts.
6. Data collected on your child can include medical, psychological, and religous information.
5. Reduced ability to differentiate for gifted and struggling learners.
4. Student performance on standardized tests is linked to teacher evaluations.
3. Classic literature reduced and replaced w "informational texts" in language arts.
2. Schools, homeschools, teachers and parentshave less control over education
1. and the number 1 thing you need to kno about Common Core...YOU as a parent, teacher, concerned citizen do have the power to STOP COMMON CORE


NATIONAL COUNCIL OF TEACHERS (NCTM)
EIGHT MATHEMATICS TEACHING PRACTICES THAT SHOULD BE A PART OF EVERY MATHEMATICS LESSON
• ESTABLISH MATHEMATICS GOALS TO FOCUS ON STUDENT LEARNING.
• IMPLEMENT TASKS THAT PROMOTE STUDENT REASONING AND PROBLEM SOLVING.
• USE AND CONNECT MATHEMATICAL REPRESENTATIONS.
• FACILITATE MEANINGFUL MATHEMATICAL DISCOURSE.
• POSE PURPOSEFUL QUESTIONS.
• BUILD PROCEDURAL FLUENCY FROM CONCEPTUAL UNDERSTANDING.
• SUPPORT PRODUCTIVE STRUGGLE IN LEARNING MATHEMATICS.
• ELICIT AND USE EVIDENCE OF STUDENT THINKING.





Pre-Planning Teacher Notes	ESSENTIAL QUESTIONS	MARYLAND COLLEGE AND CAREER STANDARDS AND STUDENT LEARNING OBJECTIVES	
	MATHEMATICAL PRACTICES	KEY POINTS/VOCABULARY.	Materials
	• Make sense of problems and persevere in solving them. • Reason abstractly and quantitatively. • Construct viable arguments and critique the reasoning of others. • Model with mathematics. • Use appropriate tools strategically. • Attend to precision. • Look for and make use of structure. • Look for and express regularity in repeated reasoning.		
DATA REVIEW/ASSESSMENTS			
	Data Review: Formative Assessments: Interim Assessments: Summative Assessments:		
DETAILED AGENDA			QUESTIONS
Engage:			
Explore:			
Explain:			
Elaborate:			
Evaluate:			
UDL IMPLEMENTATION/ DIFFERENTIATION/ ACCOMMODATIONS AND MODIFICATIONS			
HOMEWORK			

Learning to Word Problem Solve Evaluation Forms

End of Day: Evaluation

Thank you for attending the day's workshop. Your feedback is important. Please take a few minutes to fill out the following survey.

Day ____

PLEASE CIRCLE YOUR RESPONSE TO EACH OF THE FOLLOWING ITEMS.

The presenter demonstrated sufficient expertise on the content				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The material was presented in sufficient depth				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The presentation was well-organized and easy to follow				
Strongly Agree				
The presentation enhanced my understanding of the subject.				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Handout materials enhanced presentation content				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

How will you use the information learned in this session?

____
____
____
____

Please share any additional thoughts on the topic or presentation:

____
____
____
____

Summative Evaluation

Thank you for attending the workshop training. Your feedback is important. Please take a few minutes to fill out the following survey.

Day Three____

PLEASE CIRCLE YOUR RESPONSE TO EACH OF THE FOLLOWING ITEMS.

The workshop was well-organized				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The workshop was easy to follow				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The physical environment was conducive to learning				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
There was ample time to complete each activity				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The material was presented in sufficient depth				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
As a result of attending the workshop, I have a better understanding of the Common Core State Standards of Mathematics and how to incorporate them into lesson plans				

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
As a result of attending the workshop, I have an understanding of how to use to share resources and work in collaboration with math teacher colleagues on lesson planning				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
As a result of attending the workshop, I have an understanding of how to use to share resources to create math vocabulary lessons and activities				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Handout materials enhanced presentation content				
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

How will you use the information learned in this workshop?

____

____

____

____

Please describe in detail, the parts of the workshop that were most valuable and suggestions you may have for future workshops.

____

____

____

____

Please provide any additional thoughts on the topic or presentation:

____

____

____

____

Name____________________ Date________________ Grade Level _______________

Learning to Word Problem-Solve Professional Development Training

Pretest Scenarios

Solve the word problems using the most appropriate strategy(s) and math vocabulary.

1. Freda had a party with friends, 1⁄3 of the people had curly hair. One-half of the people at the party were boys. No one over the age of 17 attended. 1⁄3 of the girls had short red hair. None of the boys had long hair.

   If there were 36 guests, what is the maximum number of girls who could have had long black hair?

   Show how you determined your answer and why you know you have a correct solution.

2. While playing a game, Nancy defeated 7 enemies with each enemy defeated earning her 6,846 points. If she traded in all her points for 5 extra lives, how many points is it per life? Show your work.

