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High School Math Teachers' Perspectives About Improving Teaching Constructed Response Questions

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COLLEGE OF EDUCATION

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MA, Louisiana State University, 2005

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Student test scores related to mathematical word problems have been declining in a rural school district in western Louisiana. Word problems constitute a major component of the Algebra 1 End of Course examination, which students must be able to pass to graduate. Mathematics teachers have struggled to find appropriate strategies to teach students to answer constructed response questions (CRQs) effectively. The purpose of this study was to investigate the perceptions of math teachers about effective teaching strategies for improving student performance on CRQs. Guided by Piaget's constructivist theory, which is characterized by an emphasis on learner control of the learning process through active engagement and activation of prior knowledge, this study investigated teachers' perceptions and practices in relation to teaching the skills needed for CRQs. The research questions focused on math teachers' perceptions of current teaching practices, instructional effectiveness, and professional development needs. A case study design was used to capture the insights of 8 participants through semistructured interviews and observations. Emergent themes were identified from the data through a code-recode approach, and findings were developed and validated through triangulation and member checking. The key results were that math teachers expressed a need to collaborate with their colleagues to develop effective strategies that would incorporate literacy and hands-on learning. A project was designed to engage teachers in collaboration and planning to prepare students to think critically and problem solve. This study may promote positive social change by providing teachers with the tools necessary to improve students' thinking skills, problem-solving skills, and learning strategies.

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Dedication

I dedicate this research study to my husband, Marcus Roberts, who has been very supportive throughout this entire process. My son, Maxwell Roberts, who has been my joy whenever I needed a smile or a friendly, loving face to get me through tough times. My sister, Ashleigh Claiborne, who has encouraged me to keep going and not give up. My mother, Dorothy Claiborne, who kept saying, “You can do it.” My father, Sam Claiborne, who has been instrumental in supporting me to begin and complete this degree. Finally, I dedicate this research to all of the teachers who work extremely hard to ensure that our students are successful in the ever-changing world.

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Section 1: The Problem

Introduction

High school students struggle to answer constructed response questions (CRQs) accurately because they do not always understand the problem-solving steps that they must follow. As Atlas (2006) observed, “By keying in on the process of learning, students activate prior schema that include related facts, concepts, and generalization” (para. 4). The process of critical thinking for problem solving is a process of organizing thoughts and ideas based on previously learned content while acquiring more information. The purpose of teaching math problem-solving skills is to allow students to focus on the development of conceptual understanding of mathematical calculation concepts, to connect ideas, and to apply critical thinking skills to solve problems (Frank, 2015).

In this study, I investigated the perceptions of math teachers regarding effective teaching strategies for improving student performance on CRQs and explored effective alternatives to current practice in this area. In a rural school district in western Louisiana, teachers are teaching students how to respond accurately to CRQs. These teachers have been able to identify the mistakes the students are making when answering these questions. Teachers are now seeking effective strategies to teach students how to solve CRQs.

In Section 1 of this project study, the problem, rationale, and review of the literature are provided. The definitions of specific terms in relationship to this project study are included. The conceptual framework is explained and aligned with the guiding research questions. Before the methodology section of the project study, the significance and implications of the investigation are addressed.

Definition of the Problem

The problem that prompted this study was that teachers were struggling to find appropriate strategies to teach students to answer CRQs effectively. This study was conducted in a school district in western Louisiana. The district was located in a rural, low-socioeconomic-status community. There were four high schools in the school district. At the high school level, there were 18 mathematics teachers and a population of 480 Algebra 1 students. Fifty-two percent of the student population was composed of members of racial and ethnic minority groups. Two of the four high schools had school performance scores above 80, which made them “B” schools. The remaining two schools had school performance scores of 70.4 and 73, which made them “C” schools (Louisiana Department of Education, 2013). All four schools had struggled with maintaining high scores in math due to incorrect student responses on constructed-response problems.

During the 2012-2013 school year, district personnel noticed a decline in Algebra 1 End of Course (EOC) test scores on state-mandated tests (Louisiana Department of Education, 2013). Based on the data that were obtained, the district determined that 65% of the decline came from inaccurate responses provided by students for CRQs (Louisiana Department of Education, 2013). Because all students must pass the Algebra 1 EOC before graduating from high school, district leaders knew that something needed to be done to remedy the problem.

Students in the study district reported feeling overwhelmed when they saw a word problem that was not multiple choice (MC) (administrator, personal communication, April 2013). They indicated that they did not know how to begin answering a CRQ. Teachers reported that students appeared to be overwhelmed and either used the wrong operations or strategies to solve problems or put nothing on the paper (teacher, personal communication, March 2013).

Questions that challenge students to think critically, activate their prior knowledge to compose an answer, and use multiple steps tend to be intimidating for students (Heritage & Heritage, 2013). It is assumed that these types of questions stimulate students to engage in higher order thinking and push students to focus on higher expectations than traditional MC questions do (Bonner, 2013).

In this school district, math teachers have tried various strategies to help students understand how to answer CRQs. They have tried planning with English teachers because they feel that the underlying problem relates to students' reading and reading comprehension skills (teacher, personal communication, April 2013). Teachers have stated that even with cross-curricular planning, there remains something that they need to learn so that they can help students improve (teacher, personal communication, April 2013). This study is important because administrators and teachers have witnessed declining math test scores and teachers are struggling to find appropriate teaching strategies to improve student performance on CRQs.

Studies in mathematical word-problem solving have shown that students do not attempt to comprehend what a problem is asking them to do before immediately beginning calculations, focusing on the numbers given and not explaining the reasoning for their answers (Kajamies, Vauras, & Kinnunen, 2010; Ramirez et al., 2013). This appears to be true for many of the high school students in the school mentioned above, as most of the students in Algebra 1 have not been successful on the constructed-response part of state standardized tests. Students should be exposed to problem-solving opportunities in mathematics to practice critical thinking and processing (National Council of Teachers of Mathematics [NCTM], 2010).

CRQs are assessment items that require students to state systematically how they solved a word problem. Mikesell (2011) suggested the following:

> CRQs seek to inform the listener/reader of the mathematical thinking of the student but much of the value instructionally of the response is to the student him/herself; the response serves as a tool for further construction of understanding, support for retention of information, and self-checking strategy. (para. 3)

In a majority of states in the Central United States, CRQs are based on the Common Core State Standards and can come from all strands. Tankersley (2007) stated that students may be asked to determine the steps in a problem or what operation the problem requires them to use. He contended that students need to be able to discern irrelevant or missing information to solve problems accurately. Although mathematics produces several unique problems to solve, there are a number of general questions that students could use to attack virtually all writing tasks.

Rationale

Evidence of the Problem at the Local Level

In a rural school district, students must be able to solve CRQs to earn Algebra 1 credit, to progress to Algebra 2, and to meet the EOC graduation requirement**.** The NCTM (2011) stated that students who understand and solve CRQs demonstrate in some way their thinking related to a mathematical concept/skill. In a rural school district, administrators and teachers have discovered that student scores have been decreasing on this particular skill over the past 4 years, that school performance scores have been decreasing, and that the community has been losing confidence in the school district (Louisiana Department of Education, 2013). According to data from the Louisiana Department of Education (2013), school performance scores have decreased in this district by 22% due to the decline in math EOC performance. Out of 480 students enrolled in Algebra 1 classes in the district, 106 were not able to move to Algebra 2 in the fall of 2013. Because of these declines, community leaders began to discuss forming charter schools so that children may attend school elsewhere. Recently, community members set up community meetings with the principals to discuss steps to move forward and increase test scores (principals, personal communication, March 2013).

An analysis was prepared by the Louisiana Department of Education of existing public and archival data related to the issue of student math performance on CRQs. A Louisiana Department of Education website provides archival data on test scores and adequate yearly progress reports. These specific data were accessed and collected by principals in the district to determine test scores on CRQs over the last 2 years (principals, personal communication, March 2013). The downloaded documents provided the descriptive statistics necessary for school officials to assess the learning problem so that the school district could determine what type of strategies need to be implemented to ensure student success in the area of problem solving (principals, personal communication, March 2013).

The state of Louisiana has adopted, along with 47 other states, the Common Core State Standards (CCSS). CCSS are based on input from educational leaders, educators, and the most effective models used in the United States and abroad (Common Core State Standards Initiative, 2013). The Louisiana Department of Education has identified the knowledge and skills students need to be successful for graduation (Louisiana Department of Education, 2011). The courses associated with those skills are English 1, 2, and 3, which focus on reading comprehension and analysis; Algebra 1 and 2, which focus on critical thinking and problem solving; and Geometry, which focuses on making predictions through observations. Based on these standards, the state of Louisiana has noted a decline in math test scores as a whole. High school Algebra 1 students dropped in proficiency between May 2012 and May 2013, from 75% to 66%, based on declines in scores on CRQs (Louisiana Department of Education, 2013).

The data reflect that test scores on the constructed-response section of the EOC for the school district declined in 2012 and 2013. The test is scored as pass or fail; however, within the category of “pass,” student scores are further identified as “good” or “excellent” for high-achieving students and “fair” for students who passed but still need additional support. In 2012, the high schools had 54% of students pass the EOC, but only

24% scored “good” or above on the constructed-response section (Louisiana Department of Education, 2013). In 2013, the high schools had 62% of the students pass the EOC, but only 13% scored “good” or above (Louisiana Department of Education, 2013). In 2014, the high schools had 67% of the students pass the EOC, but only 12% scored “good” or above. The data showed that in the local district, the students scoring “good” or above on the CRQs decreased from 24% in 2012, to 13% in 2013, to 12% in 2014. Compared to all other districts in the state, the local district is deemed below average (Louisiana Department of Education, 2013). Starting during the 2015-2016 school year, students could only pass the test if they received a rating of “good” or “excellent.” The “fair” rating was no longer being recognized as passing. This had a negative impact on the 2016 school performance scores on the EOC.

The Louisiana state assessment data informed the instructional planning of the teachers by serving as a needs assessment. The data reflected that there is a need for students to learn how to effectively analyze and solve the constructed-response part of the Algebra 1 End of Course assessment. CRQs are assessment items that require students to state systematically how they solved a word problem. Many problems have more than one task to be completed and require some type of strategy. Most of all, there are specific things that need to be done when solving problems. The following items represent the critical tasks:

1. Read and comprehend what the problem is asking.
2. Ask what type of operation the problem is asking to be used and what, specifically, the problem solver must look for to solve the problem.

3. Determine all of the information that is being given in the question.

4. After ensuring that Tasks 2 and 3 above have been completed, devise a plan.

Therefore, as students solve problems, they can focus on the best strategy to answer the questions, think about what they have already learned, and justify their solutions to the problems using the correct steps. As these problems have several steps and require students to think critically at higher levels, teachers shared during a department meeting that they needed additional support in finding effective strategies to help students solve constructed-response problems, given that the strategies they had been implementing thus far had not been effective (teacher, personal communication, 2013).

Evidence of the Problem From the Professional Literature

Students should be exposed to problem-solving questions so that they have the opportunity to practice mathematical critical thinking and processing (NCTM, 2010). Russell (2011) maintained that students can become better problem solvers in all areas of life if they learn math. Polya (1985) argued that the first step in addressing this issue is ensuring that the teacher is not afraid of problems. Then, “the teacher should find some problems to solve and have students solve problems as a part of their routine math education; discuss the solutions; and explain to them various strategies in the context of problem solving” (Polya, 1985, para. 4).

Focusing on problem solving in the classroom not only influences students’ thinking and problem-solving skills, but also improves students’ analysis skills and standardized test scores. The National Research Council (NRC, 2000) stated, “Children are problem solvers and through curiosity, generate questions and problems” (p. 234).

According to the National Mathematics Advisory Panel (NMAP, 2008), the United States ranks high in mathematical competence among industrialized nations of the world. However, math achievement of students in U.S. high schools is falling behind that of other countries (Gonzales, Miller, & Provasnik, 2009). The NCTM (2010) pointed out that quality math instruction is fundamental for a strong economy. Most states have implemented state-mandated tests to ensure that students are meeting all requirements set forth by the No Child Left Behind Act of 2001 (NCLB; U.S. Department of Education, 2007). As a result of these tests, teachers have been required to focus on teaching students how to think critically and answer CRQs.

In *Tests That Teach*, Tankersley (2007) stated that "in American classrooms, our ever-expanding curriculum has been 'a mile wide and an inch deep'" (para. 2). Within traditional classrooms, there has not been a focus on critical thinking and problem solving, but a great deal of knowledge and comprehension is required of students. This thinking has to change as the world changes. Students must begin applying more critical thinking and more rigorous problem-solving skills.

Answers are not always crystal clear, and there are often infinite solutions to a problem. As Tankersley (2007) observed, "Preparing students with only surface-level knowledge does not lead to deep thinking, to intellectual independence, or to building a student's capacity to problem solve and analyze complex situations in the real world" (para. 3). Further, Tankersley noted, "Requiring students to think and process information at much deeper levels prepares them for the real role they will face in life and in tomorrow's workplace" (para. 3).

The purpose of this study was to investigate the perceptions of math teachers about effective teaching strategies for improving student performance on CRQs and to explore effective alternatives to current practice.

Definitions

Key words that facilitated my literature research were as follows:

Constructed response question (CRQ): A constructed response question requires students to engage in real-life applications of concepts through critical thinking and problem solving (Tanksersly, 2007).

Critical thinking: Critical thinking is the process of evaluating information as it relates to an educational prompt (Kowalczyk, Hackworth, & Case-Smith, 2012).

Problem solving: Problem solving is the set of required tasks applied in order to answer a mathematics problem accurately (NCTM, 2010)

Selected response/multiple choice: Selected response is a type of question that provides a list of answer choices to choose from instead of requiring students to compose an answer (Tanksersly, 2007).

Standardized test scores: A standardized test score represents a comparison of a student's performance on an assessment to that of students of the same age completing the same assessment (Caltabiano & Flanagan, 2004).

Student achievement: Student achievement is the measure of state-mandated test scores to determine mastery of concepts (Ash & Kiriakidis, 2011).

Student-centered instruction: Student-centered instruction occurs when students do the "heavy lifting" by teaching lessons and the teacher serves as the facilitator and allows the students to communicate with one another(National Mathematics Advisory Panel, 2008).

Teacher-directed instruction: Teacher-directed instruction occurs when the teacher teaches the majority of the lesson and the students sit and listen or communicate directing with the teacher (National Mathematics Advisory Panel, 2008; Neuman & Gambrell, 2015).

Significance

The purpose of this study was to investigate the perceptions of math teachers regarding effective teaching strategies for improving student performance on CRQs and to explore effective alternatives to current practice. This study may help the local school district implement effective strategies by instructing teachers on how to teach students to solve constructed-response math problems. Strategies discovered through this study may help teachers and students begin to think critically at higher levels to comprehend what they are reading and apply appropriate operations when solving problems. In addition, it may be possible to use these strategies in science to analyze scientific information.

This study may change the way in which teachers challenge students to think and process information. In this way, it may benefit not only math teachers and students, but also other subject-area teachers and students in the district, as the findings may help teachers lead students to think at higher levels. This may also benefit the community because students may graduate ready to enter the workforce, with the ability to comprehend required information. Most importantly, society may benefit because students may become better prepared to be productive citizens in an ever-changing world.

Guiding/Research Question

Math teachers are charged with many tasks to help their students master math concepts. One of the most important tasks is teaching students how to think critically and answer CRQs. The following research questions were addressed by this study:

1. What are the teaching strategies that teachers currently use to teach students to answer CRQs?
2. What are the perceptions of teachers regarding their current practices in teaching students to answer CRQs in this local district?
3. What professional development (PD) opportunities could enhance teachers' instructional delivery to support CRQ instruction?

Review of the Literature

Conceptual Framework

The conceptual framework of this project study was based on Piaget's cognitive constructivist theory. *Cognitive constructivism* is characterized by an emphasis on student control of the learning process through active engagement and activation of prior knowledge to solve new problems. Cognitive constructivist theory indicates that children can think critically, problem solve, discover, and construct viable arguments instead of simply participating in rote learning (Lunenburg, 2011). Piaget's constructivist theory was based on his observations of children in classrooms and social environments; he believed that to answer the question "How do we acquire knowledge," he had to study the way in which children think and process information (Kami, 1980). As Bodner (1986) noted, “Piaget argued that knowledge is constructed as the learner strives to organize his or her experiences in terms of preexisting mental structures or schemes” (p. 874).

Piaget’s constructivist theory has been the foundation for the creation of developmentally appropriate practices in education. These practices offer an umbrella of child-centered approaches in which teachers are instructed to stand back and allow children to make choices regarding when and how to construct their learning (Solomon, 2012). Constructivist ideology has been applied to develop advancements in the area of learning and teaching mathematics (Abdulwahed, Jaworski, & Crawford, 2012, p. 49).

Constructivism focuses attention on how individuals learn. Advocates of constructivist learning propose that math comprehension is a result of individuals engaging in real-life math problem solving on an everyday basis (Solomon, 2012). Robinson and Maldonado (2014) argued that constructivism is based on the assumption that knowledge varies among individuals. Lessons should focus on the learner’s needs rather than focusing just on what the teacher enjoys teaching (Akyol, 2011). The challenge for teachers is to develop experiences that engage the student and support the student’s own explanation with evidence, evaluation, communication, and application of the mathematical models needed to make sense of these experiences. The curriculum should match and challenge children’s understanding, promote academic achievement, and activate a progression of the mind (Özcan, Gunduz, & Danju, 2013). Knowledge is not passively received by learners from the environment but is actively created or invented by them. Piaget contended that “mathematical ideas are made by children, not found like a pebble or accepted from others like a gift” (Clements & Battista, 1990, para.

4). By focusing on how children learn to solve math problems through active participation, educators can enhance the learner's experience by providing opportunities for cooperative learning experiences that allow for exploratory activities in a social setting.

Bruner (1986), an educational theorist who advocated a constructivist approach, described "learning as a social process in which children grow into the intellectual life of those around them" (p. 34). Through learning, children build relationships that can have a positive impact on their academic success. In addition to this social nature, learning has a cultural element. Mathematical thoughts and conclusions, for instance, are agreeably established by the members of a culture. That culture then establishes mathematical instructional practices. From a constructivist point of view, mathematics instruction has two important outcomes (Cobb, 1988). First, students should build on mathematical procedures that are more challenging and commanding than the procedures that they have already learned to solve higher order thinking problems.

Second, students should develop into self-directed and forceful learners in mathematics. Highly talented students think that mathematics entails thinking critically to solve problems involving numbers, variables, and formulas (Battista & Clements, 2009; Sahan, & Terzi, 2015). They think that they explore, discover, and understand mathematics based on their own capabilities as opposed to learning from their teachers (Battista & Clements, 2009). They see their duty in the mathematics classroom as making sense of and discussing the important problem solving in mathematics. Students who are this independent think of themselves as calculators and creators of mathematics.

A teacher taking a constructivist approach provides opportunities for students to direct their learning by engaging in productive mathematics conversation with their peers (Bruner, 1986). Constructivist teachers provide opportunities for students to think critically and organize their thought processes to answer mathematics questions accurately. They know how each student learns and processes mathematical concepts (Battista & Clements, 2009). Students excel or succeed when teachers understand how students learn and apply teaching strategies that align with the learners' needs (Batdi & Semerci, 2015).

Constructivism has been defined as "an epistemology, a learning or meaning-making theory that offers an explanation of the nature of knowledge and how human beings learn" (Ultanir, 2012, p. 195). Constructivists view critical student learning experiences as instances of individual engagement and exploration of a problem (Battista & Clements, 2009). Therefore, the constructivist classroom is a dynamic learning environment characterized by students being fully engaged in exploratory and discovery experiences through which they exchange academic feedback by reasoning, sharing, and evaluating.

Constructivism and constructivist teaching approaches anchor this study because they provide a framework for students to learn, understand, and solve CRQs and for teachers to guide students toward appropriate learning strategies. When teachers serve as learning facilitators, they provide students with more opportunities to express their own ideas and conclusions. In this study, I examined teacher perceptions and instructional practices through the conceptual framework of constructivist practices. Within this framework, “constructivism is about self-construction of knowledge: student-centered approaches have been seen to play an essential role in this process” (Abdulwahed, Jaworski, & Crawford, 2012, p. 49). This framework supported my project study because it emphasizes exploratory learning by students to strengthen their cognitive abilities. This conceptual framework provided a critical lens to define and to analyze data that flowed from the research questions.

Current Research Literature

Solving problems, thinking critically, and reasoning are complex tasks and require the student to think mathematically while focusing on reading and writing. Many students need assistance in finding strategies for organizing their thinking. Learners should work toward choosing from multiple strategies to identify what works best to solve mathematical word problems (Allen, 2011). This literature review contains a critical summary and analysis of the available literature on effective teaching practices for engaging students in mathematics instruction. The literature revealed that “many reforms rely on teacher learning and improved instruction to increase student learning” (Palmer, 2007, para. 3). The literature contained in this review was found by using the Walden library search engine and Google Scholar. The following terms were used to identify literature appropriate for the study: *problem solving, constructed response*, *constructivism*, *cooperative learning*, *critical thinking and reasoning*, and *mathematics instruction*.

There are several important points that build upon one another to explain the importance of CRQs. The key elements in researching effective strategies to help students solve CRQs are addressed in this literature review. The following key elements are addressed as topical areas identified by the following subheadings: Effective Math Instruction, Instructional Methods That Support the Constructivist Approach, Problem Solving, Cooperative Learning in Mathematics, and Creating Effective Math Assessments.

Effective Math Instruction

Through the eyes of an educator, “mathematics instruction is a complex process that attempts to make abstract concepts tangible, difficult ideas understandable, and multifaceted problems solvable” (Steedly, Dragoo, Arafeh, & Luke, 2008, p. 8). In addition, mathematics is a form of thinking and problem solving through reasoning. Processing information mathematically involves thinking critically, exploring, developing key concepts, constructing viable arguments, and explaining reasoning. Teachers model mathematical activities when they use patterns, construct models to prove conjectures, create symbols to represent unknowns, and develop steps to solve problems accurately (Battista, 2012). In terms of mathematics instruction, teachers usually think that the best practices promote student engagement in critical thinking, which reflects student mastery of mathematics concepts (Jackson, Shahan, Gibbons, & Cobb, 2012).

The NCTM (2010) standards emphasize that mathematics is not just a set of procedures to be learned. The NCTM standards focus on students engaging in effective problem solving with others. According to the standards, “students should engage in mathematical activities with confidence and enthusiasm, and teachers should use assessment strategies that focus on understanding rather than on right answers" (NCTM, 2010, para. 2).

The need for effective mathematics instruction was documented in February 2006. The U.S. Department of Education conducted a study using data from a sample of high school graduates from 1992 who went on to attend a 4-year college. The study found that taking high school courses in addition to math courses beyond Algebra 2 determines whether a student will graduate from college. The study also found that high schools needed to increase the rigor in the content they were using to prepare students for their first semester in college (U.S. Department of Education, 2007). Students from low socioeconomic backgrounds need to be challenged in high school because they are less likely to attend college than students from high socioeconomic backgrounds (Cullen, Levitt, Robertson, & Sadoff, 2013).

Hull, Miles, and Balka (2013) described *mathematical rigor* as “effective, ongoing interaction between teacher instruction and student reasoning and thinking about concepts, skills, and challenging tasks that results in a conscious, connected, and transferable body of valuable knowledge for every student” (para. 4). Good rigorous math instruction is evident in a classroom when students are engaging actively in the lesson, generating questions on their own, using visuals repeatedly to organize thinking and to serve as reminders, thinking at high levels, providing high-quality feedback to one another, and solving real-life problems (National Center for Education Achievement, 2010). In that same classroom, the teacher is signifying the approval of students' self-developed ideas and conclusions, prompting the learning process by asking challenging and stimulating questions that require students to think at higher levels, modeling a positive attitude about mathematical processes and procedures, and being a facilitator (Van de Walle, Kerp, Lovin, & Bay-Williams, 2014). The teacher allows the students to do the cognitive lifting and apply what they are learning to their everyday lives (John, Joseph, & Sampson, 2014).

Instructional methods that improve teaching include having students generate word problems and reinforcing math skills through games such as Think Aloud or I Do. Teachers incorporate thinking strategies in math, such as those demonstrated in Think Aloud or I Do, to help students understand how to think and problem solve during math instruction. The purpose of a Think Aloud is to read aloud while verbalizing to determine the meaning of a text (Farr & Conner, 2013). The goal of demonstrating a Think Aloud to start a mathematics lesson is to ensure that teachers model the thinking process and the process of sharing their thoughts with others. During a Think Aloud, the teacher sets up the model by completing a problem and then questions the students to check their understanding after the model. This helps the teacher determine whether all students are in the game (Jackson et al., 2012).

Jackson et al. (2012) stated that how a problem is modeled "impacts both what students and the teacher are able to achieve during a lesson" (p. 24). Using a Think Aloud demonstration or an I Do promotes students' engagement in meaningful communication with their peers. Using a Think-Aloud strategy gives teachers opportunities to use explicit explanations of steps involved in problem solving. The teachers model their thinking and problem solving. Students' development of word problems is based on specific math concepts that need to be learned and mastered. By creating the word problem on their own, students discover what operations to use and what steps to follow. Students play games to reinforce math concepts that they have already learned. The outcomes of the games help teachers determine which students are showing mastery of the concepts (Hodara, 2011; Swan & Marshall, 2009).

Instructional practices that may help teachers help students be successful in math classrooms have been identified through research studies (Clements & Sarama, 2012; Rosenshine, 2012) and from observations of successful teachers impacting students (Taubman, 2014). Those studies have also looked at successful and unsuccessful associations between math instruction and student achievement. Clements and Samara (2012) studied the impact of a prekindergarten mathematics curriculum, *Building Blocks*, on the oral language and letter recognition of children. They found that the children using the *Building Blocks* curriculum in math and English outperformed children in the control group.

Rosenshine (2012) focused on 10 research-based principles of instruction to help teachers help students be successful in the classroom. He found that all the principles complemented and supported one another, which aided in the success of the students. Some studies have compared “teacher-directed” practices with “student-centered” practices (National Mathematics Advisory Panel, 2008). The National Center for Education Evaluation (2013) found that teachers who spent a large amount of mathematical instructional time differentiating for students and making instruction student centered by allowing students to teach one another saw higher gains in student achievement. Teachers who spent a large amount of time providing the students with the steps to solving the problems and conducting whole-group discussions saw declines in student achievement (National Center for Education Evaluation).

Two of the most important considerations in preparation for teaching are what content the teacher is to teach and how the teacher will present the content. Effective math instruction strategies informed my project study problem because teachers were struggling to find effective teaching strategies to help students think critically and problem solve. Because teaching involves assisting individuals in learning, knowing and understanding what is to be taught and how it is to be taught are essential prerequisites of teaching. The many responsibilities of teaching, such as choosing engaging learning activities, providing meaningful and continuous feedback, asking probing questions, and assessing students' learning, all rely on the teacher's comprehension of what and how the students are to learn. Joseph and John (2014) contended that the structure of specific subject matter affects what the teacher will decide to teach as well as how the teacher will implement the content so that students can master it. Thus, effective instruction can help to strengthen the cognitive abilities of teachers and students so that academic proficiency can increase in Algebra 1.

Instructional Methods That Support the Constructivist Approach

There are many approaches to improving teaching including the following: identifying different ways to engage individual students; developing rich environments for exploration; developing challenging real-world problems that require critical thinking; and eliciting and communicating student insights and explanations (Slavin, 2012).

Constructivists suggest that students develop their own problem solving steps to answer questions accurately. They are asked to refine their own thinking instead of adopting someone else's thinking. When working through these mathematical discoveries, student thinking moves from concrete to abstract (Constructivist Learning and Teaching, 2013).

Hence, mathematics teachers need to learn effective literacy strategies to teach students how to effectively read and understand math word problems (Powell, 2011). Math proficiency is linked to vocabulary and literacy. Pierce and Fontaine (2009) found that "proficiency in mathematics has increasingly hinged upon a child's ability to understand and use two kinds of math vocabulary words: math specific words and ambiguous, multiple-meaning words with math denotations" (p. 242). Most individuals who stress teaching literacy strategies in mathematics feel that students struggle due to their low reading abilities (Ozgen & Bindaka, 2011).

Although literacy strategies are usually thought of as having little to no relevance in mathematics other than word problems, incorporating literacy strategies in math helps with the distinction between words in math and numbers in math. Powell (2011) found that literacy coaches do not seem to see the symbols and syntax in mathematics as its own language. Once coaches realized the similarities and how important literacy was in math, they were better able to assist mathematics teachers in applying literacy strategies in their instruction to help their students develop mathematical understanding through reading. Therefore, mathematics requires students to learn the skills associated with reading (Van Steenbrugge, Lesage, Valcke, & Desoete, 2014).

Adams and Lowery (2007) stated, “Students ‘doing’ mathematics ultimately results in students reading mathematics. This reading of mathematics is manifested in students reading words, symbols (including numerals), and visuals such as diagrams and graphs” (p. 161). Solving mathematical word problems has been labeled as one of the most difficult components of mathematical education (Powell, Fuchs, & Fuchs, 2013). Students must be proficient in these math skills. They must be able to apply these skills in correlation with reading skills to find the correct solution for any given math problem. Beyond reading, analyzing, and comprehending what the problem is asking them to do, students must also decide upon a correct strategy or method to solve the problem. Once they determine the steps to take, students must still change specific words into numbers and equations and finally calculate the correct answer.

Vilenius-Tuohimaa, Aunola, and Nurmi (2008) explored the association between mathematical word problems and comprehension. In their study, students were divided into reading groups based on reading comprehension ability. The students were then given a standardized test of mathematical word problems. The results showed that students in the high achieving reading group performed better on both the reading comprehension and mathematical word problem tests than did those students assigned to the low achieving reading group. A study conducted by Fuchs et al. (2011) involved providing an intervention for students in mathematical word problem-solving. After implementation of the intervention, students showed no improvement in their ability to solve word problems. They concluded that the reason for their difficulty is due to their inability to read and comprehend the problem. The researchers went on to say that their results indicate the lack of reading comprehension skills were the basis of the deficit in mathematical word problem-solving competence (Fuchs et al., 2011). Therefore, it is evident that reading comprehension has a direct correlation to mathematical problem solving.

Dagget (2014) believed that attaining academic proficiency is the starting line for students to be successful in education as well as the ever-changing world. Students will gain more from engaging in rigorous and relevant instruction in the classroom (Daggett, 2014). Thus, the instructional methods that support the constructivist theory helps to shift the process from a teacher-centered learning process to a student-centered learning process. Instructional strategies that support the constructivist approach include processes to help students refine their own thinking and develop their own steps for problem solving. These strategies inform my study when they are applied in mathematics because when students are able to read and comprehend CRQs, they will be able to develop the critical thinkering skills necessary to succeed in this ever-changing world.

Problem Solving

Traditional drill and practice instruction has been a normal process in math classrooms because teachers begin with concrete models that students can draw or see and move to more abstract ideas (Mayrowetz, 2009). Morton and Qu (2013) stated “the computation of mathematical word problems opens a domain of real world solutions” (p. 89). Van de Walle, Karp, and Bay-Williams (2013) found that when teachers create a student- centered environment their students are better prepared to explore and discover their own, problem solving steps, and solutions. The NCTM (2009) also emphasized that secondary students must learn to use algebra to solve problems.

> Problem solving with equations should include careful attention to increasingly difficult problems that span the border between arithmetic and algebra. Such problems can help students view algebra as a sense-making activity that extends one's problem-solving skills into domains in which reasoning, as done in arithmetic, becomes too complicated or cumbersome to carry out. Seeing the essential parallels between algebraic and arithmetic solution methods can help students gain confidence that Algebra 1s a more powerful tool for dealing with problems (p. 32).

A teacher provides opportunities where the students can monitor their thinking and problem solving to ensure that they are mastering the objectives being taught and are aware of different strategies they can use to master the concepts. Engaging in problem solving promotes critical thinking, activates self-discovery, and engages students in dialogue where they exchange ideas. Teachers can change their teaching and students can change their thinking and learning through sustained, steady use and application of critical thinking and problem solving skills (Learning, 2011). Solving math problems can consist of trial and error until the correct answer is reached (teacher communication, 2014). When students are used to being reactive learners because they merely memorize and recall information, it may be difficult at the beginning to engage them in effective learning situations that involve critical thinking and problem-solving skills. Teachers should pay close attention to students' initial refusal to think critically and they should promote an culture in which students are at ease with engaging in analyzing the content. This prepares students to analyze content by thinking and problem solving, rather than simply giving an answer without evidence or reasoning.

Through critical thinking and problem solving, the concept of mathematics can be developed and understood. According to Mayer and Wittrock (2006), problem solving is “cognitive processing directed at achieving a goal when no solution method is obvious to the problem solver” (p. 287). Understanding how to solve a word problem motivates students to think critically rather than repeatedly teaching drill and practice skills without an effective outcome. This kind of motivation reflects problem solving as a vehicle for acquiring new concepts or the reinforcement of concepts already learned (Hassan, 2014). Polya (1985) suggested the following:

> Solving problems is a practical art, like swimming, or skiing, or playing the piano: you can learn it only by imitation and practice . . . if you wish to learn swimming you have to go in the water, and if you wish to become a problem solver you have to solve problems (para 1).

Polya believed when the problem solver is interested in way concepts are being discovered in math, they understand how these things can be applied in real life (D'Agostino, 2011).

Schneider (2011) believed the challenge is developing a plan to change instructional objectives into real, on level appropriate problem solving activities that are incorporated into lessons across the curriculum. To implement these objectives and strategies, teachers may have to change their approach to teaching the curriculum.

Teachers can provide daily opportunities for students to identify the objectives to be mastered for the lesson, determine what strategies need to be used to master those objectives, and consider the prior knowledge they need to have to get started on solving the problems. Teachers can also provide the time and space for development and exploration of ideas and for making and testing of strategies.

There are several ways that educators can help students explore problems solving tasks. For example, they can teach elementary students to think critically across the curriculum by having them plan and construct habitats for animals in science, divide a set of different sized cookies equally amongst their classmates in math, chart a map of their neighborhoods in social studies, or have them reconsider a character or setting of a given story to retell it a different way in reading. As Hersh (2011) wrote,

> Critical thinking, analytical reasoning, problem-solving, and writing are called collective outcomes which means that they cannot adequately be taught in any one class or year; all teachers and faculty have a responsibility to teach for such skills within each subject area and discipline. (para. 4)

Learning how to solve problems in mathematics is about knowing how to determine the relevant and irrelevant information to solve a solution. Word problems require students to know what procedures or steps to use. In addition, "communicating problem solving reasoning is a complex task and requires the student to develop both mathematically and with words" (NCTM, 2000, p. 1). Through problem solving, students can model their own thought processes through specific evidence shown through the steps in their solutions (Cai et al., 2014). Mathematicians who have no difficulties solving problems express that the experience of solving a problem leads to the appreciation for the “power and beauty of mathematics” (NCTM, 1989, p. 77), the "joy of banging your head against a mathematical wall, and then discovering that there might be ways of either going around or over that wall" (Taplin, 2014, as cited in Olkin & Schoenfeld, 1994, p. 43).

As theories of how students learned changed over time, the comprehension of the problem-solving process also progressed. Behaviorism, cognitive psychology, and information processing are the dominant theories applied to problem solving. Schoenfeld (1985) suggested that “behaviorists view problem solving as a process that develops through positive and negative reinforcement mechanisms” (p. 190). Schoenfeld also proposed that “cognitive psychologists view problem solving as a process that includes introspection, observation, and the development of heuristics” (p. 191). The information processing view of problem solving is centered on basic problem solving skills, comprehension, and intellect (Brown & McNamara, 2011; Schoenfeld, 2011). The core theoretical argument in *Mathematical Problem Solving*, elaborated slightly in Schoenfeld (1985), was that the following four categories of problem solving activity are necessary and sufficient for the analysis of the success or failure of someone’s problem solving attempt:

a) The individual’s knowledge;
b) The individual’s use of problem solving strategies, known as heuristic strategies;

c) The individual’s monitoring and self-regulation (an aspect of metacognition);

d) The individual’s belief systems (about him- or herself, about mathematics, about problem solving) and their origins in the students’ mathematical experiences. (p. 206)

One of the major goals of education is to ensure students can apply the concepts and skills they are learning in school in real-life situations. Therefore, problem solving is essential improving students' ability to think critically and problem solve. Educators must supply students with the necessary skills and strategies to effectively think critically to problem solve. Students are not typically taught to think, problem solve, or learn independently, and they rarely "pick up" these skills on their own.

Therefore, teachers must learn and acquire the ability to teach students to think critically to implement effective problem solving strategies. The process for teachers and students involves exploring and developing successful lessons encompassing effectively problem solving approaches. Applying these critical thinking and problem solving skills inspire students and teachers in the classroom. Teaching students to think critically and problem solve will help to address my problem because if students are able to problem solve accurately, they will be able to answer CRQs accurately.

Cooperative Learning in Math

Cooperative learning is favored highly as one of the best approaches for teaching mathematics. Lavasani and Khandan (2011) believed that when group members are cohesive and working together, the effects will be positive. In cooperative learning, children work in pairs or small groups cooperatively providing academic feedback to one another to help each other solve problems and master mathematics concepts. Kermati's (2009) research on cooperative learning in mathematics has found that the cooperating impacts learning if the students are held accountable for group work and individual work. For example, cooperative learning improves mathematics learning when students work in small groups and are held accountable for their individual contributions to the group (Slavin, 2012).

Cooperative learning is heavily encouraged by experts in mathematics instruction. Group work and cooperative learning are priority structures needed to promote numeracy (Department for Children Schools & Families, 2009; Tsay & Brady, 2012). Many primary and secondary teachers report using cooperative learning often in teaching mathematics. However, it has been found that the cooperative learning that is most often executed in the math classroom involves minimal group work structure and no individual guidance (Hertz-Lazarowitz, Kagan, Sharan, Slavin, & Webb, 2013). Students sit together in groups of three or four and are allowed to work problems out together; however they seem to spend more time copying one another's answers as opposed to providing academic feedback to each other (Slavin, 2011). When students' share answers without effectively going through the process of solving the problems step by step, their learning is stifled (Bottia, Moller, Mickelson & Stearns, 2014).

Cooperative learning positively impacts students' mathematics achievement because the process requires students to use their own ideas and discoveries (Slavin et al., 2013). Cooperative learning is the process of knowing and being able to explain why a concept is understood and how the concept is understood. Mathematics education focuses on this through promoting cooperative learning. Tracey, Madden, and Slavin (2010) believe that "the content of mathematics allows for specific models of cooperative learning to accommodate individual differences between students. Mathematical problems can be situated in real-life contexts and designed in such a way that solutions can be reached along different routes and at different levels" (p. 86). Shimazoe and Aldrich (2010) provided six benefits of implementing cooperative learning in the classroom.

1. Cooperative learning encourages in depth learning of the content
2. Students tend to perform better when in a cooperative learning setting
3. Students learn how to communicate effectively with their peers
4. Students learn higher-order, critical thinking skills
5. Cooperative learning promotes personal growth
6. Students begin to think positively about engaging in the learning process

The implementation of engaging the students in cooperative learning greatly influences its impact on student learning.

When cooperative learning takes place in the classroom, the use of manipulative materials to investigate a concept is encouraged. Manipulatives are hands-on tools used to create an external representation or model of a mathematical idea. A good manipulative can help determine if the mathematical instruction is formal or informal by examining the developmental level of the child. To accomplish this objective, the manipulative used must fit the achievement level of the student (Setlalentoa, 2014).

Improvement of student achievement can result positively through the use of cooperative learning instructional strategies (Carbonneau & Marley, 2013; Powell, 2014). Math manipulative-based instructional techniques provide opportunities for students to use objects which require them to move from concrete to abstract thinking in math to master concepts being taught (Carbonneau & Marley, 2013). Gürbüz, (2010) found that using manipulatives in math instruction benefits student learning and achievement. Rohani (2014) found that students' achievement test scores were superior in the areas where the teachers effectively implemented cooperative learning as opposed to areas where the teacher lectured or did all the cognitive lifting by solving the problems without insight from the students.

Slavin (2012) suggested that when teachers group students together are in cooperative groups, the students understand the instructional content better. When cooperative learning is implemented effectively, students work with partners to request help on certain concepts or clear up misunderstandings. This strategy does not exist during traditional teaching because teachers do most of the talking and assisting. Through cooperative learning, the teacher suggests that students solicit assistance to ensure they understand the objectives of the lesson being taught. This helps the students actively take responsibility for their learning.

Cooperative learning provides students with opportunities to engage in social interaction and active learning where inquiry, curiosity and exploration are valued. Cooperative learning lessons carefully planned by the teacher, lend themselves to positive communication between students. Therefore, students identify their classroom as a place to share ideas, explore, discover, investigate, create, and give specific and high quality feedback to one another. Engaging students in cooperative learning activities will help address my problem because students will be encouraged to do the cognitive lifting by exploring and discovering on their own with their classmates. Thinking critically and problem solving on their own will help students become more proficient in answering CRQs.

Effective Math Assessments

Formative assessment is generally defined as assessment for the purpose of instruction (Heritage & Heritage 2013). Assessments are used to help teachers plan their instruction. The data from the assessments should drive the instruction. Abida et al. (2011) stated, “the main objectives of education tools are to help teachers decide what they want their students to learn and to make sure they learn it” (p. 138). Math teachers rely heavily on student performance on assessments to determine the student's learning potential (Heritage & Heritage, 2013).

The form of assessments can be just as important as the purpose. The assessment must be created in a manner in which the assessment tasks are parallel to what the assessment is actually measuring (NRC, 1996, p. 83). Typically math assessments that are part of standardized tests are comprised of MC and CRQs. MC items require test takers to choose a response from set of provided answers, while CRQ items present a real life word problem and require test takers to create a response using critical thinking skills by explaining their reasoning from scratch. Scoring MC is known to take less time because the answer is either right or wrong.

Therefore, students and teachers are provided with feedback on MC tests faster. All these elements make MC items extremely appealing to teachers and students. Many educators believe that MC questions are more efficient opposed to CRQs (Abida, et al., 2011; Bowen & Wingo, 2012). Although MC items can be intended to interpret the way the students are processing the material, many researchers think that they will not get the important explanation of the students' thought process as effectively as CRQ items do. CRQ items assess students' abilities to evaluate and analyze content (Stiggins, Chappuis, & Arter, 2014).

When creating several test formats, teachers follow guidelines to ensure that the formats of the test are similar in subject matter and distinctiveness. For test containing MC items, the guidelines must include an answer key showing the right or wrong answer choice. A MC test enables students to identify the correct answer through a process of elimination. This process of elimination cannot be done with CRQ items. Because students are not penalized for wrong answers, MC test performance can be enhanced by the student's ability to guess. For tests containing CRQ items, the specifications must also include a scoring rubric for each item, which the teachers must follow to provide accurate scores for each student's responses (Kim, Mchale, & Walker, 2010).

Since CRQ items require students to reason and process information by using their own background knowledge to produce solutions these processes imitate the processing and reasoning that theorists support (Lissitz, Hou, & Slater, 2012). CRQ items allow for a range of answers depending on the students thinking process, all of which are provided by students using their original ideas rather than building on or copying someone else’s (Bennett, 2011). CRQ items reduce the likelihood of consistently guessing the correct answer by choosing it from a list because the correct answer is not provided in a CRQ item. In addition, students are required to use their own ideas, thoughts, and words to answer a CRQ item accurately (Hersh, 2011). Therefore, on math assessments, CRQ items are included to ensure students’ can provide the proper steps to answering the question and receive credit for doing so; whereas a MC question is marked right or wrong.

Assessments drive instruction. They have a major impact on how the material is presented and taught to the students. Students must be assessed on how they construct the solution as well as how they select an answer to ensure that they have accurately learned the skill (Lissitz et al., 2012). Therefore, if only MC items are included in the assessment, then students will only be learning the skill of selecting from given options instead of providing their reasoning. The Race to the Top Program’s application for new grants for Comprehensive Assessment Systems calls for a system that “elicits complex student demonstrations or applications of knowledge and skills” (U.S. Department of Education, 2010, para. 1). Both the Smarter Balanced Assessment Consortium and the Partnership for the Assessment of Readiness for College and Career have CRQ items and extended performance assessments as part of their assessment designs to ensure students are required to select answers as well as think critically and problem solve (Center for K-12 Assessment, 2012).

Diagnosing student willingness to learn content material is an essential component to effective teaching; and a starting point for a series of the inquiry process that teachers engage in consistently to help students achieve and close the achievement gap. Having an accurate understanding of the knowledge gaps in their classrooms assists teachers in creating appropriate lessons, units, and long-term goals for students. As a result, all teachers have to make sure that each minute counts. They can prioritize content effectively by the use of formal and informal assessment results and focus on areas where they see the greatest opportunities for growth.

In addition, they can determine what type of assessment, such as a MC assessment or constructed response assessment, needs to be used to assess certain material. Veldhuis and van den Heuvel-Panhuizen, (2014) believed that using a classroom assessment can help teachers understand the needs of their students. Therefore, creating effective assessments will help to address my problem because teachers must know what assessments to use to effectively assess the needs of their students.

Implications

Effective strategies to help students accurately answer constructed response math questions are imperative for student success. The implications of this study may reveal that implementing an effective strategy to teach students to accurately answer CRQs could improve students thinking and problem solving skills. Creating a PD program could assist teachers by providing them with strategies and approaches to work effectively with students to answer CRQs. Findings from the data collection may be used to document successful PD approaches and possibly create a handbook of strategies to share with math teachers and other educators who work with students in math classrooms. Research on implementation of successful strategies may assist teachers in better preparing students for the ever-changing world of math, science and technology.

A PD program for teachers could offer teachers with research supported best practices to enhance the learning experience of students. Teachers could benefit by learning a variety of teaching strategies so they have a collection of approaches from which to choose to address specific student learning needs.

A further consideration may be to share an adapted version of the PD workshop to parents. This would provide parents with the vocabulary and problem solving strategies to help students in the home setting in a manner consistent with classroom instruction.

Summary

The implementation of effective strategies, which can help teachers instruct students about how to accurately answer a constructed response question, may offer students the necessary tools and skills to achieve success in this task. Students enter classrooms knowing how to answer traditional MC questions, but they do not know how to answer CRQs through critical thinking and problem solving. This can inhibit them from being successful on standardized tests with CRQs (Teacher, personal communication, April 2013). Many of the Algebra 1 teachers in this North Louisiana school district are familiar with the CRQs, but they have not been effective in teaching students how to de-construct CRQ's and how to think through the process of solving successfully.

The purpose of Section 1 was to provide an overview of the project study. Section 1 included an outline of the focus of the study, the problem, the rationale, evidence of the problem at the local level, evidence of the problem from professional literature, the significance of the study, and a literature review. Section 2 will provide readers with an explanation of the methodology used for the study and will include information about qualitative design and case study methodology. Furthermore, Section 2 will include an overview of the setting, participants, data collection methods, data analysis methods, and evidence. The research design will be justified by relating research to the professional literature, including reasons why other professional development that has already been implemented has not been successful for many teachers. The criteria and procedures for choosing participants will be explained in detail. This study will be designed to investigate the perceptions of math teachers regarding effective teaching strategies for improving student performance on CRQs.