3. Kasey has a pail that holds 16 liters of water. She fills it up 9 times to fill up the bathtub.

   Part A: How much water did Kasey use to fill up the bathtub? Show your work.

   Part B: Kasey's brother has a pail that holds 12 liters of water. If Kasey's brother fills his pail 7 times, how many more times will her brother need to fill his pail to have the same amount of water as Kasey? Show your work.

4. Suppose that it takes Beth and Karen 3 hours to do a certain job, it takes Beth and Gwen 4 hours to do the same job and it takes Karen and Gwen 5 hours to do the same job. How long would it take Beth, Karen, and Harry to do the same job if all 3 worked together? Show your work.

5. A math department had supplied schools with 27 boxes of new books with each box containing 56 books. They plan to send the boxes of books out to 9 schools but want to give each school the same number of books. How many books should they give to each school? Show your work.

Name________________ Date__________________ Grade Level _______________

Learning to Word Problem-Solve Professional Development Training

Posttest

Solve the word problems using the most appropriate strategy(s) and math vocabulary.

1. A restaurant chef was ordering supplies. He ordered 5 pounds of beef at 10.25 per pound, 7 pounds of tomatoes at $6.86 a pound and 4 pounds of spinach at $7.81 per pound. He estimates that this will make 28 meals. How much profit will he make if he charges 49.37 per meal?

   Show how you determined your answer and why you know you have a correct solution

2. Paige was playing a word game where you gained points for correct answers and lost points for incorrect answers. At the start of round 4, she was at -800 points. During the round, she answered nine 350-point questions correct, and she answered nine 500 points questions incorrect. What was her score at the end of the round? Show your work.

3. A new fast food restaurant opened 6 months ago. The table below shows the number of crabcakes they have sold so far.

   Months Crabcakes Sold

1	4,265
2	3,174
3	4,998
4	4,362
5	4773

   The next month (after spending some money on an ad) they sold 4 times as many as they had sold in the previous 4 months. How many more crabcakes did they sell after running the ad? Show your work.

4. Eric and Orchid are 500 miles apart. If Eric travels at 60 mph and leaves her house at p.m., what time will she arrive at Sam's house?

5. A restaurant chef was ordering supplies. He ordered 5 pounds of beef at 10.25 per pound, 7 pounds of tomatoes at $6.86 a pound and 4 pounds of spinach at $7.81 per pound. He estimates that this will make 28 meals. How much profit will he make if he charges 49.37 per meal?

   Show how you determined your answer and why you have the correct solution.

Appendix B: Demographic Questions for Participation

Demographic Questions

Several demographic questions were prepared in advance to gain background information of individual research participants. The information from the demographic questions may assist in better understanding participants’ experiences and responses to the research questions. These questions will be used to identify participants for the study.

1. How many years have you been a teacher?
2. For how many of your teaching years have you taught mathematics?
3. What grade do you currently teach?
4. What is the highest degree you hold?
5. Have you participated in a math professional development within the last 5 years?

Appendix C: Interview Protocol

Interview Protocol Guide for Teachers' Interview
Interviewer's Name: Crystal Baldwin
Position: Teacher of Mathematics Students
Interview Date: ________________________ Interview Time: _____________
Interview Locations: ____________________

Research Study Purpose

The purpose of the interview will be to understand teachers' perceptions about the mathematics instruction of underachieving students on mathematical word problem-solving. Kindergarten through Fifth grade teachers were chosen to participate in the study because the teachers interact with the underachieving students on a daily basis. Data about teachers' perception on the instruction of underachieving students in mathematics word problem-solving will be collected through teacher interviews. Teacher confidentiality will be protected because teachers' names will not be used in the data or final project study report. The interview will take approximately 60 minutes. The study is voluntary and, even though the participants signed the consent form, participants may withdraw from the study at any point. A taped recorded will be used to ensure that data is collected accurately.

Interview questions

1. What skills and strategies do you use to instruct underachieving students to help them learn how to mathematically problem-solve?
2. What types of word problems do you use to teach mathematical problem-solving?
3. How confident do you feel about instructing students on mathematical problem-solving?
4. What types of professional development training do you have that helps you in instructing students on mathematical problem-solving?
5. What do you find challenging when teaching mathematical word problem-solving?

6. What are the challenges you face concerning the students learning during mathematical problem-solving instruction?
7. What are the challenges you have concerning your teaching of mathematical problem-solving?
8. Describe the types of assistance you perceive you need to aid you in increasing your underachieving students' success in mathematical problem-solving?
9. What resources do you need to aid in teaching students how to solve word problems?
10. What resources are you currently using doing mathematical problem-solving instruction?
11. What else would you like to share concerning your experiences in working with underachieving students on mathematical problem-solving?