Section 2: The Methodology

Introduction

Lichtman (2012) noted that researchers conducting qualitative studies concentrate on deepness, as they go into depth in examining participants and their cultures. Qualitative researchers are concerned with meaning (Lodico, Spaulding, & Voegtle, 2010). In other words, they want to determine how people view their own lives. In this study, I sought to capture perceptions of teachers as they reflected on their instructional procedures in the classroom. The research design that I chose was a qualitative case study that used “a variety of data collection procedures, including interviews and observations” (Creswell, 2013, p. 13). According to Yin (2014),

> a case study design should be considered when: (a) the focus of the study is to answer “how” and “why” questions; (b) you cannot manipulate the behavior of those involved in the study; (c) you want to cover contextual conditions because you believe they are relevant to the phenomenon under study; or (d) the boundaries are not clear between the phenomenon and context. (p. 2)

Conducting a case study allowed me to investigate the perceptions of math teachers about effective teaching strategies for improving student performance on CRQs.

This study of teachers’ perceptions of effective teaching strategies explored a present-day trend or phenomenon in a real-world school setting. The case study design allowed me to determine rising themes and patterns that could help teachers advance in understanding about why students are unable to accurately answer CRQs. Research questions should always be researchable because they are “the seeds from which the study will eventually grow" (Lodico et al., 2010, p. 27). The research design of this study was derived logically from the following research questions:

1. What are the teaching strategies that teachers currently use to teach students to answer CRQs?
2. What are the perceptions of teachers regarding their current practices in teaching students to answer CRQs in this local district?
3. What professional development opportunities could enhance teachers' instructional delivery to support CRQ instruction?

Answers to these research questions were developed from teachers' perceptions and my observations, which informed an analysis of mathematics strategies that may help students answer CRQs in mathematics effectively. The research questions structured the study; by focusing on them in my communication with participants, I gained an understanding of which strategies were effective and which were not. As teachers shared their perceptions, data consistencies were revealed and developed into findings.

For this study, a case study approach was selected. Yin (2014) stated, "A case study allows investigators to focus on a 'case' and retain a holistic and real-world perspective" (p. 4). By using a case study design, I examined the data to define the nexus between the phenomenon and the local context. Grounded theory was not used for this study because its outcome requires the researcher to construct predictive statements about individual experiences (Creswell, 2012). Although I sought to explain educators' perceptions of what effective strategies can be employed to teach students to answer CRQs effectively, I did not choose a narrative design because there were more than one or two participants. Ethnographic research was also not chosen because it focuses on the interaction of an cultural group through firsthand experience, note taking, and observations in the classroom, and this study would not have been conveyed appropriately through analysis of a cultural group's shared pattern of behaviors and beliefs (Creswell, 2012). After reviewing the characteristics of the previously mentioned research designs, I concluded that a case study was the most advantageous choice to support the qualitative design of the research study.

Participants

Criteria for Selecting Participants

Potential participants were invited to an informational meeting about the study. At this informational meeting, I explained what the study was about and asked the potential participants to consider taking part in the study. During the informational meeting, potential participants self-selected to volunteer to participate in the study by acknowledging the following criteria: (a) they were familiar with the Algebra 1 curriculum and (b) they had at least 3 years of teaching experience. I also provided each attendee with a copy of the informed consent form for review. During the meeting, potential participants were able to ask questions and seek clarification on the study, the requirements, and/or the consent form. I provided a signup sheet at the end of the meeting for those individuals who were interested in participating in the study. After at least eight individuals had signed up, I had a purposeful group of eight participants for this study. Creswell (2013) stated that in qualitative research "the intent is not to generalize to a population, but to develop an in-depth exploration of a central phenomenon," which is best achieved by using purposeful sampling strategies (p. 203).

My job title is master teacher; I conduct PD workshops to provide teachers with effective teaching strategies that can be used in all academic disciplines. I do not supervise, evaluate, or manage any teachers. There are four high schools in the local district. I am assigned to work in one of those high schools. This study was conducted at three high schools to which I am not assigned. I had no engagement or interaction with the teachers who participated in the study. Authorization to conduct the study was received from the local school district.

Justification for the Number of Participants

Through a purposeful sampling method, I selected eight math teachers based on the following self-selection criteria: (a) they were familiar with the Algebra 1 curriculum and (b) they had at least 3 years of teaching experience. Creswell (2013) stated that "purposive sampling refers to selection of sites or participants that will best help the researcher understand the problem and the research question" (p. 185).

By selecting eight participants, I obtained enough detailed perspectives on the total population of Algebra 1 teachers from my participant group. . Data saturation takes place when the qualitative researcher no longer captures any new data (Creswell, 2013). The number of participants required to reach data saturation is reliant on the situation. Different studies require a different number of participants for data saturation. One study may only need a few participants to reach data saturation, whereas another study may need several participants. Creswell (2013) suggested that 10-12 participants are sufficient to reach the point of data saturation.

Procedures for Gaining Access to Participants

I gained access to the participants by establishing a partnership with the selected school district and administration of the four high schools, through which invitations were sent to all mathematics teachers (see Appendix B). The teachers were invited to an informational meeting through email in which the study and requirements of the study were explained. Email addresses were available and obtained through the school district's public website. Potential participants signed up at the end of the meeting or emailed me to acknowledge their interest and acceptance of the terms of the informed consent agreement (see Appendix C). Selections were made based on the criteria above. Selected participants were asked to sign and return the informed consent agreement or email their acceptance of the terms of the agreement before any data were collected.

Establishing Researcher/Participant Relationships

As the researcher, I was responsible for conducting a project study on the perceptions of math teachers about effective teaching strategies for improving student performance on CRQs. Before I initiated contact with potential participants, I obtained the approval of Walden University's Institutional Review Board (IRB). For this study, researcher/participant relationships were established based on current professional interactions within the school district. Each participant had a vested interest in student learning and achievement in mathematics and was willing to share information about professional development and instructional strategies that had helped students answer CRQs.

Participation within the study was on a voluntary basis as stated in the informed consent agreement, which was signed or accepted by each participant before I assembled the participant group. After conducting an informational meeting, I accepted volunteers for consideration. From among the volunteers, I sought to have between eight and 12 preservice teachers volunteer to participate in my study. Each potential participant was asked to sign and return a consent to participate form. Participants were provided with my contact information and had access to contact me at any time throughout the course of the study.

Ethical Protection of Participants

I assured the potential participants' ethical protection and confidentiality when they considered participating in this study. Permission to collect data from participants was gained from both the Walden University IRB (# 01-20-16-0294567) and the local school district where the study was completed. Participants were required to sign an informed consent agreement (Appendix C) before any data were collected. Ethical considerations included the confidentiality of the data collected from the interviews and observations. Measures for ethical protection of participants included the following: (a) informing participants of the purpose of the study; (b) sharing information about the study with participants; (c) conducting meetings in a private, locked room; (d) respecting the thoughts and feedback of the participants; (e) using ethical interview practices; (f) maintaining confidentiality; (g) securing all data collected; and (h) collaborating with participants.

Lodico et al. (2010) suggested two aspects of credibility to ensure accuracy and credibility of findings. Both the level of engagement in a study and the researcher's ability to collect multiple sources of data provide evidence of credibility (Lodico et al., 2010). Dependability and transferability are two additional criteria for ensuring accuracy and credibility in a qualitative study. These criteria were identified in the study by including a thorough description of how the data were collected from the teachers through interviews and observations.

Issues of Confidentiality

Selected participants were sent notification of their acceptance into the study via their personal individual email addresses. All study information was kept confidential. All data were stored on a password-secured computer; all documents, transcriptions, tape recordings, and flash-drive storage units were maintained in a locked filing cabinet in my home. All records will be maintained for the required period of 5 years from the completion of the study.

Data Collection

Data collection methods included interviews and observations. Merriam (2014) stated that qualitative research consists of multiple forms of data. I chose these data collection approaches because they provided the best data to address the research questions, and they allowed the participants to provide rich data reflecting individual perceptions and actions.

Interviews

The interview process is a vital part of the case study process that helps the researcher gain more in-depth and widespread material for the study (Yin, 2012). The purpose of interviewing is to find out the experiences of others and what they think about those experiences (Jacobs & Furgerson, 2012). Each semistructured interview took place during the participants' scheduled planning hours. The interviews lasted approximately 30–45 minutes. The interviews took place in a private, secure room within the school facility. Participants who were unable to participate at their scheduled times were provided with an alternate time. (Marshall & Rossman, 2014). Yin (2012) suggested that

> throughout the interview process, you [the researcher] have two jobs: (a) to follow your own line of inquiry, as reflected by your case study protocol, and (b) to ask your actual (conversational) questions in an unbiased manner that also serves the needs of your line of inquiry. (p. 108)

The interview model for these interactions was a conversational partner format.

The interview protocol consisted of eight interview questions (see Appendix D) addressing the key points of the following research questions:

1. What are the teaching strategies that teachers currently use to teach students to answer CRQs?
2. What are the perceptions of teachers regarding their current practices in teaching students to answer CRQs in this local district?
3. What professional development opportunities could enhance teachers' instructional delivery to support CRQ instruction?

The interview questions were aligned to the research questions. Three questions (Questions 1 through 3) were derived from the first research question; two questions (Questions 4 and 5) were derived from the second research question; and three questions (Questions 6 through 8) were derived from the third research question (see Appendix D). Interviews were recorded with an audio tape recorder and transcribed to create an exact account of each participant's response (Creswell, 2013). I transcribed the interviews using the Microsoft Word program. In addition, I collected clarifying notes in a journal during the interviews to capture any additional visible information such as facial expressions, gestures, and voice tone. I also noted any strong statements or significant insights.

Observations

The purpose of an observation is to focus on human actions and gain more evidence about the person or subject being studied (Merriam, 2014). This is a period of in-depth communication between the researcher and the subjects. Yin (2012) suggested that observations are invaluable aids for understanding the importance of why the problem is occurring. Administrative approval was not necessary for these observations because they were not formal observations, and they were not placed in the teachers' personnel files or shared with administrators. I am not in a supervisory position, nor do I supervise any of the potential participants. The classroom observations allowed for insight into contexts and teaching behaviors within the classroom. The observations provided me with data that responded to the first research question regarding teaching strategies currently being used. Conducting observations allowed me to identify different teaching strategies that were used within classrooms. They also provided a rich source of data that could be compared to participants' interview responses.

Participants who taught Algebra 1 were observed teaching during two 30-minute regularly scheduled classes without any disruption of their normal activities. I conducted two observations of each participant's Algebra 1 classroom during the data collection period. I collaborated with the teachers through email to determine the days of the week on which they focused on CRQs. Prior to the observations, I discussed with the participants what I would be looking for when I observed them, and I assured them that they would not be judged on the things I saw during the observations. Hill, Charalambous, and Kraft (2012) suggested that it is vital for researchers to share important criteria with the participants regarding observations.

I scripted the observed lessons with notes recorded on the Classroom Observation/Walkthrough Form (Appendix E), which indicated the four steps that students need to follow to answer a constructed response question. Polya (1985) suggested that four steps should be followed to solve a CRQ. The Classroom Observation/Walkthrough Form was a form that I created to record my observations, reflections, and thoughts. I specifically looked for examples of teachers modeling steps needed to answer CRQs. Using the Classroom Observation/Walkthrough Form (Appendix E), I provided a check mark next to the steps I saw and provided rich, descriptive notes and examples for specific evidence. This form helped me to focus on those strategies that seemed to be preferable to teachers.

Researcher's Role

I have 12 years of teaching experience as a math teacher in the local school district. Presently, I am a curriculum specialist who develops curricula, models new teaching strategies, and assists teachers who request help. My role is to support math teachers without any supervisor or evaluator responsibilities. My current working relationship with the teachers who participated in this study is professional. As this study was conducted in my local school district, teachers were assured that they would not be evaluated based on their responses during the interview or the notes from my observations; all conversations were confidential.

Teachers were assured that the goal of the study and the focus of the data collection were solely to examine the various teaching approaches used in Algebra 1 classrooms. Teaching performance was not evaluated because my observations focused on the teaching strategies that teachers used. A personal reflection log used by me to personally answer the interview questions before I began collecting data allowed me to fully disclose my responses and opinions.

Data Analysis Results

Data Analysis Process

The purpose of qualitative data analysis is to identify, examine, and interpret patterns and themes in data and determine how these patterns and themes help answer the research questions (Lodico et al., 2010). Qualitative data were collected through interviews and observations; the methods were chosen by aligning the methods with the study problem and the research questions (Merriam, 2014). I interpreted the data in different ways; it is important to enhance the trustworthiness of the findings using various approaches (Merriam, 2014). Using several sources of data evidence makes the study convincing and accurate because several different sources of information come together to form the big picture (Yin, 2014).

As I gathered data and later analyzed it, I made sense of the phenomena to understand how participants attempted to give meaning to it (Merriam, 2014). Upon completion of the data collection, I took multiple steps to complete the data analysis. The analysis began with systematically organizing the data. Interpreting the data seemed a little challenging at times, but once data saturation was reached, I was able to accurately see my themes and key categories emerge from the data. Creswell (2012) identified six steps to analyze and interpret qualitative data. The six steps are as follows: (a) exploring data by coding, (b) using codes to find themes, (c) using codes to develop a general idea of the data, (d) representing findings through narratives and visuals, (e) interpreting the meaning of the results, and (f) conducting strategies to validate the findings. Using the open coding process that Creswell (2012) described, I began the coding process by identifying themes derived from the interviews and observations.

A researcher should conduct a code-recode procedure on data throughout the analysis phase of the study (Saldana, 2013). Code-recode involves identifying themes and recurring ideas that appear throughout the collected data (Creswell, 2012). I incorporated Saldana's (2014) process by waiting one week after coding a section of data, and then I returned and recoded the same data and evaluated the results. I listened to the interview recordings and transcribed them in week one, and I repeated this process again during week two. By listening to the interview recordings twice, I was afforded the opportunity to really hear the participants' perceptions and ideas clearly.

Both the interview and observation data were coded for responses related to each research question. Code-recode allowed me to refine the initial coding and to develop new codes through analysis (Saldana, 2013). Saldana (2014) stated that during the first cycle of coding, themes consisting of one word to a full sentence may be developed; during the second cycle, there may be a reconfiguration of the codes. I approached this process by examining the notes from the transcribed interviews and highlighting words or phrases that were related to each of the research questions, and I began grouping these by concepts. I repeated this process with my notes from the classroom observations (Creswell, 2012).

The text segments provided additional information that was added to the coded data. Once each data source was coded, I looked for similarities and reduced the list to a minimal number. I looked for repeated words. In addition, I highlighted everything that had to do with research question 1 in pink, question 2 in blue, and question 3 in green. Then I looked through to determine which comments and responses referred to strategies that help students perform better on word problems.

The coded data were organized into thematic clusters that suggested possible findings. According to Merriam (2009), the essential objective of coding data is to obtain emerging themes that are consistent throughout the collected data to provide a detailed description of the data.

The data were organized in a table to create a visual which represents all discovered repeated words, key categories, themes, and findings. The themes deeply revealed the experiences and practices of participants as they emerged from their perceptions, struggles and successes. Careful data analysis allowed me to create a picture of the professional experiences of Algebra 1 teachers by capturing their voices and the deep and diverse contexts of their classroom experiences. All patterns and relationships evolved as the data were coded by themes, based on the frequency of appearance in the transcriptions, recordings and notes.

I continuously checked for reliability and validity in my findings. Merriam (2014) explained that the procedure known as member checking can be used to help maximize the trustworthiness of the findings. This process will be discussed later in this section. I also used triangulation to verify the data by checking the data sources against one another. According to Yin (2014), the principal of triangulation relates to the purpose of trying to find ways of verifying a particular event, description, or fact being reported in a study. The data collection methods were individual interviews and classroom observations. The collected data were triangulated by comparing the two sets of data to provide evidence and to substantiate the perceptions of math teachers about teaching students to answer CRQs. The interviews provided individual teacher perceptions about the problem and how they worked with students; the classroom observations provided data about how teachers actually worked with students to instruct and assist them in solving CRQs.

Because of the different methods I used to collect data, I have provided a study that is rich with detail. A detailed, rich description helps the reader envision what the researcher is trying to say (Merriam, 2014). To analyze the collected data, each interview and observation was thoroughly reviewed to identify patterns, themes and strategies which related to my research questions. I reviewed data by using a recursive process of continuously reading the text until categories of themes emerged (Merriam 2014). A researcher's interpretation of the data is only one of several ways of understanding the data, but any interpretation of the data must be supported by the data (Auerbach & Silverstein, 2003; Merriam 2014).

Once the data collection was complete, all of the interview transcripts and observation notes were compiled to organize the information gathered and to identify patterns, themes and strategies (Merriam, 2014). Once patterns and themes emerged from the data, each theme and strategy was charted on poster paper and color coded to identify significant findings. This provided a visual way to help identify findings that offered evidence of effective teaching strategies and that provided clues toward improving student performance.

To ensure accuracy and credibility, data analysis included a code-recode approach on the data, a member checking process, and triangulation of data. The code-recode procedure was on-going throughout the data analysis as described above. A member checking process was utilized to verify the information gained from the participants' interviews. I used member checking process by sending an email copy of my projected findings to each participant in the study. I asked each participant to review the findings to ensure that I captured their perceptions and thoughts accurately (Creswell, 2012).

Each participant was then given an opportunity to discuss the findings with me. Creswell (2012) stated that member checks may involve sharing all of the findings with the participants, and allowing them to critically analyze the findings and provide comments on the findings. This assists in decreasing the chance of incorrect data and the incorrect interpretation of data (Creswell, 2012). Member checking allowed me to ask participants for feedback on "emerging findings" (Merriam, 2009, p. 217). Checking to make sure that data are not misinterpreted is essential to ensure that participants "recognize themselves" in the researcher's analysis (Merriam, 2009, p. 217).

I triangulated the collected data to corroborate the findings. Stake (1995) identified triangulation as "a quality assurance tactic to ensure that case study research is based on a disciplined approach and not simply a matter of intuition" (p. 107). I examined the interview transcriptions and my observation records. The data collected was triangulated by comparing the two sets of data to provide evidence and to substantiate the perceptions math teachers about teaching students to answer CRQs. I observed participants in classroom settings to collect data on teaching strategies that were used, and then interviewed those same participants to gather their perceptions of their experiences in teaching CRQ strategies.

To triangulate the data, I compared the data collected from the two sources to gain a greater perspective about the data. By comparing one data source with another, I was able to cross check for less obvious findings, potential bias and possible issues within the data. "The most important advantage presented by using multiple sources of evidence is the development of converging lines of enquiry" (Yin, 2009, p. 115). Yin (2014) further stated that the findings of a case study are more authentic and convincing when a variety of data sources are available. By interviewing eight math teachers, I was able to gather various perspectives on my research questions. The research results were shared in a 1-2 page summary with the participants, principal, and the district superintendent.

A key element of improving validity is dealing with discrepant data that does not fit dominant patterns and themes. If there had been discrepancies of accuracy or process within the data, the data would have been looked at in detail to determine why they differed and checked for consistency. The discrepancy would have been coded, categorized and reported as such along with all other data (Patton, 2014). Analysis of discrepant data could help revise, broaden and confirm the patterns emerging from data analysis (Patton, 2014). Discrepant cases were not evident due to the positive and extended responses received during the data collection and the member checking processes.

Findings

In this section, I discuss the patterns and themes that emerged from the data I collected. My plan for analysis was to identify, examine, and interpret patterns and themes that emerged from the data and to determine how these patterns and themes helped answer the research questions (Lodico et al., 2010). According to Merriam (2009), the essential objective of coding data is to obtain emerging themes that are consistent throughout the collected data to provide a detailed description of the data. I discovered three themes that emerged from RQ1, four themes from RQ2, and three themes from RQ3. From these themes, I identified three findings which respond to the three research questions and to the problem that prompted the study. I discuss each of the findings and provide examples from the collected data that support the findings. When I refer to the eight participants in the study, I use pseudonyms to share their thoughts and perceptions.

The problem that prompted this study was that teachers struggled to find appropriate strategies to teach students to answer CRQs effectively. The research questions focused on math teachers' perceptions of current teaching practices, the effectiveness of their work, and their identified professional development needs. The following research questions were addressed in this study:

1. What are the teaching strategies that teachers currently use to teach students to answer CRQ?
2. What are the perceptions of teachers regarding their current practices in teaching students to answer CRQ in this local district?
3. What professional development opportunities could enhance teachers' instructional delivery to support CRQ instruction?

These research questions formed the basis of the interview questions (Appendix D) and the classroom observation/ walkthrough (Appendix E).

The themes that emerged from the data respond to the three research questions and to the problem that prompted the study. First, I searched the relevant data for repeating words and phrases, similarities, and differences. Repeated words included are taken from participants' interviews. Participants used the phrase "strategy that breaks down the content" 18 times in all forms of data collection, and the words "reading comprehension" and "vocabulary" 26 times. I then organized the groups of repeating words and phrases into key categories and then into common themes which helped me to organize the findings. The data were reviewed by using a process of continuously reading and reviewing the text from the interviews and observations until groups of themes emerged. This process resulted in 10 themes that addressed the three research questions. I identify three themes that emerged from RQ1, four themes from RQ2, and three themes from RQ3. I then matched up each of the 10 themes with one of the related research questions. Second, I used this information to create my first table. Table 1 lists the research questions, themes, and findings.

Finding 1. The first finding revealed that teachers rely on formula-based instructional strategies to introduce and reinforce CRQ problem solving, but they recognize the importance of engaging students in more active learning strategies. During the individual interviews, each participant offered their personal preference for a specific strategy that they use to teach students how to answer CRQs. In the interviews, each participant consistently noted that the particular strategy used to instruct students provided the students with a set of steps to assist them in determining what the question is asking them to do and what operations or math formulas should be used to answer the questions. During the observations, I noted four teachers instructing students to use a step by step strategy. They modeled each step for the students by stopping to tell them the purpose for completing each step and how this process helps them obtain the correct answer. The strategies required the students to find the answer to the problem using steps instead of engaging them in active learning strategies. I noted that the step by step process worked for many of the students because they were able to see how and why each step was completed and why following these steps led them to the correct answer. However, I also noted that when it was time for the students to solve a problem individually, without the help of the teacher, they forgot the steps unless the steps were posted in the room somewhere. In addition, many of the students asked the teacher to remind them of the steps when they completed their exit tickets. Therefore, I noted that the step by step strategies work, but there needs to be some reinforcement of the strategy such as a game or chant to remember in order for the students to remember the steps in the strategy. Then, the students will be more actively engaged. Phrases like “strategy that breaks down the content” or “strategy that picks out details” frequently appeared in the interview transcriptions and observations notes. Participants agreed that there should always be a “step by step approach” to solving any type of word problem.

Participants also agreed that having the students restate the question in their own words should always be a part of the step by step process. In her interview, Nicole pointed out that teachers should teach strategies that involve helping the student really focus in on the question. She stated that, “having a strategy that involves some type of restatement of the question and just some steps that they should go through to make sure that they completely and accurately responded to the question definitely elicits successful performance from students on constructed response questions”. During an observation of Nicole’s lesson, she modeled for the students how to restate the question by focusing on familiar words in order to understand what the question was asking. Because she knew that all students learn differently, she gave students a choice of underlining the familiar word, highlighting the familiar word, or writing the meaning of the word out to the side. The students seemed to really grasp this. They all were able to identify at least one familiar word which led them to understand what the question was asking. During the interview, Michelle explained that, “before the students can restate the questions and follow a step by step approach, they must understand the math concept that is being addressed in the entire word problem” (see Table 1).

Table 1

Perceptions of Math Teachers About CRQ—Findings

Research questions	Themes	Findings
RQ1. What are the teaching strategies that teachers currently use to teach students to answer CRQ?	Math teachers use formula based strategies. Math teachers have preferred formula based models that they tend to use as their sole method for CRQ problem solving. Math teachers recognize the importance of active learning for students	Teachers rely on formula-based instructional strategies to introduce and reinforce CRQ problem solving, but they recognize the importance of engaging students in more active learning strategies
RQ2. What are the perceptions of teachers regarding their current practices in teaching students to answer CRQ in this local district?	Math teachers are challenged by students with reading difficulties. Math teachers recognize the need to work with students to develop healthy math vocabularies. Math teachers recognize their need to develop strategies to teach reading in their content area. It is important for students to demonstrate their competency for solving CRQs by showing each step of the process.	Teachers acknowledge that reading comprehension and vocabulary are major stumbling blocks to students answering CRQs.
RQ3. What professional development opportunities could enhance teachers' instructional delivery to support CRQ instruction?	Math teachers want to engage in hands-on professional development to broaden their knowledge and use of working with manipulatives and cooperative learning strategies. Math teachers want to participate in professional development that employs the use of student work samples. Math teachers want professional development training in using scaffolded lessons to help students understand the content better.	Teachers would like to engage in hands-on professional development that provides differentiated teaching approaches, manipulatives, scaffolded learning strategies, and cooperative learning.

One participant, Kim, recognized the importance of modeling when she stated the following:

> The teacher modeling is most helpful and then also not just modeling your response but modeling your thinking. As you approach a prompt where they [the students] have to construct their own responses or strategies where they can grade other students' work, they need to see your rubric and see what an exemplar of a response. Therefore, they are not always just following a step by step strategy without understanding or knowing the logic behind the use of the strategy.

Another participant, Mike, expanded on this idea of modeling the process for students. He stated that "getting students to underline the key details" has been a successful part of his strategy steps. Every teacher whom I observed modeled some part of the problem solving process to ensure that the students knew what the teacher expectations were for solving a problem. Every study participant agreed that the most important thing is for the students to understand how they need to begin and end the process of solving the problem.

What emerged repeatedly in interviews and observations was the notion that there must be a strategy in place for students to use to be successful in answering the constructed response questions. However, while participants felt that there always should be a strategy in place, they also believed that there should be more cognitive lifting on the students' part as opposed to the students' continued reliance on the teachers to provide step-by-step instruction. Mary captured this idea when she stated:

> The challenge that students are having with using the strategies is that they are not engaging in some type of hands-on activities, such as game-like structures, simulations, product creation, and self-directed and self-monitoring strategies. Therefore, as a teacher, I know we need to dig deeper to find ways to engage our students more.

John added that there should be more time for “student to student interaction and student reflection” so that the students can be peer coaches to one another, as well as have time to reflect and to decide if the strategy works or if they need to try another approach. Lisa stated that, “When students use manipulatives, they seem to understand the questions better; they can visually see their process of solving the problem emerge right in front of their eyes”. I observed Lisa use a hands- on equations kit with a balance beam to demonstrate for the students how equations should be balanced. The purpose of the balance beam was to show that an equation has to be balanced to be solved correctly. Borenson stated,” by first teaching the concept of equivalence nonsymbolically, using the balance model or using concrete objects, and only afterward relating that learning to the symbolic notation, we can provide young students with a successful introduction to the relational meaning of the equal sign." (p. 94). Kim added that any strategy can be successful if the teacher “provides differentiated instructional methods to ensure students have the opportunity to master what is being taught”.

All participants perceived that there should be a strategy in place for students to use when answering constructed response questions. Dana provided a good summary when she stated, “all students need a set of steps to follow to be successful when answering these types of questions. It's just about if you develop the steps or you let the students develop them". Teachers are concerned that all students have a strategy in place. They always want to ensure the strategy will help students achieve success.

According to Stols, Ono, and Rogan (2015), it is necessary to provide all students with quality math instruction in a way that is both rigorous and keeps them engaged. The students should be doing the cognitive lifting by developing their own strategies, and the teacher should be facilitating (Jackson et al., 2012). These types of strategies would build on and extend students' innate abilities to perform at higher levels. According to the National Center for Education Evaluation (2010), teachers who spend a large amount of time providing the students with the steps to solving the problems and not allowing them to discover some strategies, saw declines in student achievement. Therefore, if teachers incorporate student-centered strategies to assist students in developing their own processes, students will become active learners. Çubukçu (2012) stated that teachers should provide time for students to engage in student-centered learning activities because it gives students an opportunity to learn on their own. Two participants shared that they have begun trying to move from teacher-centered learning to student-centered learning.

Finding 2. The second finding revealed that teachers acknowledge major stumbling blocks to students answering CRQs are reading comprehension and vocabulary. Study participants agreed that students must be able to read and comprehend the content and understand the vocabulary to effectively answer CRQs. During the interviews, Mary stated, "The students are having comprehension problems; most of them are not comprehending what the questions are asking them to do." In her interview, Kim pointed out that students just do not know where to get started. She stated, “Because their reading comprehension levels are so low, it just takes them a while to sequence their thoughts and just get started”.

One participant, Dana, recognized the connection between knowing the vocabulary in the CRQ to comprehending what is being asked when she stated the following:

> Most students do not comprehend what they read in the questions because they do not understand the vocabulary. Understanding the vocabulary is the key to effectively answering the question. For example, if the students do not know that finding the quotient means to divide and they multiply instead, they have already started off on the wrong track. Therefore, they will definitely get the question wrong.

Another participant, Lisa, pointed out that it is important to have the students underline, highlight, or circle the key vocabulary in the CRQ. She stated, “Students with low comprehension skills need to identify the vocabulary first before trying to answer the question because without knowing the vocabulary, there can be no success in answering the question”. I observed two participant teachers instruct students to highlight key vocabulary while; three others were observed instructing students to box in key vocabulary and write the definitions out to the side. All the students seemed to have already become comfortable with completing this task. Some even started completing this task before the teacher instructed them to do so.

Nicole discovered that the students who have low comprehension skills and do not know the vocabulary tend to guess their answers.   She said, “Students just begin selecting numbers out of word problems without understanding what the question is asking them”. During my observations, Nicole had her students refer to a key word chart in order to determine what operation to use. Below each heading, key words were listed. For example, under the heading, *division*, the word, *quotient,* appeared. This chart was used to help students determine the mathematical process needed to solve a CRQ. I noticed that the majority of the students consistently looked at this poster to determine the operation they needed to use. However, three students still needed assistance with determining the operation. They could solve the problem once they knew what operation to use but they just needed more assistance getting to the actual problem solving. John added that students “rush through their work without proofreading or checking to make sure the right question has been answered”.   Michelle stated that the students that have low comprehension skills also “prefer to be tested in MC formats because they can guess at the answers”. During the interviews, 6 out of 8 participants said students feel that guessing the answers on MC questions seem a whole lot simpler to students than having to actually think critically. Kim captured this idea when she stated:

Students have a mental block at first where they just think that they cannot answer the question. They perceive that MC questions are easier and that the constructed response questions are more difficult, so they come in with just an attitude of this is going to be difficult. Mike stated, “The hardest thing for our students these days is answering an open-ended question where they cannot just choose an answer.”

During the observations, I was able to see the teachers teaching the students how to identify key vocabulary and break down the CRQs so that they would have a better understanding of the content. In the majority of classrooms, between 5 to 10 minutes were spent reviewing vocabulary in order to assist students with word comprehension to understand word problems. Four teachers asked the students to highlight, underline, or circle key terms, while two teachers asked them to write the vocabulary word on a board in the front of the classroom and give a detailed definition of the word. Michelle had her students box the key words and write the operation to be performed next to the word.

During Mike's observation, he asked the question, "What does the word evaluate mean in this problem?" He posed this question to the students, "This is a key term that you will see on the constructed response section of your EOC; how will you answer the question?" There were several students who did not know what evaluate meant. Therefore, Mike had to take time and explain what the word meant before he could move forward with the lesson. John took a different approach and asked the students to focus on key vocabulary at the beginning of the class for the first ten minutes. Then, he directed the students to answer CRQs using those vocabulary terms. Lisa, used an operation chart with key terms to help students remember where to begin solving the problem. Based on my observations, teachers, who required students to focus on vocabulary and comprehension, produced improved student performance. Although the teachers used different strategies to accomplish these tasks, they all assisted the students with reading comprehension in math. As teachers focused on the comprehension and math connection, student performance appeared to improve. The inclusion of teaching literacy in math seems to offer students an effective learning strategy. Furthermore, each one of the participants expressed a desire to learn more effective strategies that will assist students with reading comprehension and with vocabulary building in math.

According to a study conducted by Imam, Mastura, and Jamil (2013), low reading comprehension skills of students are consistent with their performance in mathematics. Teachers try to assist students in reading and interpreting mathematics text and discuss problem-solving strategies that will help them get accurate answers. When answering word problems in mathematics, students are presented with words centered on numbers instead of “naked computations” (Friedland, McMillen, & Hill, 2011, p. 57). Teachers use such phrases as times means to multiply and quotient means to divide. However, most strategies are still procedural and follow a process or a set of steps rather than about helping students to read and comprehend for understanding (Riccomini, Smith, Hughes, & Fries, 2015). Reading comprehension is a very important component of problem solving in math (Ness, 2016). Therefore, students should be given the opportunity to learn how to comprehend what the problem is asking them to do as well as communicate their thinking during problem solving process.

Finding 3. The third finding revealed that teachers would like to engage in hands-on PD that provides differentiated teaching approaches, manipulatives, scaffolded learning strategies, and cooperative learning. During interviews, all participants expressed the need for a hands-on PD session. Mary stated, “The perfect professional development would be hands-on, where we could all dig in together and build on each other’s ideas”. Michelle suggested the following:

> The PD sessions need more hands-on where I am actually working in a classroom setting like I am the student. I do not want to be told what I should do; just teach me as I'm a student so I can see the student perspective and I can actually model that for my students.

Another participant, Lisa, said, “I just want to be involved and feel like I am learning something that will really help my students”. Nicole pointed out that the PD session needs to focus on teaching teachers how to model the process of solving the problems. She stated, “I would like to do a lot of modeling consisting of an "I do" and then "we do" and a “you do” where the students solve the problems on their own”. Dana added an example of what a model by a presenter should look and sound like. She stated the following:

> The presenter should provide the same handouts labeled by number to the teachers as he or she would the students. Then, the presenter should go through the entire process of modeling the “I do” first. Following that, the presenter should go through the “we do”, and finally have all attendees complete an exit ticket as our “you do” to determine our level of understanding. As teachers, we should be given development time to plan out a lesson based on what we learned that day.

Kim believed that there should definitely be a process that includes and “I do”, “we do”, and a “you do”, but the process could be switched around. She stated the following: Why don’t we learn how to allow the students to discover the formula first which will be the “we do” and then after they have discovered the formula, we can come back and complete the “I do” using a model. I just think we should give the students more opportunities to think critically.

Mike stated, “The more hands-on and student-centered the professional development is, the better the training is for the staff”.

In addition to hands-on PD, the teachers wanted to learn how to incorporate scaffolded lesson strategies. Michelle stated the need to include student work samples. She stated, “The best professional development I could see myself attending would involve seeing some students’ work before and after a specific learning strategy and seeing different types of responses which would help me scaffold my instruction better”. Dana added, “I just really want to learn how to scaffold my instruction using the student work, and then really break down the strategy with my students based on their levels of understanding so that they can understand what I did to answer the question”.

Finally, the use of manipulatives and cooperative grouping emerged through my data collection. John stated, “I think it would be great to learn different ways to use cooperative grouping and manipulatives in my classroom”. Mary added, “The use of manipulatives will assist my students in going from concrete to abstract thinking in mathematics”. Nicole shared, “Cooperative learning may be a way to help my students understand better; I think if I cannot get them to understand, their peers can do so in a different way”. Teachers want to ensure that whatever PD is offered, it will have the greatest positive impact on student achievement.

Teachers being prepared when they walk into the classroom is linked to student achievement (Opfer & Pedder, 2011). Professional development can help remedy this situation in most settings. According to a study conducted by Bayar (2014), “any effective professional development activity should consist of the following components: 1) a match to existing teacher needs, 2) a match to existing school needs, 3) teacher involvement in the design/planning of professional development activities, 4) active participation opportunities, 5) long-term engagement, and 6) high-quality instructors” (p.1). Therefore, effective professional development is learning from the work teachers do in their classrooms (Zepeda, 2011). More importantly, effective professional development occurs when teachers work together to support, encourage, and learn together.

Discrepant Cases

Participants generally agreed that teachers need to engage in a PD session that teaches them how to teach students to use an effective strategy when answering CRQs. Discrepant cases were not evident due to the positive and extended responses received during the data collection and the member checking processes. However, during the interview, one participant, Mary did express some concern about the format and presentation of a PD session, “I like to plan alone so I do not know if there is an ‘ideal’ professional development session for me.” Then, during our talk as we went through the member checking process, Mary said, “I know I said I like to work alone but I definitely like learning new strategies and ideas, so attending a PD with other teachers that have been successful with this will definitely help me help my students.” These data were included and analyzed as vital information related to the perceptions of teachers about attending PD sessions.

Evidence of Quality

After all the data were gathered and analyzed, I triangulated by comparing the two sets of data to substantiate the validity of the emerging themes and findings. By comparing one data source with another, I was able to cross check for less obvious findings, potential bias and possible issues within the data. The findings revealed that the participants' responses to my interview questions were displayed in their actions in the classroom during observations. While participants responded differently to both forms of data collection, the emerging themes were in alignment.

First, I conducted face-to-face interviews with individual participants in a private, secure room. I provided all participants with an adequate amount of time to think and answer the questions. I recorded all interviews with an audio tape recorder, and I transcribed the taped information to construct an exact account of each participant's responses. I completed this process after each interview. By listening to the interview recordings and transcribing them, I was afforded the opportunity to really hear the participants' perceptions and ideas clearly.

In addition, this gave me time to record some my perceptions of the teacher responses in my own journal. For example, in the first interview, I realized that my questions were very crisp and clear, I would listen to my participant's responses but not ask any probing follow-up questions to ensure she provided expanded in-depth answers. Therefore, in subsequent interviews, I corrected my interviewing technique by asking follow-up questions if the participants did not provide in-depth responses. This resulted in more detailed and thoughtful responses.

Secondly, I observed each participant's Algebra 1 classroom twice for 30 minute periods to identify the teaching approaches and strategies that were being used within each classroom. During the observations, I recorded notes on a Classroom Observation/Walkthrough form (see Appendix E) that I created to record my observations, reflections, and thoughts. I recorded specific examples of strategies the participants used to teach their students how to answer CRQs. For example, during my first observation, I witnessed a teacher use a problem-solving strategy where students are asked to read and restate, identify, plan, and solve (RIPS) that required the students to follow four steps.

The students were required to read and restate the question, identify key information, create a plan of action, and solve the problem. This participant asked the students to read and restate a problem question, identify key information, create a plan of action, and solve the problem. I noted the process steps and the strategies employed by the teacher, and I recorded rich, descriptive notes and examples for specific evidence. These observations provided me with the information about teaching strategies which seem to be preferable to teachers.

Two different forms of data provided me with rich responses that captured recurring themes. The data were analyzed through a code-recode process as well as triangulated by comparing the interview responses to the evidence collected during observations. In addition, I used a member checking process to verify the information gained from the participants' interviews and to provide the participants an opportunity to read and respond to my initial findings. I sent out an email copy of my projected findings to each participant in the study. I asked each participant to review the findings to ensure that I captured their perceptions and thoughts accurately; each participant was invited to discuss the findings with me.

Four participants requested to meeting to add additional thoughts and perceptions. I wanted to ensure I understood what everyone was saying. This member checking process assisted me in decreasing the chance of incorrect interpretation of data and allowed me to ask participants for feedback on emerging findings. By using code-recode, triangulation, and member checking, I ensured all findings were a reflection of the participants' thoughts and perceptions. Transcripts of interviews, observation form notes, and reflection journal notes provided evidence of data collection and essential reflections that resulted in the data analysis.

Conclusion

By capturing the perceptions and experiences of teachers about improving student performance on constructed response questions, I addressed three research questions. The research questions were related to participants' perceptions of effective teaching strategies and professional development opportunities that could enhance teachers' instructional delivery of answering CRQs.

1. What are the teaching strategies that teachers currently use to teach students to answer CRQ? In Finding 1, I indicated that teachers rely on formula-based instructional strategies to introduce and reinforce CRQ problem solving, but they recognize the importance of engaging students in more active learning strategies. To illustrate Finding 1, during the interviews, participants shared

several specific formula-based strategies consisting of four to five problem-solving steps for students to follow to effectively answer CRQs. The strategies that were mentioned included the following: (a) the RIPS strategy, which requires students to read and restate the question, identify key information, create a plan, and solve the problem; (b) the CUBES strategy, which requires the students to circle the numbers, underline the question, box the key math words, evaluate the steps, and solve the problem; (c) the KIMS strategy, which requires students to key in vocabulary words, identify the definition, use a memory clue, and solve the problem; and (d) TAPE diagrams which requires students to use masking tape to solve the question.. During the observations, I witnessed participants using these strategies during classroom instruction. Participants did not implement any hands-on or student-centered learning strategies.

2. What are the perceptions of teachers regarding their current practices in teaching students to answer CRQ in this local district? In Finding 2, I indicated that teachers acknowledge that reading comprehension and vocabulary are major stumbling blocks that prevent students from answering CRQs. To illustrate Finding 2, participants provided several examples of students not understanding what a mathematical word problem was asking of them. This occurred when students struggled with identifying the meaning of words and when they were unable to comprehend the meaning of a written word problem.

3. What professional development opportunities could enhance teachers' instructional delivery to support CRQ instruction? In Finding 3, I indicated that teachers would like to engage in hands-on PD that provides differentiated teaching approaches, manipulatives, scaffolded learning strategies, and cooperative learning. To illustrate Finding 3, participants provided several different perceptions of an ideal PD sessions centered on CRQs. The participants provided strong feedback on effective ways to involve teachers in the learning process to assist in student success on answering CRQs.

I will design a PD project based on the findings to assist and support teachers in teaching students to answer CRQs. I learned that all teachers have their own style of teaching, but they want to learn more effective ways to engage students in the learning process. I will develop the PD for teachers to encourage them to build on their reading and language skills in mathematics, use active learning strategies for students such as cooperative grouping and hands-on learning through manipulatives, and build their skill levels with scaffolded learning strategies. I will design the PD to help teachers learn how to make their lessons more student-centered by incorporating more manipulatives, by effectively grouping their students, and by using student work to inform their instruction and increase student achievement on CRQs.

Current findings captured the teachers' perceptions of teaching students how to answer CRQs. A review of literature about problem solving in mathematics classrooms gathered the perceptions of scholars who study problem solving in mathematics to strengthen this study's findings. In the project design, I will draw information from the findings and the literature review to provide teachers with effective strategies to implement in their classrooms to assist students in answering CRQs.

Section 3: The Project

Introduction

This qualitative study captured the perceptions of Algebra 1 teachers about their instructional practices with CRQs in a case study design. Findings revealed the instructional strategies and processes teachers need assistance with to successfully teach students to answer CRQs. The following section outlines a project based on the genre of professional development. The intent of this project is to assist teachers in implementing successful instructional strategies to assist students in answering CRQs in their classrooms. I provide a description of the project goals, rationale, implementation, potential barriers, potential resources, and supports to assist teachers who struggle with CRQ implementation and as a model for school leaders who might want to create similar training sessions to effect social change in their schools**.** I include a review of the literature to deepen and expand understanding of my study's findings and critical components. Finally, I discuss the evaluation of the project to offer a framework for reflection on the project's success and possible improvements or changes.

Description and Goals

Description

This project is a 3-day PD for teachers who want to build their reading and language skills in mathematics and learn how to teach active learning strategies such as cooperative grouping and hands-on learning through the use of manipulatives that can assist students with answering CRQs and building their skill levels with scaffolded learning strategies. I created this project based on study findings that indicated that teachers would like to engage in hands-on PD that teaches them effective learning strategies to use in their classrooms. In this section, I outline the purpose and goals for the project. The overarching goal for the PD is to equip teachers with effective strategies that can be implemented in their classrooms to assist students with accurately answering CRQs. Furthermore, each day of the program will have a distinctive purpose along with additional goals.

During the first day of the PD, I will present teachers with an overview of what will be covered during the 3-day PD, research-based information on literacy in mathematics, and sample activities involving literacy activities that can be implemented in mathematics classrooms to strengthen students' reading and language skills. Teachers will engage in a workshop where they will be given an opportunity to plan a literacy-based mathematics lesson. On the second day of PD, I will engage each teacher in participating as a student in a model lesson incorporating manipulatives and cooperative learning. In addition, I will provide the teachers with sample lesson plans identifying ways to scaffold content being taught in their classrooms.

On the third day of the PD, I will facilitate a lesson planning structure. Teachers will plan a lesson incorporating hands-on learning using manipulatives and cooperative grouping. Teachers will be required to present their lesson plans to the group. After their presentations, all participants will submit their plans to me so that I can create a booklet of effective math lesson plans to distribute to all participants who attended the PD through email within a week. This active planning will support successful implementation of active learning strategies in the mathematics classrooms**.** At the end of the session, participants will complete an evaluation providing feedback on the success of the PD and/or modifications needed for the PD. I will use the goals for the PD to help me structure an effective plan to provide teachers with skills and resources to support students in improving their skills for answering CRQs.

Rationale

The problem that prompted this study is that teachers are struggling to find appropriate strategies to teach students to answer CRQs effectively. Piaget's cognitive constructivist theory (Lunenburg, 2011) provided a conceptual framework for this study that led me to develop a PD project because teachers expressed that they would like to be engaged in hands-on learning sessions to acquire new strategies and skills to assist students in answering CRQs. Completing a PD project seemed to be an ideal way for me to share effective strategies for answering CRQs with teachers and to assist them with ways to implement these strategies in their classrooms. Furthermore, the project genre was chosen because when teachers engage in effective PD, they feel more prepared to work with students, which may result in improved student performance (Bayar, 2014).

The National Staff Development Council (NSDC, 2011) stated that effective professional development must be in place for teachers to be effective when working with children in a learning environment. The PD was designed based on the notion that professional development sessions that focus on the development of teachers' pedagogical content knowledge and skills must involve "examples of expert teaching of subject matter" (Van Driel & Berry, 2012). Therefore, many school principals are realizing that less successful teachers can become more effective with high-quality professional development and professional coaching by experienced professionals (Carlisle & Berebitsky, 2011).

I designed PD work sessions based on an analysis of data drawn from interviews and observations that revealed patterns, relationships, and themes about the perceptions of math teachers about improving student performance on CRQs. I created the PD to address the study problem by encompassing current findings into a series of collaborative activities, research-based strategy implementation, and lesson planning. I drew the content from the responses I received during individual interviews and instruction I observed in the classrooms. Participants in the study indicated important instructional learning activities they needed to familiarize themselves with and engage in to be successful in teaching students to answer CRQs. The three findings provided the informational core of the PD for planning, discussion, and collaboration.

I developed PowerPoint presentations to frame and inform the PD sessions, to provide participants with logistical information, and to guide the learning plan for each session. The slides include effective research-based strategies and were designed to assist participants in reflecting on their own practices and beginning to implement more effective strategies. Participants will receive a printed copy of the presentation to serve as a place to take notes, jot down questions, or reflect. In addition, the presentation will be projected to the front of the room on a smart board. In specific cases, I will offer participants information about websites that contain research-based, useful readings or information. In addition to these examples, participants will be encouraged to use sticky notes and share their favorite tools, resources, and insights with the group by placing the notes on a resource board by the front of the room. By participating in this way, teachers will be able to contribute by sharing their expertise with their colleagues.

I will use the National Institute for Excellence in Teaching's instructional learning portal (NIET, 2015). This portal provides multiple sources for PD participants to upload and retrieve examples of effective strategies along with supportive data. All teachers will be able to assess the site at any time. To build a sharing relationship among all participants, I will employ PD protocols that foster sharing and reflection. Furthermore, all teachers will be provided with a booklet of lesson plans and strategies from the PD sessions.

These protocols were drawn from my personal experience as a master teacher from 2011-2016. During that time, I participated in and led a variety of content-specific cluster meetings. During these meetings, participants brought lesson plans, data from student work, and actual student work samples and shared their experiences based on their implementation of strategies they learned during weekly cluster meetings. Cluster meetings, by promoting teacher planning and preparedness, have made a very positive impact on student success (principal, personal communication, April, 2014). I have observed that providing teachers time to reflect, share, and collaborate is useful for capturing the concerns and expertise that all participants bring into a PD session. Bayar (2014) stated that when teachers engage in cooperative work sessions with other teachers, they feel more prepared because they have learned several new ideas.

The PD series developed for this project is designed to involve participants in a hands-on learning session focused on teachers learning new skills and strategies and on transferring that learning to students. Each day, I will offer increasing amounts of time for reflection, open discussion, and learning in which participants will be encouraged to think deeply about their own context, needs, and expertise as math teachers and how this expertise will impact their students' performance.

Review of the Literature

A review of the literature helped me to connect math teacher participant reflections to the literature on effective math instructional strategies that improve student achievement on CRQs. I searched scholarly literature with key words such as *cooperative learning strategies, reading in content areas,* math *manipulatives, scaffolded learning*, and *professional development*. The review of literature expanded on my findings and allowed me to capture the following significant ideas that emerged from the findings and research.

1. Math teachers engage students in more active learning strategies in comparison to other subject area teachers.
2. Math teachers focus on reading comprehension when teaching problem solving.
3. Math teachers strengthen their instruction by engaging in professional development.

In the following sections, I expound on research related to these critical themes. Scholarly studies assisted me in expanding and deepening this study's contribution to the education field.

Math Teachers Engage Students in More Active Learning Strategies

Math teachers develop strategies to assist their students in answering word problems effectively. However, those strategies are often formula-based instructional approaches that do not allow students to be actively involved in the lesson. As a result, lessons often become more teacher centered as opposed to student centered. Teachers can foster the development of students' problem-solving abilities by engaging students in lessons that are rich in critical thinking, that indicate the value of individuality, and that support exploration (Clements & Sarama, 2014).

In a qualitative study about teachers' mathematics strategies for supporting students' metacognitive development, Hill (2012) found that teachers felt a need to increase their levels of expertise in relation to metacognition and strategies that support it. However, due to teachers' limited ability to articulate their understanding of metacognition and the strategies that can support it, their need for professional development could be inferred (Hill, 2012). Improving teachers' understanding of metacognition and the instructional practices that support students' development in mathematics can assist teachers with developing and implementing effective student-centered learning strategies in the mathematics classroom.

As teachers develop a sense of what types of effective instructional strategies need to be in place, they begin to encourage students' strategies and build on them as a means of developing more student-centered strategies (Clements & Samara, 2014). Teachers should facilitate students' mathematical learning by asking probing questions, allowing students to discover new ideas, and engaging students in active learning.

Teachers should present questions that kindle students' curiosity and that assist them in developing their own student-centered strategies (Stols, Ono, & Rogan, 2015). This approach will lead students to begin relying on their own knowledge and ideas about mathematics and problem solving. Teachers should ensure that students engage in solving interesting problems and talk through stimulating math conversations every day to ensure student success in problem solving (Eby, Herrell, & Jordan, 2011).

Teachers can engage students in more active participation by involving them in activities that include cooperative grouping and the use of manipulatives. Activities involving cooperative learning strategies place students in groups where they all have an equal role in helping the group members achieve their goals and in which both the individual and the group are accountable for mastery of the content (Hertz-Lazarowitz et al., 2013). Tsay and Brady (2013) found that students are better able to make sense of what they are learning by engaging in conversations about class content with their peers. They found that student participation in cooperative learning activities is a strong predictor of students' improved individual academic performance (Tsay et al., 2012). Cooperative learning facilitates the process outlined by Piaget (1952). Slavin (2014) stated that learners must engage in some form of cognitive elaboration of new materials to learn and understand them. Mathematics learning improves when students work cooperatively in small groups (Johnson & Johnson, 1989; Slavin et al., 2013).

The use of activities involving manipulatives in mathematics instruction has been cited as a successful strategy that allows students to draw on their real-world knowledge through student-centered hands-on activities (Carbonneau, Marley, & Selig, 2013). A *manipulative* is any object, picture, or drawing that represents a concept or the relationship in which that concept can be imposed (Van de Walle, Karp, & Bay Williams, 2013). Dunn (2013) found that students can increase their mathematics achievement by using various representations of manipulatives. Piaget (1952) suggested that children begin to understand symbols and abstract concepts after experiencing the same ideas on a concrete level.

Manipulatives play a major part in student success. It is essential to supply all students with rigorous math instruction in a way that promotes student-centered learning, wherein students can actively participate in the learning process and accept new challenges. Through the use of cooperative grouping and implementation of hands-on activities with manipulatives in the classroom, student achievement in mathematics can be improved (Dunn, 2013).

Math Teachers Focus on Reading Comprehension When Teaching Problem Solving

Reading comprehension and vocabulary understanding are major factors in overall comprehension in many content areas, including mathematics (Riccomini et al., 2015). Teachers must understand that math is more than just equations, experiments, and formulas (Alvermann, Gillis, & Phelps, 2012). As with all other academic subjects, literacy skills provide the foundation for understanding. Understanding the vocabulary is one of the key components of mathematics content comprehension. There are many effective and diverse approaches for teaching vocabulary in all content areas. Therefore, teaching and learning the key vocabulary and language of mathematics are imperative for the development of students' mathematical proficiency.

Most mathematics teachers are not generalists and have not been trained in reading instruction; they do not see literacy development as part of their skill set (Purpura, Hume, Sims, & Lonigan, 2011). In addition, most reading teachers do not teach the skills necessary to successfully read and comprehend material in mathematics class. According to a study conducted by Imam et al. (2013), weak reading comprehension skills negatively impact students' performance in mathematics. Research has shown that mathematics texts tend to have more concepts per problem or sentence than any other type of text (Pugalee, 2015). The questions are written in a very concise style; each sentence contains a lot of necessary information, with minimal redundancy. The text can contain words and phrases as well as numeric and nonnumeric symbols to process and understand. In addition, there may be graphics that must be understood in order for the text to make sense. These graphics may occasionally include information that is aimed at helping students comprehend a problem but instead distracts them from what they actually need to do to solve the problem (Pugalee, 2015).

Mathematics teachers do not have to become reading experts or specialists to help students read and comprehend mathematics texts, but they do need to understand that students must know how to comprehend the text in order to understand how to answer the questions (Hernandez, 2013). Teachers should do whatever it takes to ensure that students can read and comprehend so that understanding mathematics is explicit and clear to the students. Therefore, teachers must implement some strategies to assist students with learning vocabulary and reading math word problems for meaning (Imam et al., 2013).

Learning in math requires students to constantly engage in higher order thinking. As one math skill is attained, another is presented. There are two strategies that have been successful in helping teachers apply literacy across content areas. First, the Think Aloud is a literacy strategy intended to help students comprehend content and guide their critical thinking as they work through the problem solving process (Farr et al., 2013). The Think Aloud strategy allows teachers to share with their students exactly what they are thinking as they solve many types of problems (Richardson, Morgan, & Fleener, 2011).

The Think Aloud process assists students when they do not understand one step in the solution of a problem by allowing them to see their teachers work out the problem step by step. Then, they can see the step they missed or do not understand to attain a clearer understanding. Secondly, Think, Write, Pair, Share is a literacy strategy that is intended to give students the opportunity to think about a given topic, reflect on their learning and engage in a discussion about their learning with a peer (Duke & Del Nero, 2011). During a Think, Write, Pair, Share, students are asked to write about what they learned, problems they faced when they solved mathematics problems, and how well they were able to comprehend the concepts (Ardini, 2012).

During the thinking step, teachers begin by asking the students to read and solve a specific higher-level word problem. Students read the word problem and think about the steps they will take to solve the problem. During the write step, students solve the word problem. During the pair step, each student will pair with another student and share the thought process they used when solving the problem with their partner. They will then discuss ideas and ask questions of their partner about their thought process. During the share step, the partners share with the entire class and engage in a whole-class discussion. Each group will present their thoughts, ideas, and questions to the rest of the class. After the class discussion, pairs will meet again to see if their thought processes changed as a result of the class discussion (Duke & Del Nero, 2011). Both of these strategies engage students in discussion which provides them opportunities to focus on the meaning of the vocabulary as well as reading comprehension in mathematics.

In content teaching, the incorporation of reading comprehension and writing reinforces content mastery. Mathematics teachers strive to help their students understand mathematics and to use it in their everyday lives (Smith, Angotti, & Fink, 2012). Teachers must be aware that students' prior knowledge and background affects their comprehension in all subjects. Strategies that are shared for comprehending text, questioning our students about their conceptual understanding, and modeling performance expectations are assisting students in developing metacognitive processes for approaching mathematics word problems (Bacon & Muilenburg, 2012).

Math Teachers Strengthen Their Instruction by Engaging in Professional Development

Effective PD plays a major role in ensuring teacher and student success (Zepeda, 2011). Effective PD encourages active engagement and collaborative learning from participants applying real-life activities. PD activities conducted during and beyond the school day impact teachers positively (Bayar, 2014). Because student learning and achievement is greatly impacted by the quality of teaching, effective teacher growth is vital for all educational systems. Bayar (2014) conducted a study to determine the components of effective professional development. He concluded that "any effective professional development activity should consist of the following components: (a) a match to existing teacher needs, (b) a match to existing school needs,(c) teacher involvement in the design/planning of professional development activities, (d) active participation opportunities, (e) long-term engagement, and (f) high-quality instructors" (Bayar, 2014, p. 1). For teachers to grow, PD must be significant and instructionally-focused, active, and collaboratively focused on practices that will turn students into critical thinkers and problem solvers (Gibson & Brooks, 2012).

Effective PD for teachers is instructionally-focused because it highlights subject area content and instructional teaching strategies that model how to teach the content as well as student learning outcomes (Gibson et al., 2012). The essential goal of PD is to increase student achievement and instructionally-focused PD directs teachers toward achieving this goal. Another important component of any effective professional development session is allowing the participants to learn by being actively engaged (Bayar, 2014). Starkey et al. (2009) stated that it is important to provide opportunities for teachers to practice what they will be teaching for the instructional practices to become more effective.

Finally, collaboration is an important component of an effective PD (DuFour, 2004). Effective PD for teachers is collaborative because it focuses on both active and interactive learning experiences through teacher participation (Hunzicker, 2011). Franke, Carpenter, Levi, and Fenema (2001) conducted a study on teacher sustainability. During the study, teachers participated in a PD program that provided a framework for children's mathematical thinking. The teachers met continuously during the project to discuss their students' thinking and learning in relation to this framework and to discuss instructional strategies that would assist students in being successful in their thinking processes. The study concluded that "one characteristic of the teacher professional development that contributed to this sustained result was the opportunity for participants to collaborate with other teachers to discuss student thinking and learning. The teachers reported that the level of support from colleagues was critical because it made the reform a school endeavor rather than a single teacher's endeavor" (Dyer, 2013, as cited in Franke et al., 2001, p. 653).

Professional development is the connection between teachers' individual abilities and comprehension and the impact they make on a school and students (Avalos, 2011). Because the classroom is continuously changing, teachers must be prepared to meet needs of their students. The process of professional learning should offer teachers the opportunity to broaden their instructional abilities, develop new teaching strategies, and extend their understanding of subject content (Reeves, 2012).

Project Description

Potential Resources and Existing Supports

School districts aim to ensure all stakeholders provide, foster, and monitor high quality PD that encourages improved job performance for all teachers resulting in increased student achievement (Hunzicker, 2011). By offering the district this PD series, I will assist teachers in increasing their repertoire of effective instructional strategies that may positively increase student achievement in reading and mathematics. To implement this project, I will need essential resources. Before the sessions begin, I will meet with the mathematics supervisor to share my study results and present to her my agenda for the PD sessions. Then, I will send all math teachers and principals an email invitation to the 3-day PD. The math curriculum supervisor will ask teachers to participate in the program, preferably when they are under contract before the summer vacation. If the PD cannot be planned before summer vacation, I will ask teachers to come two days during the summer. I will hold the PD sessions in school classrooms or libraries, using a laptop and smart board. The math supervisor will provide supplies including photocopies of handouts, chart paper, chart markers, and cardstock for name badges, using the school budget for materials. I will provide math manipulatives, lined paper, timers, and writing utensils.

Potential Barriers

One potential barrier may be the school administrator's lack of support for the project. They may not want to support the project because they may feel that their teachers do not need the extra training or they may already provide training at their schools. In addition, they may be uncertain if this training will positively impact their teachers' and students' performance. To gain the support of school administrators, I will present an in depth overview of my study findings to all administrative leaders and to the math department supervisor. I will review mathematics data from the previous school year, and I will engage the administrators in a discussion of this PD. I will also try to schedule individual meetings with each administrator to share information about how schools and teachers can benefit from PD opportunities.

Another potential barrier is m teachers may be reluctant to participate in a PD that requires more time and work without additional compensation. To ensure there is teacher participation, I will provide teachers with manipulatives that can be used in the classroom immediately. In addition, all participants will receive a handbook of lesson plans and instructional strategies that they can use when planning their daily activities. I will share with the teachers how collaborative planning during the workshop may save them time on planning later on their own. By attending this PD, they will be given the opportunity to gain insight from their peers.

I plan to ask the school administrator for funds to purchase lunch and snacks for the participants' working lunch to maintain continuity of the presentation. If the school administrator is not able to provide lunch, I will request that teachers bring their own lunch or I will ask the parent teacher association or a local business to offer food and refreshments as a gift to the faculty. Space for meetings should not be a problem because I will hold the PD at a time when there are no other student learning experiences taking place. If the project is approved and scheduled, however, I will have to reserve rooms early in the year by working with the proper administrative office staff members who will ensure a professional place to host the sessions.

Proposal for Implementation and Timetable

Planning for implementation of the PD will take place during the academic year. This planning will include the math supervisor, the principals, and me. The details of the proposed timeline are shown below. (See Table 2).

Table 2

Proposed Timeline

Date	Task	Person	Deliverable
August	Meet with principals and math supervisor	Math supervisor, principal, and researcher	Slide show
August/September	Plan meetings	Math supervisor, principal, and researcher	Program announcement
October	Design key participant emails	Researcher	Email
November	Develop and submit volunteer responses	Potential participants	Emails
December	Select first 20 participants	Committee	School email announcement
January	Share presentation with principals and math supervisor	Researcher	Slide show highlighting PD
February	Coordinate time and place for PD	Math supervisor, principal, and researcher	Daily agenda
March-May	Conduct PD sessions	Researcher and participants	Slide show, instructional manipulatives and lesson plans

Roles and Responsibilities

My responsibility and role will be to organize all meetings, facilitate communication between all stakeholders, and present all workshops for the PD. The math supervisor and the principals are important instructional leaders who can contribute to the success of this initiative. Principals will support the work by encouraging and assisting teachers to implement the instructional improvements that are part of the presentation.

The math supervisor is responsible for securing the facilities, approvals and materials needed for a productive presentation. In addition, the math supervisor will also work with the presenter to review and approve the strategies implemented and to confirm their alignment with the standards for each mathematics course. For this program to be successfully implemented, I will create constructivist learning experiences to involve and connect participants in discovering and learning new teaching strategies. These activities will be coupled with informational sessions to provide participants with active learning sessions. Workshops are planned to provide participants opportunities to work in cooperative groups; they will be challenged to explore math manipulatives and create CRQ lessons based on discovery with the manipulatives. Participants will also be provided with opportunities to share lessons that have been effective in their experiences with students. They will be tasked with engaging their colleagues by modeling short concept lessons to share a favored strategy. Time and space will be provided for participants to share copies of successful lessons and student work samples. Even though this will be a well-planned PD program, stakeholder support is essential for implementation. I recognize that I will ask for employee time, institutional space, and collaboration when educators may have other concerns and priorities. Presentation of the project will be an important vehicle for school improvement efforts that relate directly to the work of the district. In this way, my role will be that of a facilitator to all stakeholder groups.

Project Evaluation

Formative Evaluation

Formative assessments are tools that should be used throughout a lesson to ensure student learning is taking place. Sargent and Curcio (2012) suggested that formative assessments are useful tools that help to "increase learning and motivation by offering students feedback about gaps between current and desired levels of performance" (Sargent & Curcio, 2012, p. 381). In order to provide participants with opportunities to give feedback on the progress they are making towards the goals set for the PD, they will reflect on what worked for them and what would have been even better to cover for the PD. These formative assessments will be in the form of reflection walls where participants will write on a t-chart written on poster paper their comments on "what worked" that day and "even better if" and exit tickets that will ask for a quick response to a key question related to the daily objectives.

All formative assessments used in each session are included in workshop PowerPoint presentations, handouts and notes to presenter. In addition to written feedback, the participants will engage in high quality dialogue by asking through open-ended question prompts and a parking lot poster for participants to post questions that to answer throughout the day. Engaging in this dialogue will help determine the participants' level of engagement and their understanding of the content being covered. At the end of each session, I will review the participants' exit ticket responses and reflections to ensure I am connecting the content covered in the sessions to the participants' needs. An exit ticket is a quick way to assess that participants have learned the information presented. Through a review of these responses and reflections, formative assessment data will be used to inform effort to achieve intended learning outcomes through re-teaching or redirection, when needed to best assist the participants to achieve their goals for this PD.

Summative Evaluation

In this project, I will use a summative evaluation to assess the amount of learning that has taken place during the PD (Sargent & Curcio, 2012). At the end of the PD, participants, administrators, and the mathematics supervisor will complete an evaluation on the effectiveness of the content they learned in the PD. Participants will answer questions pertaining to the presentation of the content as well as the impact the content will have on their student success in the classroom. For the summative assessment, I will distribute a handout that will ask the participants to respond to six narrative questions:

1. Did the presenter appear to possess substantial content knowledge and expertise in the content being presented?
2. Do you feel you learned enough to be able to immediately implement the suggestions from this PD in your classroom?
3. Please explain what has been the most useful information you obtained during this PD session?
4. How can you use this content to enhance your instruction in your classroom?
5. How do you think the content learned will influence your instruction on CRQs?
6. If you could change anything about the sessions, what would it be and why?

The answers to these six questions will serve as an end product that I will analyze to determine how to structure future PD work sessions to assist teachers in being successful in the classroom.

Overall Evaluation Goals

Evaluation methods, both formative and summative, are directly aligned with PD goals in order to assist teachers with implementing effective strategies to help students answer CRQs. Teachers who participate in the PD will be able to engage in hands-on activities that can be used in their classrooms to assist students with answering CRQs. I include formative assessments in every session by building in time for reflections, having participants complete exit tickets, and engaging them in rich conversations about the content being covered. When the participants complete the PD, they will be provided with a handout containing six narrative questions. I will collect the responses to the narrative questions as a summative assessment in order to determine what has been useful for the teachers and what may need to be changed for future sessions. The evaluation process is a part of the PD training as it engages teachers in rich dialogue and on-going reflection about the impact of effective math strategies. I will use the overall evaluation goal as an influence to assess whether or not effective mathematics PD can have a positive impact on teacher instruction and student learning.

Key Stakeholder Group

I created this PD based on my findings from this study. Based on those findings, it was clear to me that teachers work in settings that involve multiple stakeholders, and it will be important to include all stakeholders in conversations and planning related to the project. Participants for the PD will be district teachers and the math supervisor who will participate in all 3 days of the PD; the principals will be given a choice to attend all 3 days or attend only one day. The math supervisor will be engaging in some of the hands-on activities to assist the presenter daily. In addition, she will be able to present this session to other teachers who may not attend. Because I know that principals are busy during this time of the year, they will be asked to attend at least one day. When administrators attend and participate with teachers in an activity, they demonstrate the importance of PD workshops, and they recognize teachers' efforts. Administrators will be able to observe what the teachers will be implementing in their classrooms. In the timeline planning, I include key stakeholders such as teachers, administrators, and the math supervisor. I indicated in the timeline for the project implementation when the stakeholders will be invited into the planning and implementation process.

Teachers. The core group of participants for this PD will be the first 20 teachers who self-select to participate in the program. The only additional group will be administrators who volunteer to attend on the lesson planning day. The focus for the PD will be to engage teachers in hands-on activities that they can implement in their classroom to better assist students with answering CRQs. Teachers who volunteer to participate in the program may teach any high school mathematics subject such as Algebra 1, geometry, or Algebra 2, but some may continue to work together, as a cohort with the individuals that teach the same content as them. Collaboration, reflection, shared strategies and information, and lesson planning with colleagues may prove useful in their continuous instructional success.

Administrators. School principals and assistant principals will form the administrative team that will be crucial to the success of the PD. I will include district administrators in the planning and implementation discussions. Principals are busy during this time of the year; they are scheduled for a separate advanced overview of the workshop's content and procedures (see Table 1). Furthermore, in the recognition of the importance of this group, I will invite administrators to share expectations for lesson plans on the third day of the PD. When the principals spend some time in the workshop, it will symbolize the importance of the workshops to the participants. Perhaps this will help participants plan their lessons successfully incorporating new ideas and strategies while following mandatory procedures. This way, the teachers will not have to change any formations on the lesson plans they complete during the sessions and they will know their principals' expectations. In addition, principals will be equipped to interpret classroom interactions when they observe classes and evaluate teachers.

Math supervisor. The math supervisor is the person who makes all the decisions about the math curriculum, assists teachers with effective classroom strategies and implementation of those strategies, and provides opportunities for math teachers to engage in effective PD that will help strengthen their instruction. Furthermore, I envision that the feedback that the participants will offer during the sessions and the input and guidance that the math supervisor will offer will help them to discover ways to jointly solve problems and look for ways to ensure student success when answering CRQs. The math supervisor and principals are the driving force who propel teachers to implement newly learned strategies in their classrooms.

Implications Including Social Change

Social Change Implications

When teachers understand their ability to influence student learning and to improved student success levels, they become vehicles of social change. In this study, the analysis of data has helped me reveal key findings that can have a strong impact on student success in mathematics. Through my research, I have learned that teachers do have strategies that they use in their classrooms to assist students in mathematics class, but they are always willing to learn more to help their student increase their performance. I also learned that preparing students to read, comprehend, and think critically is important to do across all curriculums because it can have a positive effect on the students' future successes in life. Furthermore, by using these findings as the basis to build my PD for teachers who desire to better assist their students, I am able to assist teachers in their journey to plan implement effective classroom instruction.

Effective teacher instruction will significantly impact the lives of individuals. Sometimes, this instruction may alter the way a student in Algebra 1 class answers a CRQ in mathematics class. It may also have practical applications, such as improving the way a student calculates a real-life math problem, such as creating a budget, planning a payment schedule, or balancing a bank account. Solomon (2012) suggested that math comprehension is a result of individuals engaging in real-life math problem solving on an everyday basis.

Importance of the Project to Local Stakeholders

This project has potential importance to local stakeholders because I will offer it within the district where I currently serve. The teachers of this district could benefit from the PD because high school math teachers are struggling to find appropriate strategies to teach students to answer CRQ effectively. During these meetings, participants brought lesson plans, data from student work, and actual student work samples and they shared their experiences based on their implementation of strategies they learned during weekly cluster meetings. This PD could provide an opportunity for teachers to collaborate and learn new strategies to increase their students' academic performance. I will reach out to the district's principals and math supervisor so that they can assist teachers in implementing the new strategies as well as support them during the presentation of the PD. This project could prove to be of immediate use to district leadership and teachers.

In addition, the administrators of two surrounding school districts have voiced their interest in participating in PD collaborative opportunities. District administrators report that teachers need to collaborate with others outside of their schools to learn more hands-on strategies and instructional techniques to assist their students in being successful. I anticipate that these findings and the subsequent project will be important to local stakeholders.

Importance of the Project in the Larger Context

In the larger context, I believe that this project has great potential for assisting teachers, students, and schools. As I have stated in the review of literature, the NCTM (2010) identified that quality math instruction is fundamental for a strong economy. Therefore, focusing on comprehension and problem solving in the mathematics classroom not only influences students' thinking and problem-solving skills, but also improves students' analysis and real-life application skills.

The project presented here is designed to be continuously restructured for recurring presentations using updated mathematics strategies that teachers can implement in their classrooms. This PD workshop can also be modified for presentation to elementary and middle feeder school staff members. This would expand the effort to a district wide initiative. Focusing on this as a district wide initiative could help bridge the gap between schools. By doing this, feeder schools staff members would have the vocabulary to meet across grade levels to determine where gaps in student understanding in mathematics begin and how they can work as a team to decrease the number of student deficiencies in mathematics. Finally, I plan to share this study's initial findings with my colleagues in local, state and national curriculum organizations to lead conversations about how these findings may be useful to teachers.

Section 4: Reflections and Conclusions

Introduction

Teachers in this local school have been struggling to find appropriate strategies to teach students to answer CRQs effectively. This problem has impacted student performance on CRQs. The data and findings from this study indicate that teachers need to be given an opportunity to engage in effective PD that will help them assist their students in successfully answering CRQs. Focused PD sessions may positively influence students' academic performance. This section focuses on my reflections and conclusions about the project.

Project Strengths

This project's strengths connect to the research and analysis of findings. Piaget (1952) suggested that knowledge is constructed by the learner. Piaget's cognitive constructivist theory provided a conceptual framework for this study that led me to develop a PD project to engage teachers in hands-on learning (Lunenburg, 2011). Bray (2011) suggested that teachers would benefit from a PD that focuses on hands-on learning and cooperative grouping regarding how these strategies are related to success in the mathematics classroom. Bray's (2011) focus on PD efforts in mathematics that are organized to model teaching practices to help improve student performance in mathematics class is specifically what I have striven to accomplish in the PD that was developed based on this study's findings.

As a result of the PD, teachers will have the opportunity to collaborate with their peers to plan effective lessons that will positively impact their students' performance. I have designed the sessions to engage participants in model lessons incorporating literacy in math, cooperative grouping, and hands-on math, as well as to assist participants as they draft lesson plans. Participants will also gain a deep awareness of the importance of their relationships with fellow colleagues as they collaborate to plan lessons that can assist them in accomplishing school, district, and state goals. The greatest strength of this project is that it will provide participants with opportunities to be continuous learners and improve their instructional processes by engaging in effective educational experiences that involve collaborating with their colleagues and planning effective lessons that will impact the students they serve. For that reason, this study may promote the understanding that the teaching profession involves significant, specialized, and public work that impacts an ever-changing world.

Project Limitations

A limitation for this study involves ensuring that the 3-day PD will begin an ongoing collaborative effort among teachers. I will offer all participants the opportunity to engage in an effective PD through collaborative planning. An effective PD for teachers becomes collaborative when it emphasizes active and interactive learning experiences through professional learning communities (Hunzicker, 2011). Effective professional development is active and interactive when it engages teachers physically, cognitively, and emotionally through an ongoing process (Hunzicker, 2011). However, the collaboration that teachers may experience while engaged in the PD may be hard to maintain as teachers return to their daily responsibilities. To foster a continuous spirit of collaboration among the teachers, I suggest that program members organize planning sessions with food and refreshments, on or off campus, throughout the school year to create the experience of participating in a professional learning community. In an effort to encourage continuous collaboration, I will ask the teachers to share their collaboration successes with everyone though email. Furthermore, I will keep all lines of communication open for any teachers who may need assistance from me to keep their professional learning communities going.

Recommendations for Alternate Approaches

Alternate Approaches to the Problem

In previous section, I indicated that it would be difficult to determine if this project would begin an ongoing collaborative effort among teachers. Because of this limitation, a different approach to the problem is needed to provide PD and collaboration opportunities for teachers who would like to continue engaging in professional learning communities with their peers.

Alternative Definitions of the Problem

The problem that prompted this study was as follows: Teachers are struggling to find appropriate strategies to teach students to answer CRQs effectively. I worked with a participant group of eight teachers who were familiar with the Algebra 1 curriculum and had at least 3 years of teaching experience. The data that were obtained as a result of two forms of data collection indicated that the teachers wanted to participate in a collaborative hands-on PD. In the project that was developed based on this study, I support the collaboration of teachers through planning. By participating in this project's PD, teachers will be given the opportunity to plan together and engage in model lessons together. However, some teachers may only take advantage of this opportunity to collaborate during the 3 PD days. They may not follow up with one another and continue the collaboration. Therefore, two alternative definitions of the problem for this study are as follows:

1. Reveal ways in which teachers can continuously collaborate and plan together to develop effective lessons incorporating successful strategies to assist students with problem solving in mathematics.
2. Reveal ways to create local networks of teacher leaders who want to develop pacing guides and lesson plans to share online to assist teachers with effective instructional delivery of thinking and problem-solving strategies in the mathematics classroom.

These alternative definitions of the problem align with the problem that prompted this study because all of the problem statements have been written to reveal how teachers can assist students with improving their problem-solving skills.

Alternate Solutions to the Local Problem

Teachers who work in schools where they do not have the opportunity to collaborate and plan with their fellow teachers may benefit from alternate solutions. Such alternate solutions may be designed to engage groups of teachers who may need to collaborate with others to strengthen their instructional delivery skills and to allow teacher leaders an opportunity to share their expertise, instructional strategies, and success stories. Alternate solutions are a good way for the researcher to identify teachers' strengths in their successful instructional delivery.

Ways in which teachers can continuously collaborate and plan together. When teachers are not able to plan in collaborative groups, they may feel unsure of their effectiveness in the classroom. In such a setting, teacher leaders could develop schedules to ensure that they get to meet to plan and collaborate on a regular basis. Teachers could meet monthly to ensure they are covering the same material and discuss the outcome of strategies that they have implemented in their classrooms. In addition, they could share student work samples displaying the students' thoughts, ideas, and problem-solving steps. The idea would be to include various teacher and student artifacts to highlight success. Furthermore, the teachers could determine areas of reinforcement and refinement in the lesson plans. The collaboration meetings would not require the approval of the school administrator, but the school administrator could definitely join the meetings or be provided with feedback about them. Ideally, this type of collaboration would foster a reciprocal agreement in the school or district about the favorable impact of teachers planning together consistently.

At the school, the teachers could plan weekly. Cluster meetings, professional learning communities, or informal lunch-and-learn groups could be formed to allow teachers to share ideas about lesson planning, instructional strategies that work, or pedagogical content. Teachers could be invited to participate during their planning time on certain days to share their concerns and work together on lessons. All schools can benefit from teacher collaboration in content area groups that focus on developing the kind of learning community that will help to increase student success in the classroom.

Ways to create local networks of teacher leaders who want to develop pacing guides and lesson plans to share online. Many schools and districts offer teachers the opportunity to post lessons online and to share their expertise. Teachers may be able to search for and find such resources online, but they may not be able to consistently meet with teachers at another school or other teachers at the same school. An alternative solution to the problem could be the creation of pacing guides and lesson plans that the teachers could obtain through email or find on the district website. Teachers can retrieve ideas and plans from sites such as Teachers Pay Teachers and Learnzillion. In addition, teacher leaders could invite fellow teachers to share their successful lesson plans online.

In order to discuss the success of the lessons' implementation, teachers could engage in a blackboard discussion. Teachers could also engage in an online learning environment through webinars focusing on classroom instruction that works. Therefore, teachers who want to collaborate and plan together but do not have time to meet face to face will be offered ample opportunities to do so without feeling overwhelmed.

Scholarship, Project Development, and Leadership and Change

As I researched ways in which teachers can assist students in accurately answering CRQs, I developed findings with teacher participants who were driven to ensure increased student achievement in thinking and problem solving. As a math teacher and coach, I have observed math teachers implementing hands-on instructional strategies and cooperative grouping that have kept students highly engaged in lessons, and I have observed other teachers just lecturing and not implementing any hands-on strategies or cooperative grouping.

My desire was to acquire a clear understanding of which types of strategies being implemented help students most when they are answering CRQs. I wanted to gain an abundance of differentiated hands-on strategies that teachers could implement so that they would begin to see the students' thinking and problem-solving skills improve. I also wanted to find out from teachers why they thought that students were really having difficulties when trying to respond to a CRQ. I was excited about completing this research because I knew that the results would definitely impact teachers' success during instruction in the mathematics classroom.

As I gained experience and grew in this process as a scholar, I had to learn to withhold my opinions and biases. This was a challenge because of my passion for the subject matter and because of the discipline required to ground myself in the research process. I knew that a problem with students accurately answering CRQs had existed for years, but I needed to confirm that other scholars also believed this to be true and that they had stated it in their research. In my expansive review of the literature, the scholarship of Tsay et al. (2013), Iman et al. (2013), Dunn (2013), and Bayar (2014) provided me with evidence that other researchers have found some of the same results. Their ideas on the impact of cooperative grouping, hands-on activities, literacy in mathematics, and collaborative planning on student achievement presented me with a promising outcome of assisting teachers with these concepts that impacted my scholarship throughout the study.

Once I had selected the participant group of eight Algebra 1 teachers, I was eager to begin to collect two forms of data. Within the timeframe of 1 week, participants volunteered for the study and I began to schedule individual interviews and observe each teacher.

After I finished my data collection and developed my findings, I focused on project development. I learned that project development is definitely driven by findings, and I learned what would make the greatest impact on student and teacher learning. Developing a PD session may help teachers to have more time to explore, discover, and develop effective strategies for instructional delivery in the classroom. In turn, teachers may positively impact students' performance by helping them to develop their abilities to think critically and problem solve at higher levels.

As a leader driven by the goal of positive academic change, I found that by having a growth mindset about the research process and the impact the results and project would have on teacher and student performance, I could offer participants a better opportunity to engage in collaborative learning environments where they could share their experiences and insights. Therefore, my success as a researcher was closely connected to my ongoing learning through the research process.

Reflective Analysis About Personal Learning

Once I gained insight as an interviewer and observer, my self-assurance in completing this study and project grew. I began to see that all teachers try to ensure that what they are teaching will help students be successful in their real-life experiences. I was able to capture data through conversations in both formal and informal settings. For example, I captured the lived experiences of students and parents when shopping. I realized that all students love to convince their parents to buy the most popular tennis shoes in the shoe store. Those shoes sometimes go on sale. I considered whether any of those students could calculate how much the shoes would be on sale without having to ask the salesperson and then determine which pair would be the better deal. This experience brought a lot of clarity to me about real-life experiences that students encounter on a regular basis.

When I worked on a service learning project focusing on beautifying elderly individuals' homes with a youth group, I noticed that to determine the number of flowers to put in each flower bed, the youth had to know the area and perimeter of each flower bed and understand the importance of those dimensions. As a result, I wanted very much to learn about the lived experiences of individuals who complete customized yard designs. Ultimately, I learned to observe these events with close attention and excitement while maintaining the main focus on my study. I was able to determine that connecting all of the interesting data would be great. I determined that if I focused heavily on data collection within my study, I could positively impact other well-researched projects in the future.

Growth of Self as a Scholar

As I completed this study, I began to classify myself as a researcher. I began to see that I started to possess the qualities and perseverance of known researchers. Because of these qualities, I began to analyze my research with significance, collect data methodically, and use systematic research strategies to identify specific findings in transcribed data and observation records. I collected many pages of data to analyze, which led me to my findings. I made it my point to pay close attention to my participants' time, specific words, and details of strategies they implemented in their classrooms. I had to make certain that I would see the themes and patterns that emerged from their words and ensure that there would be no biases. As I analyzed the data as a researcher, I determined the findings by identifying, examining, and interpreting patterns and themes that emerged from the data through repeated words and common student misconceptions and misunderstandings. I learned that through thorough analysis, teacher's lived experiences and insight might yield important findings.

Growth as a Practitioner

My research for this study impacted my growth as a practitioner tremendously. The first impact was evident as I taught my field testing mathematics group. I work as a master teacher providing teachers with effective research-based strategies that they can implement in their classrooms with their students. I teach a field testing group a strategy in chunks before I show the teachers so that I can model exactly what I did with the students and show proven data results indicating how the strategy increased student performance on math constructed response word problems. Immediately, I saw that the research I was conducting as a doctoral researcher was having an impact on my teaching. I began to develop word problems that required me to provide students with strategies to help them comprehend what the questions were asking them to do. I explained the importance of understanding what the question was asking them to do before they actually tried to answer it. Students immediately began to understand how to identify key vocabulary that helped them to understand the question. By knowing the importance of reading comprehension in mathematics, I was able to effectively assist the students in answering the questions. In addition, students felt better about the answers to the questions.

The second impact was noticed in my work with teachers in my school. I have been able to implement the research I have done for this study in my presentations and cluster meetings to support teachers. I have been able to share some effective strategies with the teachers as well as model lessons incorporating the strategies for some math classes. Additionally, I have been asked to present some of the strategies at other schools inside and outside of my school district. The knowledge I have gained in this research and in this study has clearly impacted my educational delivery of strategies that work positively.

Growth as a Project Developer

As I designed a project for this study, I realized I was able to provide teachers with educational tools for success. By creating a PD, I offered teachers a way to reflect upon their own instructional delivery methods and to learn to use those reflections to strengthen their abilities to engage their students in more student-centered activities by implementing different hands-on strategies. To accomplish this, I needed to reflect upon what the findings indicated was necessary for teachers to implement in their classrooms for student achievement in mathematics to improve. I learned from the findings that reading comprehension in mathematics needs to be strengthened and that students need to engage in more hands-on learning activates. I also developed a 3-day PD experience for teachers that focused on research based strategies and models of ways to implement the strategies effectively. For this reason, in my PD project, I wanted to provide teachers with opportunities to collaborate with others who might be inspired by their ideas as well as share other effective strategies with them.

As I developed the project, I recognized that the participants in this project would want to engage in hands-on activities so they could experience success before taking them back to their students. This project signified for me the opportunity to offer quality collaboration on instructional strategies for teachers that may not have had the chance to collaborate on a regular basis. Being the project developer has helped me to grow in my ability to think of math instruction through the eyes of these teachers as I have learned to use this study's findings to successfully structure the content of my PD project.

Reflection on the Importance of the Work

This study is important because I have obtained findings from the perceptions of math teachers about improving student performance on constructed response questions. The participants in this study have all at least 3 years of teaching experience and are familiar with the Algebra 1 curriculum. Teachers with such experience can easily share areas of strengths and areas of weakness in student responses. This study could assist teachers with discovering effective hands-on strategies to help students effectively answer CRQs. This community of teachers, eager to learn new instructional strategies, may create new learning vessels, guided by their own classroom experiences and research instead of endorsing changes made by others who may not know or appreciate the capabilities of their students. If this study can help teachers understand that their instructional delivery is important, that there is a connection between reading comprehension and mathematics, and that engaging students in hands-on activities will improve the students' performance, then it will have far reaching importance at the local, state, and national level. Teacher collaboration on the things listed above is vital to the success of them all. Therefore, teacher collaboration should not be limited to school buildings, but can connect through virtual communities such as email, blogs, and blackboard discussions as well as presentations at conferences.

As I reflect upon the importance of this work, I find myself realizing how powerful collaborative professional learning can be to each individual's learning. By allowing teachers time to reflect, plan, collaborate and develop lessons through the PD, I will be offering them opportunities to be reflective teachers and life-long learners. Once the first group of teacher have attended this PD and provided feedback, the workshop sessions may be offered to more teachers across the state and nation. Therefore, other groups of teachers not limited to a geographic area can attend. Thus, the project could become a global one that has the potential to engage teachers in ongoing collaborative learning meetings. When I reflect upon the importance of this project, I imagine its potential impact on the lives and experiences of math teachers who would like to engage in professional learning communities on a consistent basis.

Implications, Applications, and Directions for Future Research

This study adds to the literature about the importance of students being able to think critically and problem solve (Battista & Clements, 2009; Frank, 2015; Heritage & Heritage, 2013; Sahan & Terzi, 2015). By obtaining my findings from 8 highly qualified veteran math teachers, I have captured their perceptions and insights of what causes students to perform poorly when answering CRQs. When I analyzed the data and revealed the three findings, I designed a PD to assist teachers who would like to learn how to engage their students in hands-on activities that will improve their performance in mathematics class.

Potential Impact for Social Change

As teachers share their reflections about their ability to influence student learning, they become vehicles of social change. By listening to teachers' reflections and respecting their levels of expertise, I can gather vital information and lessons to share with others who may benefit from what is being shared. This study has given me the channel to gather data, to analyze it and discover its findings and to create a PD program that can directly transfer this information to teachers who want to improve their instructional delivery in the classroom.

Each participant in the PD will bring to the program a set of experiences and perceptions. Although I began the study with a focus on the problem of students not being able to accurately answer CRQs, I had no idea of all the insights I would gain from the study participants. As I collected my data, I was captivated by all the different topics the teachers shared as contributions to the lack of quality responses on CRQs. The teachers' knowledge and insight generated the substance of this research study. Therefore, for this project I designed activities that could assist participants in increasing their libraries of strategies for assisting students with answering CRQs. As the researcher in a project designed to assist teachers with developing and discovering effective strategies to implement in their classrooms, it was necessary to engage them in collaboration. In that way, the potential impact for social change, may occur within networks of teachers across the district, state, and nation because effective teacher instruction will significantly impact the lives of all students. It will impact practical applications, such as improving the way a student calculates a real-life math problem, such as creating a budget, planning a payment schedule, or balancing a bank account.

Methodological, Theoretical, and Empirical Implications

This study has important methodological, theoretical and empirical implications because the problem that prompted it focused teachers struggling to find appropriate strategies to teach students to answer CRQ effectively. Possible solutions to this problem have become known from the experiences and insights of math teachers, supported by scholarly research. The methodology used in this study allowed me to engage in communication with math teachers in individual interviews and observations. This provided participants an opportunity to think about the research questions and to offer their insights and perceptions through two forms of data collection. Using a qualitative study design for this study was the best methodology to gather these insights and perceptions to learn what participants believed had the greatest impact on students' ability to effectively answer CRQs.

The conceptual framework of this study was based on Piaget's cognitive constructivist theory that children can think critically, problem solve, discover, and construct viable arguments instead of simply participating in rote learning (Lunenburg, 2011). Solomon (2012) proposed that math comprehension is a result of individuals engaging in real-life math problem solving on an everyday basis, and Özcan et al. (2013) believed that the curriculum should match and challenge children's understanding, promote academic achievement, and activate a progression of the mind. I consistently analyzed rising data through this lens as I looked for ways to assist teachers with finding effective strategies. Theoretical implications from this study specify that by providing students with options for problem solving, teachers can provide students with the mathematical tools to construct individual approaches that can they can use in everyday problem solving situations.

The empirical implication of this study suggests that math teachers are good sources of information about their practice and expertise. Moreover, researchers can determine this through carefully analyzed data, directed by a conceptual framework that focuses on how students think critically and problem solve. The data have indicated that teachers do have strategies that they use in their classrooms to assist students in mathematics class, but they are always willing to learn more to help their student increase their performance. However, to achieve their goals, teachers have discovered ways to collaborate with their colleagues to research and develop more effective strategies. The empirical implication of this study suggests that additional studies that capture teachers' insights and experience may prove useful to teachers and to school systems that wish to increase student critical thinking and problem solving skills. These studies could provide further examples of effective practices and strategies that teachers can use as models for their own professional learning communities.

Recommendations for Practice and or Future Research

The education field is rich with opportunities for future research that focuses on capturing the expertise and experience of math teachers. The findings of this study indicated a that teachers need to engage students in more active learning strategies, that reading comprehension and vocabulary are major stumbling blocks to students answering CRQs, and that teachers want to engage in hands-on PD. Additional studies that focus on effective teaching strategies that incorporate literacy and mathematics, may be useful to potential mathematics teachers. Furthermore, research that is focused on providing time for students to engage in student-centered learning activities that give students an opportunity to learn on their own would be a welcomed contribution to this body of knowledge (Çubukçu, 2012).

Additional research about the impact of teaching reading in mathematics can be beneficial because teachers may be provided with additional strategies to assist students in reading and comprehending word problems in mathematics. Finally, research about how teachers respond to individual student work may be valuable because the way in which teachers respond determines the ways in which students will correct their work as well as understand why they are making the corrections. Participants in this study consistently pointed out that teacher collaboration on lesson planning and developing strategies would help strengthen their instructional approaches. Therefore, research that describes data revealing ways teachers can collaborate through professional learning communities could be significant.

Conclusion

Effective mathematics instruction begins with effective teaching (Clements et al., 2014). In this qualitative case study, I invited 8 math teachers to share their perceptions about student responses to CRQs and their practices in helping students respond accurately to CRQs. As I gathered data and later analyzed them, I sought to understand this phenomenon to identify with how participants attributed meaning to it (Merriam, 2009). Although proficiency in mathematical problem solving has been an important topic for many national educational organizations, this study focused on ways that teachers could determine the areas in which the students needed help when answering CRQs and on effective strategies that could be implemented to assist students with answering CRQs (NCTM, 2010; National Center for Educational Achievement, 2010; National Institute for Excellence in Teaching, 2011; National Center for Education Evaluation, 2013).

The problem that prompted this study was that teachers struggle to find appropriate strategies to teach students to answer CRQ effectively. When I collected and analyzed the data, I learned important lessons that participants shared about problem solving. I analyzed the data, guided by the three research questions, to uncover findings that described participants' perceptions of (a) teaching strategies; (b) current practices in teaching; and (c) PD opportunities. This study is important because it reveals teachers' perceptions and practices of ways they can strengthen their instruction to increase student achievement in mathematics. Teachers who are aware of the impact effective instruction can have on student performance may be motivated to consistently collaborate with their colleagues to ensure student success takes place. In addition, the shared products, such as lesson plans of the PD participants, make an important contribution to the teaching field because they provide tangible evidence of ways that teachers can assist students in improving their academic achievement by working collaboratively.

The 21st century is a time of changes and challenges when students who graduate from grade level schools must be prepared to become productive citizens in the ever-changing world. Therefore, teachers must be prepared to meet the students where they are and help them build on what they know to be successful. Teachers who are driven to ensure all students can think critically and problem solve inspire students to strive for bright futures and make unparalleled contributions to school communities.

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Appendix A: The Project

Goals: In this 3-day PD, teachers will be provided with the knowledge and skills that will assist them with developing lessons that will engage students in hands-on activities that will help them accurately answer CRQs. Teachers will learn about literacy in mathematics, the use of manipulatives in mathematics lessons, and effective lesson planning. The trainer will use reflection, collaboration, modeling, guided conversations, and research-based strategies to assist teachers with finding ways to enhance their lessons to ensure student academic success in mathematics.

Learning Outcomes: Teachers will be able to identify effective strategies to assist students in answering CRQs effectively to increase student achievement in mathematics. Teachers will understand how they can keep the students engaged in math class to be successful. Teachers will engage in a self-assessment that will help them determine what they need to keep doing or to modify to make their students mathematical classroom experiences effective and rewarding. At the end of the PD, teachers will develop lesson plans detailing their step by step process of how they will engage students in their lessons when teaching students how to answer CRQs. Teachers will be able to collaborate with their peers and designated stakeholders will be able to review these lesson plans.

Target audience: Twenty high school math teachers, who have volunteered to participate, will be the target audience for this project. On day three, a group of volunteer administrators will be invited to participate in the lesson planning by giving feedback and providing some guidelines. On all three days, the math supervisor will be invited to provide support, guidance, and feedback.

Components: The PD will be divided into the following topics that will help guide participants to accomplish their goal of teaching students to accurately answer CRQs:

Day 1: Literacy in mathematics

Day 2: Hands-on mathematics & cooperative learning

Day 3: Hands-on lesson planning

To plan the PD project, the three findings served as a guide to illustrate the effective components that need to be incorporated into a lesson to ensure students can accurately answer CRQs. The project was designed to assist teachers, who volunteer to participate, to acquire effective strategies that they can implement in their classroom. Finally, since findings indicated that teachers need to collaborate with their peers, the third day will include lesson planning with collaboration and feedback.

Each day's activities are organized with trainer notes followed by PowerPoint presentations for each session. The presentations contain all of the links, information, references, and logistics needed for the trainer to run the session. Participants will receive a hard copy of the presentation. An electronic version of the presentation will be displayed daily on the smart board. Formative assessments are embedded in the presentation and a link to the overall reflection will be provided at the end of the presentation. The following charts outline the time, topic and methods used for each day of the professional development program:

Day 1

Literacy in Mathematics

Time	Topic	Method
8:00 – 8:30	Sign-in, materials collection & seat assignment	Sign in at entry table and collect name tent with table number on tent
8:30 – 9:00	Welcome, Introductions, Overview	Trainer Presents
9:00 - 9:30	What road are you on as it relates to literacy in math?	Individual analysis, Group Discussion using chart paper
9:30 – 10:30	*To Teach Math, Study Reading Instruction*	Jigsaw Article by Marilyn Burns
10:30 – 11:30	Literacy in my classroom!	PowerPoint Presentation displaying effective literacy strategies implemented in the classroom (How will this look in your classroom?)
11:30 – 12:30	Lunch	On your own
12:30 - 2:30	Literacy Based Planning	Group planning of literacy in math lesson
2:30 – 3:00	Closing Session	Reflection- What worked/ Even better if... Exit ticket

Day 2

Hands on Mathematics & Cooperative Learning

Time	Topic	Method
8:00 – 8:15	Sign-in	Sign- In table
8:15 – 10:00	Hands on math in action!	Model lesson using Hands on equation kit
10:00-11:30	Cooperative Grouping Activities	PowerPoint Presentation & Handout
11:30 – 12:00	Do you see what I see?	Cooperative learning in math- Teaching Channel video
		12:00 – 1:00 Lunch On your own
1:00 – 2:30	Socratic Seminar in math (How will you cooperatively group your students?)	Teachers engage in a Socratic seminar activity Feedback & Reflection
2:30 – 3:00	Closing Session	Reflection- What worked/ Even better if... Baggage Check

Day 3

Hands-on Lesson Planning

Time	Topic	Method
8:00 – 8:15	Sign-in	Sign- in table
8:15 – 11:30	Lesson Planning	Working in pairs of 2 in specific subject areas planning a hands-on math lesson. Lesson will be presented to the group
11:30 – 12:30	Lunch	On your own
12:30 - 1:15	Lesson presentations	Presentations of planned lessons
1:15 – 1:45	Resources & References	PowerPoint Presentation
1:45 – 2:30	Summative Evaluation	Participants complete
2:30 – 3:00	Closing Session	Reflection- What worked/ Even better if...

Trainer Notes for Day 1

Literacy in mathematics

The trainer will attend to the following tasks at the beginning of the first session, before the presentation:

- Welcome participants and introduce the math supervisor and any principals that have volunteered to attend all three days. Explain that this is a three day professional development program that will assist teachers in discovering and implementing effective strategies to teach students how to effectively answer CRQs. Explain that the first day will focus on literacy in mathematics and how being literate is a major building block for students to be able to effectively answer any mathematics word problem.

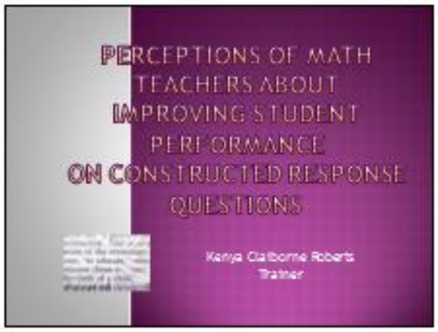
- Write down the group norms on chart paper:
    - Speak into silence (Respect others when they are speaking)
    - Thumbs up or down for more time
    - Actively participate in the activities
    - Be honest and speak from experience
    - Keep cell phones on silent
- Ask the group if they agree with these norms or if they would like to add additional norms. If everyone agrees on the group norms, post them on chart paper in the room and insert them on the daily PowerPoint presentations.
- Inform participants that they should feel free to drink water or use the restroom as needed in addition to any breaks that seem necessary throughout the day.
- Inform participants that there will be a parking lot poster at the back of the room for them to post wows and wonders that will be addressed at the end.
- Once introductions are done and norms established, session one will begin.

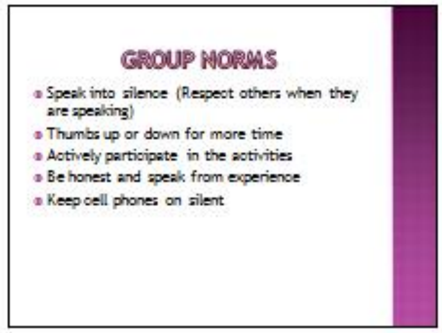
***Sessions* 1-2**

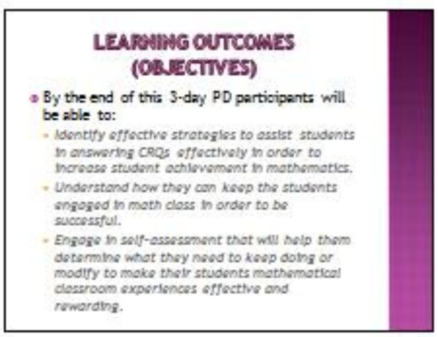
- All relevant information for participants will be included on the PowerPoint presentations and the handouts of the presentations that the participants will receive during each session. Some participants will prefer to work from their computers and will receive electronic copies of the PowerPoint presentations.

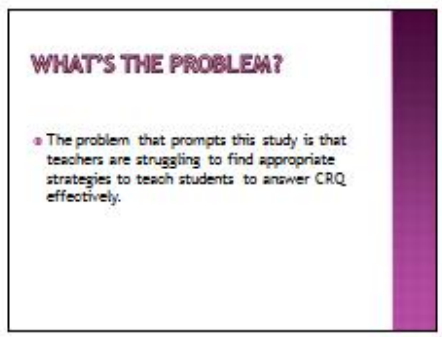
- Be responsive to participants and notice when they need a stretch break. A stretch break and bathroom break will be assigned during the morning and afternoon daily to be respectful of participants' individual needs.
- Distribute handouts, note cards, Popsicle sticks, sticky notes and chart paper to the five square tables in the room. Provide an additional table for materials to use for the organization of materials and a tool to use for resting, when not presenting. Place a basket at the exit door to collect formative assessments (exit tickets) at the end of the session.
- Hang a poster up in the back of the room for the parking lot.
- Create the reflection poster with two columns with "What worked" and "Even Better If".
- PowerPoint presentation slides are found for day 1 sessions 1-2 on the following pages of the appendix:
    - Session 1: Overview, page 129
    - Session 2: What road are you on as it relates to literacy in math? page 132
    - Session 2: *To teach Math, Study Reading Instruction,* page 134
    - Session 2: Literacy in my classroom! page 134
    - Session 2: Literacy based planning, page 136

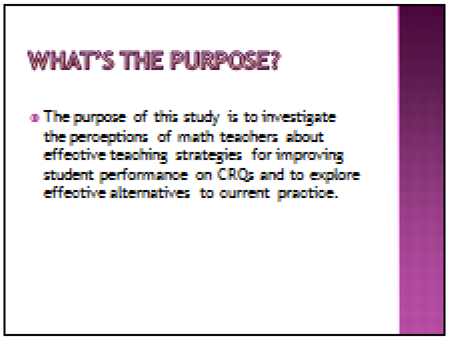
Presentation Handout (Day 1, Session 1)

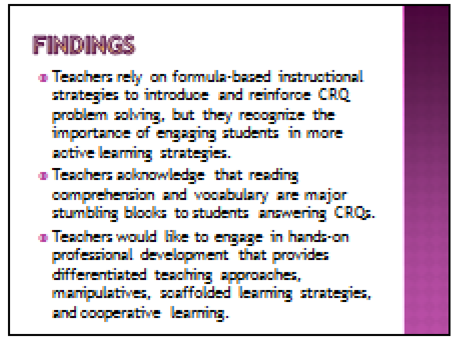


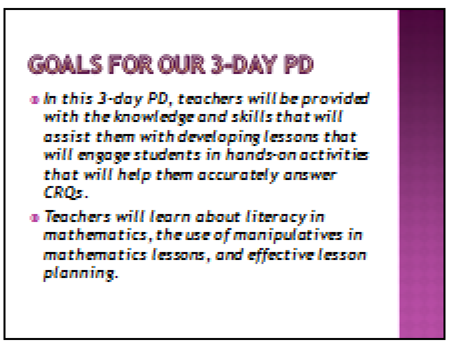


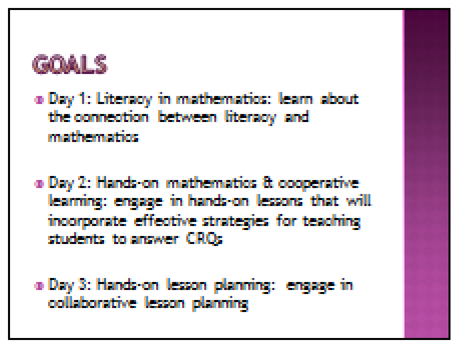





WHAT'S THE PURPOSE?
The purpose of this study is to investigate the perceptions of math teachers about effective teaching strategies for improving student performance on CRQs and to explore effective alternatives to current practice.


FINDINGS
Teachers rely on formula-based instructional strategies to introduce and reinforce CRQ problem solving, but they recognize the importance of engaging students in more active learning strategies.
Teachers acknowledge that reading comprehension and vocabulary are major stumbling blocks to students answering CRQs.
Teachers would like to engage in hands-on professional development that provides differentiated teaching approaches, manipulatives, scaffolded learning strategies, and cooperative learning.


GOALS FOR OUR 3-DAY PD
In this 3-day PD, teachers will be provided with the knowledge and skills that will assist them with developing lessons that will engage students in hands-on activities that will help them accurately answer CRQs.
Teachers will learn about literacy in mathematics, the use of manipulatives in mathematics lessons, and effective lesson planning.


GOALS
Day 1: Literacy in mathematics: learn about the connection between literacy and mathematics
Day 2: Hands-on mathematics & cooperative learning: engage in hands-on lessons that will incorporate effective strategies for teaching students to answer CRQs
Day 3: Hands-on lesson planning: engage in collaborative lesson planning

LEARNING OUTCOMES (OBJECTIVES)

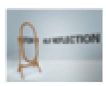
- By the end of this 3-day PD participants will be able to:
  - *Identify effective strategies to assist students in answering CRQs effectively in order to increase student achievement in mathematics.*
  - *Understand how they can keep the students engaged in math class in order to be successful.*
  - *Engage in self-assessment that will help them determine what they need to keep doing or modify to make their students mathematical classroom experiences effective and rewarding.*

WHAT TO EXPECT IN THE END

- *Teachers will develop lesson plans detailing their step by step process of how they will engage students in their lessons when teaching students how to answer CRQs.*

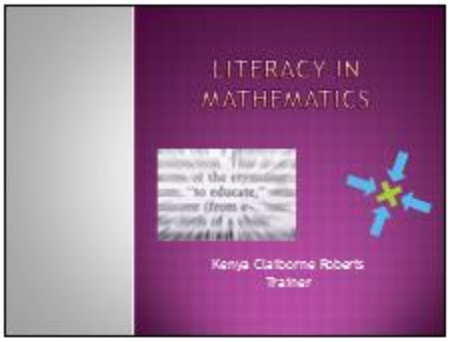
(Teachers will be able to collaborate with their peers and designated stakeholders will be able to review these lesson plans.)

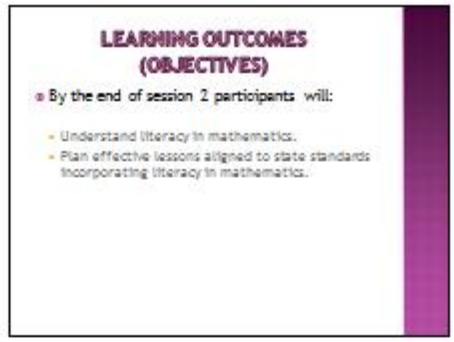
REFLECTION

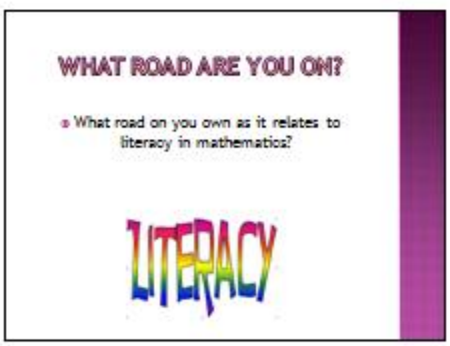


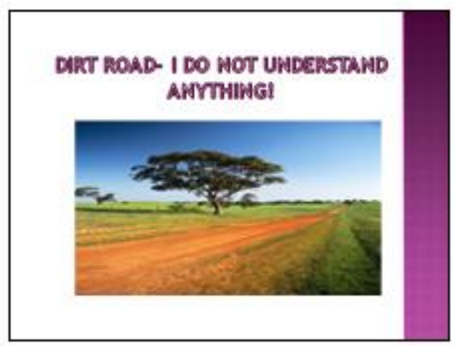
- *Take an index card from the center of the table and write down what you expect to get out of this 3-day PD.*
- *During the next 3 days, there will be ample time to share your thoughts and ideas.*
- *There is also a parking lot in the back where you can place a sticky note with wows and wonders.*

Presentation Handout (Day 1, Session 2)







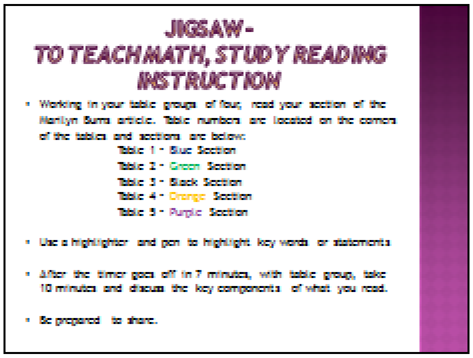


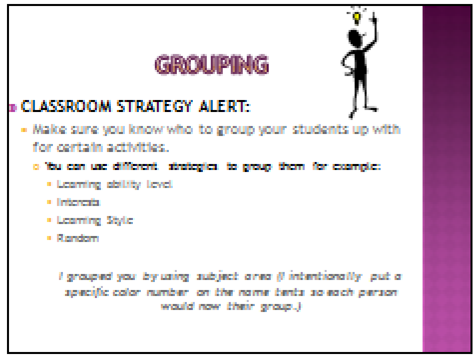

GRAVEL ROAD - I KNOW A LITTLE BUT
NEED TO LEARN MORE!


PAVED ROAD - I AM ALMOST WHERE I
WANT TO BE!

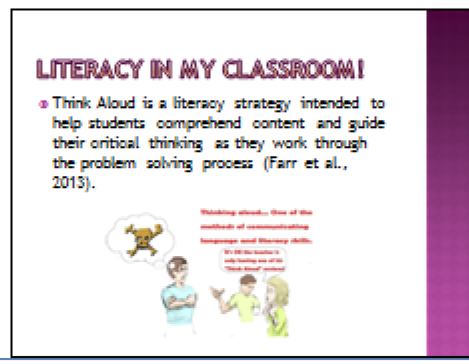

HIGHWAY - I AM AN EXPERT!


AS YOU GET TO YOUR CORNER, ANSWE
THE FOLLOWING QUESTIONS WITH THE
OTHER INDIVIDUALS IN YOUR GROUP:
Why am I on this road?
What can I do for myself to get to the next road?
What do I need help with to get to the next road?
Be prepared to Share Out!


JIGSAW -
TO TEACH MATH, STUDY READING INSTRUCTION
Working in your table groups of four, read your section of the Marilyn Burns article. Table numbers are located on the corners of the tables and sections are below:
Table 1 - Blue Section
Table 2 - Green Section
Table 3 - Black Section
Table 4 - Orange Section
Table 5 - Purple Section
Use a highlighter and pen to highlight key words or statements
After the timer goes off in 7 minutes, with table group, take 10 minutes and discuss the key components of what you read.
Be prepared to share.


GROUPING
CLASSROOM STRATEGY ALERT:
Make sure you know who to group your students up with for certain activities.
You can use different strategies to group them for example:
Learning ability level
Interests
Learning Style
Random
I grouped you by using subject area (I intentionally put a specific color number on the name tents so each person would now their group.)


KAGAN TIMER
CLASSROOM STRATEGY ALERT:
Always use a timer to stay on track and ensure that you get in all the material you need to cover.


LITERACY IN MY CLASSROOM!
Think Aloud is a literacy strategy intended to help students comprehend content and guide their critical thinking as they work through the problem solving process (Farr et al., 2013).
Thinking aloud... One of the methods of communicating language and literacy skills.

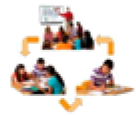
THINK ALOUD

•The Think Aloud strategy allows teachers to share with their students exactly what they are thinking as they solve many types of problems (Richardson, Morgan, & Fleener, 2011).

•The Think Aloud process assists students when they do not understand one step in the solution of a problem by allowing them to see their teachers work out the problem step by step.

LITERACY IN MY CLASSROOM!

- Think, Write, Pair, Share is a literacy strategy that is intended to give students the opportunity to think about a given topic, reflect on their learning and engage in a discussion about their learning with a peer (Duke & Del Nero, 2011).

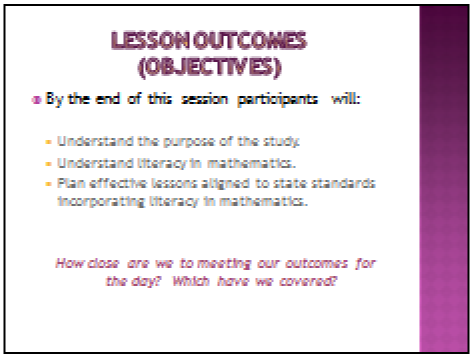


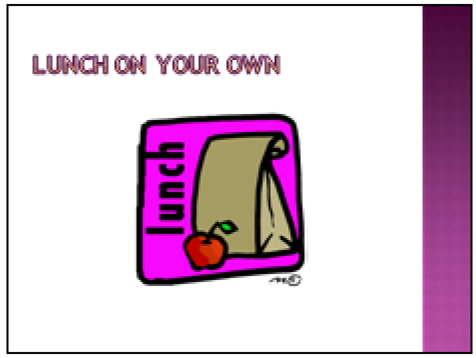
THINK, WRITE, PAIR, SHARE

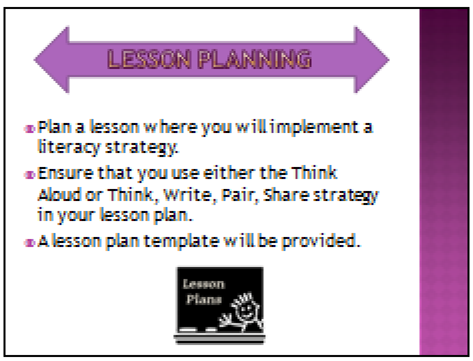
- THINK: Read a word problem and think about the steps they will take to solve the problem.
- WRITE: Solve the word problem.
- PAIR: Each student will pair with another student and share the thought process they used when solving the problem with their partner. They will then discuss ideas and ask questions of their partner about their thought process.
- SHARE: Partners share with the entire class and engage in a whole-class discussion

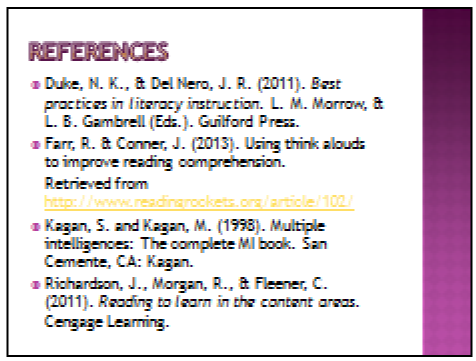
STAND UP, HAND UP, PAIR UP (SU HU PU KAGAN STRATEGY)

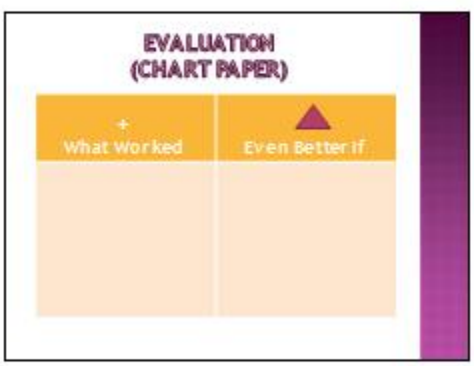
- How can you use Think Alouds or Think, Write, Pair, Share in your classroom?
  - When instructed, Stand up, put your hand up, and pair up with someone from another table. Take two minutes and share with them how you can use this in your classroom.


LESSON OUTCOMES (OBJECTIVES)
By the end of this session participants will:
Understand the purpose of the study.
Understand literacy in mathematics.
Plan effective lessons aligned to state standards incorporating literacy in mathematics.
How close are we to meeting our outcomes for the day? Which have we covered?

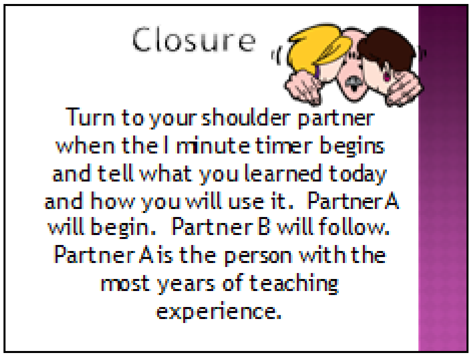

LUNCH ON YOUR OWN
lunch

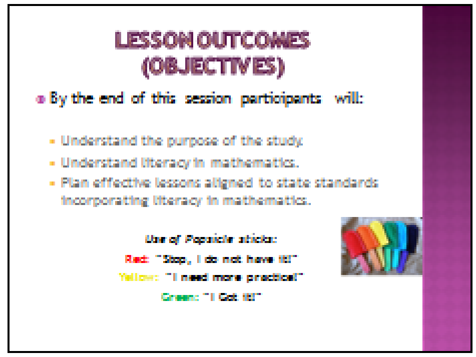

LESSON PLANNING
Plan a lesson where you will implement a literacy strategy.
Ensure that you use either the Think Aloud or Think, Write, Pair, Share strategy in your lesson plan.
A lesson plan template will be provided.
Lesson Plans

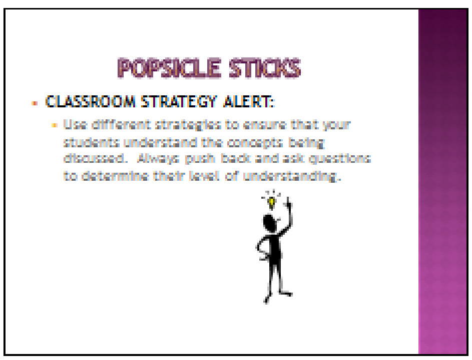

REFERENCES
Duke, N. K., & Del Nero, J. R. (2011). Best practices in literacy instruction. L. M. Morrow, & L. B. Gambrell (Eds.). Guilford Press.
Farr, R. & Conner, J. (2013). Using think alouds to improve reading comprehension.
Retrieved from http://www.readingrockets.org/article/102/
Kagan, S. and Kagan, M. (1998). Multiple intelligences: The complete MI book. San Cemente, CA: Kagan.
Richardson, J., Morgan, R., & Fleener, C. (2011). Reading to learn in the content areas. Cengage Learning.


EVALUATION (CHART PAPER)
+
What Worked
Even Better If


Have a great rest of your day!







Trainer Notes for Day 2

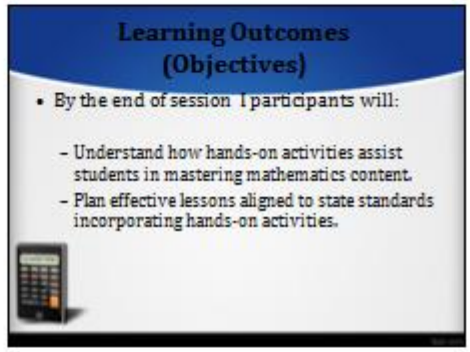
Hands-on Mathematics and Cooperative Learning

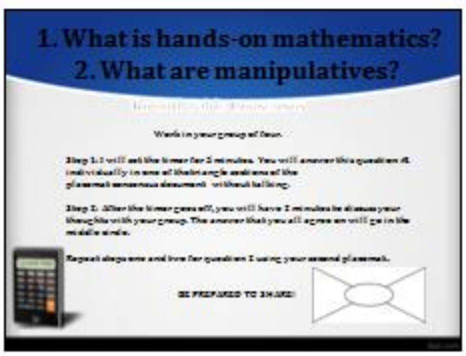
Welcome participants to the second day of the PD that will focus on implementing hands-on activities and cooperative grouping structures that will help teacher increase student success in their mathematics classrooms. The teachers will work toward leaving on the third day with a concrete lesson plan to assist with student success.

Notes to trainer for sessions 1 - 3:

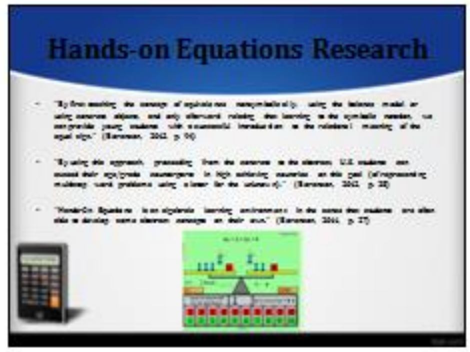
- Review the group norms that were charted the day before
- Once again, the PowerPoint presentation are simply a frame for the day's activities.
- Review the materials for each session, making sure to include note cards, sticky notes, chart paper and markers, grouping pencils, Popsicle sticks, as indicated on the slides.
- Download video clips to the presentation computer and check speakers prior to the sessions.
- Place a box at the front of the room to collect formative assessment products at the end of sessions.
- Approach participants with an affirming attitude, with strong listening and facilitation skills.
- PowerPoint presentations are found for day 2 sessions 1-3 on the following pages of the appendix:
    - Session 1: Hands-on Math in Action, page 139
    - Session 2: Cooperative Grouping, page 142
    - Session 2: Do you see what I see?, page 146
    - Session 3: Socratic Seminar in Math, page 147

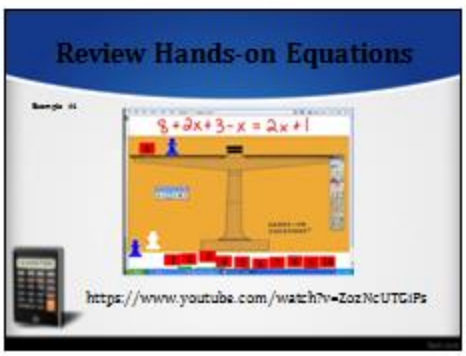
Presentation Handout (Day 2, Session 1)





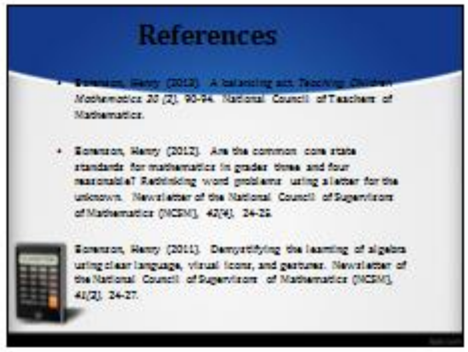

Hands- on Equations
Since algebra deals with abstract symbols many students have difficulty conceptualizing mathematics. The visual and kinesthetic approach of Hands-On Equations enables students to literally grasp algebraic concepts concretely, pictorially and then abstractly.

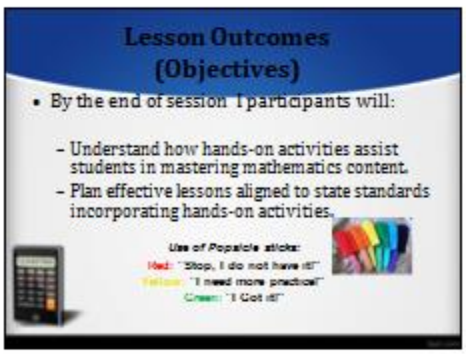

Hands-on Equations Research

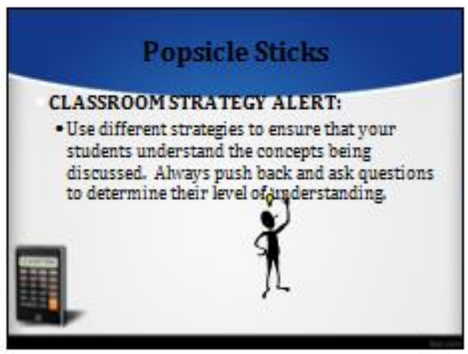

Review Hands-on Equations
8+2x+3-x = 2x+1
https://www.youtube.com/watch?v=ZozNcUTGiPs


Engage in Hands-on Equations
Use your Hands-On Equations Kit to solve:
New Work
1. 2x = x + 3 x = Check:
2. 3x = x + 4 x = Check:
3. x + 4 = 2x + 3 x = Check:
4. 4x = 2x + 6 x = Check:

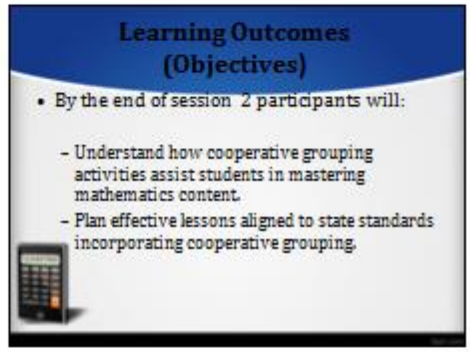

Reflection
Popcorn share
What would be the benefits of using the hands-on equations kit?


References
Mathematics 20 (2). 90-94. National Council of Teachers of Mathematics.
Borenson, Henry (2012). Are the common core state standards for mathematics in grades three and four reasonable? Rethinking word problems using a letter for the unknown. Newsletter of the National Council of Supervisors of Mathematics (NCSM), 42(4). 24-26.
Borenson, Henry (2011). Demystifying the learning of algebra using clear language, visual icons, and gestures. Newsletter of the National Council of Supervisors of Mathematics (NCSM), 41(2). 24-27.


Lesson Outcomes (Objectives)
By the end of session I participants will:
– Understand how hands-on activities assist students in mastering mathematics content.
– Plan effective lessons aligned to state standards incorporating hands-on activities.
Use of Popsicle sticks:
Red: "Stop, I do not have it!"
Yellow: "I need more practice!"
Green: "I Got it!"

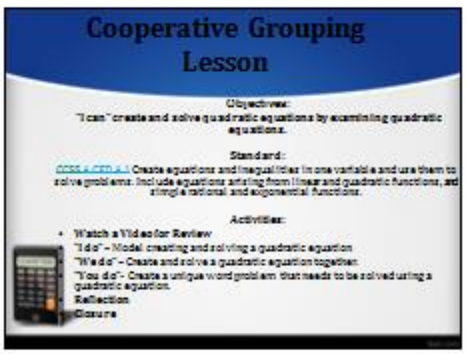

Popsicle Sticks
CLASSROOM STRATEGY ALERT:
Use different strategies to ensure that your students understand the concepts being discussed. Always push back and ask questions to determine their level of understanding.

Presentation Handout (Day 2, Session 2)

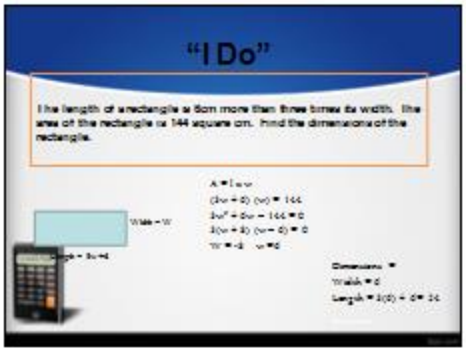



Grouping
• CLASSROOM STRATEGY ALERT:
– Make sure you know who to group your students with for certain activities.
• You can use different strategies to group them for example:
– Learning ability level
– Interests
– Learning Style
– Random

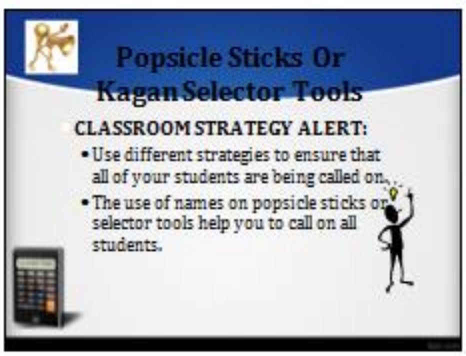

Standards for Mathematical Practice
- Make sense of problems and persevere in solving them
- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of others
- Model with mathematics
- Use appropriate tools strategically
- Attend to precision
- Look for and make use of structure
- Look for and express regularity in repeated reasoning

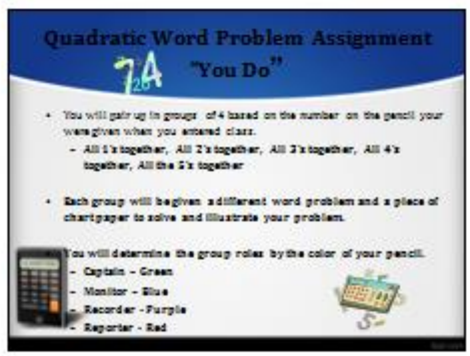

Cooperative Grouping Lesson
Objectives:
"I can" create and solve quadratic equations by examining quadratic equations.
Standard:
Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
Activities:
• Watch a Video for Review
• "I do" – Model creating and solving a quadratic equation
• "We do" – Create and solve a quadratic equation together.
• "You do"- Create a unique word problem that needs to be solved using a quadratic equation.
• Reflection
• Closure

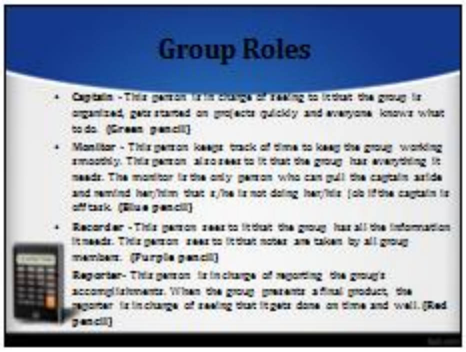

Video
Create and solve quadratic Equations


"I Do"
The length of a rectangle is 6cm more than three times its width. The area of the rectangle is 144 square cm. Find the dimensions of the rectangle.
Dimensions =

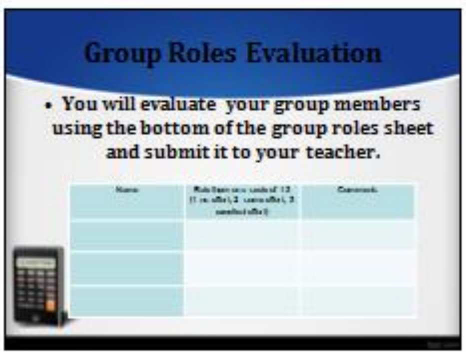

"We Do"
A square is altered so that one dimension is increased by 4, while the other dimension is decreased by 2. The area of the resulting rectangle is 55. Find the area of the original square.


Popsicle Sticks Or Kagan Selector Tools
CLASSROOM STRATEGY ALERT:
• Use different strategies to ensure that all of your students are being called on.
• The use of names on popsicle sticks or selector tools help you to call on all students.


Quadratic Word Problem Assignment
"You Do"
• You will pair up in groups of 4 based on the number on the pencil your were given when you entered class.
– All 1's together, All 2's together, All 3's together, All 4's together, All the 5's together
• Each group will be given a different word problem and a piece of chart paper to solve and illustrate your problem.
• You will determine the group roles by the color of your pencil.
– Captain - Green
– Monitor - Blue
– Recorder - Purple
– Reporter - Red


Group Roles
Captain - This person is in charge of seeing to it that the group is organized, gets started on projects quickly and everyone knows what to do. (Green pencil)
Monitor - This person keeps track of time to keep the group working smoothly. This person also sees to it that the group has everything it needs. The monitor is the only person who can pull the captain aside and remind her/him that s/he is not doing her/his job if the captain is off task. (Blue pencil)
Recorder - This person sees to it that the group has all the information it needs. This person sees to it that notes are taken by all group members. (Purple pencil)
Reporter- This person is in charge of reporting the group's accomplishments. When the group presents a final product, the reporter is in charge of seeing that it gets done on time and well. (Red pencil)

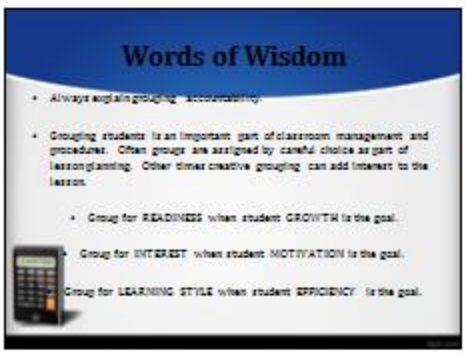

Class Period:___________ Date:_________
Group Observation Checklist

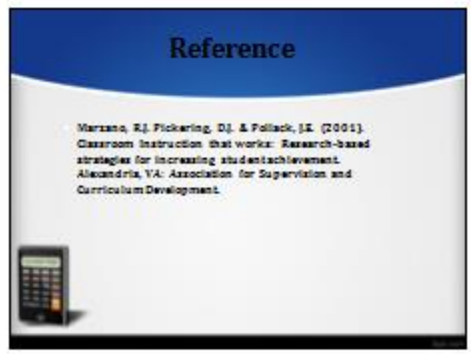

Group Roles Evaluation
You will evaluate your group members using the bottom of the group roles sheet and submit it to your teacher.

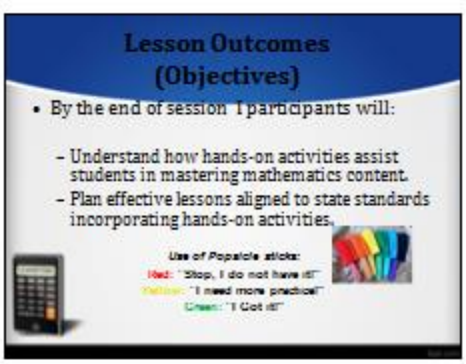

Flag it!!!
Closure – Check for Understanding
"Flag" your ideas on a sticky note…
– What do you look for to determine if a problem is quadratic?

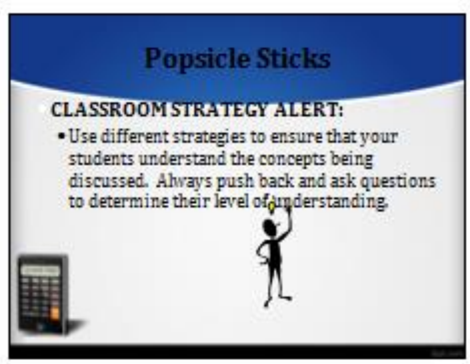

Do you see what I see?
https://www.teachingchannel.org/videos/big-brain-protocol


Reflection
– How can you use some of the things you saw in the lesson today in your classroom?
Answer this question on an index card on your table.

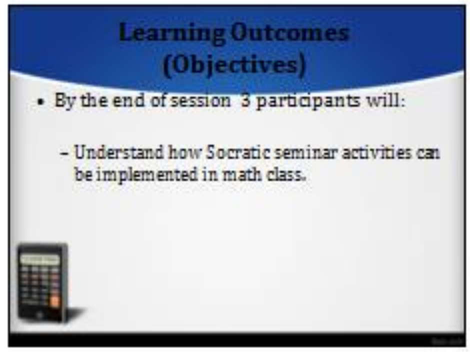

Words of Wisdom
Always explain grouping accountability.
Grouping students is an important part of classroom management and procedures. Often groups are assigned by careful choice as part of lesson planning. Other times creative grouping can add interest to the lesson.
Group for READINESS when student GROWTH is the goal.
Group for INTEREST when student MOTIVATION is the goal.
Group for LEARNING STYLE when student EFFICIENCY is the goal.

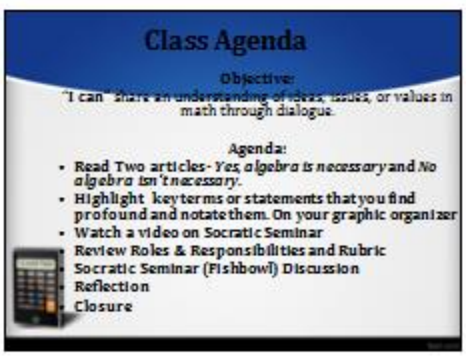

Reference
Marzano, R.J. Pickering, D.J. & Pollack, J.E. (2001). Classroom instruction that works: Research-based strategies for increasing student achievement. Alexandria, VA: Association for Supervision and Curriculum Development.


Lesson Outcomes (Objectives)
• By the end of session 1 participants will:
– Understand how hands-on activities assist students in mastering mathematics content.
– Plan effective lessons aligned to state standards incorporating hands-on activities.
Use of Popsicle sticks:
Red: "Stop, I do not have it!"
"I need more practice!"
Green: "I Got


Popsicle Sticks
CLASSROOM STRATEGY ALERT:
• Use different strategies to ensure that your students understand the concepts being discussed. Always push back and ask questions to determine their level of understanding.

Presentation Handout (Day 2, Session 3)

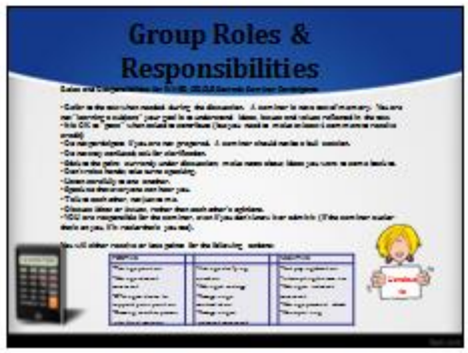


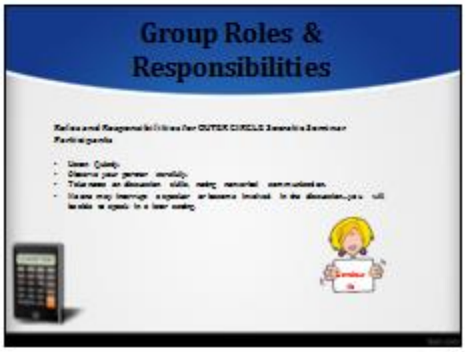



What did you find?
Highlight key words or statements that you find profound and notate them by using the following punctuation:
+ "Great point"
? "I'm confused"
?? "I have a question about this."
Then jot your information down on your gr[...]c organizer.


Socratic Seminar Video
https://www.teachingchannel.org/videos/literacy-analysis-lesson
Watch this video to gain an understanding of the Socratic seminar (fishbowl) strategy


Grouping
Look on the corner of your desk for a yellow or blue sticker and a number.
Yellow- Inner Circle
blue- Outer Circle
The number represent the seat you sit in and your partner.
For example, I have a yellow sticky note with the number 1 on it. Therefore I am in seat 1 of the inner circle. My partner is Amy because her sticky note is blue with the number 1 on it. She will sit behind me and observe me as I participate in the Socratic seminar/ fishbowl discussion.
1
1

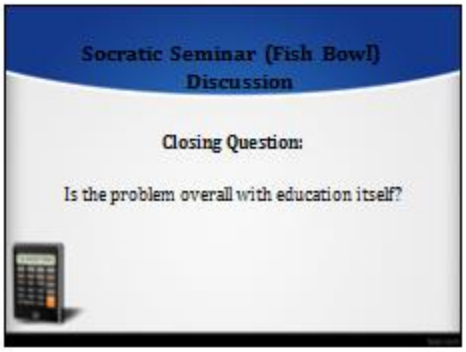

Group Roles & Responsibilities

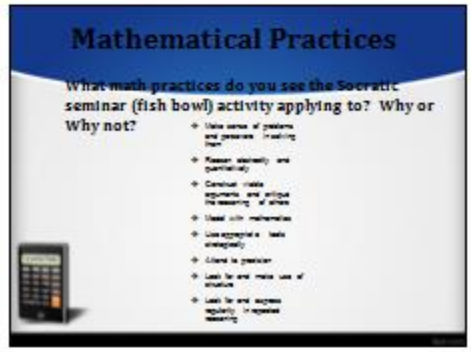

Group Roles & Responsibilities
Roles and Responsibilities for OUTER CIRCLE Socratic Seminar Participants


Socratic Seminar Inner Circle Grade Sheet

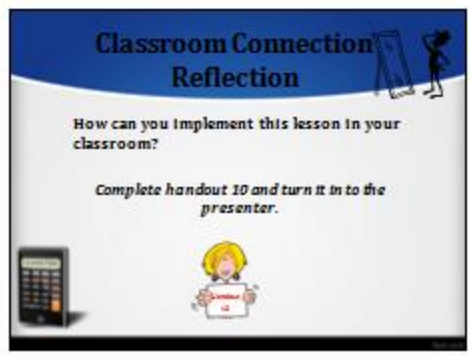

Socratic Seminar (Fish Bowl) Discussion Partner Evaluation
All Observers will complete this form as you are observing your partner.
There are 7 questions. Only fill in #1 during the discussion. You will complete questions 2 – 7 after the discussion has ended.
Please ensure that you are taking notes based on what you hear.
Take 2 minutes to review the Notes pages!

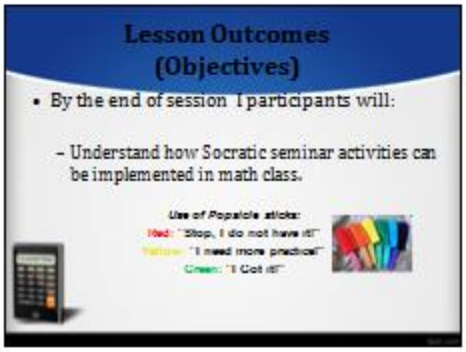

Socratic Seminar (Fish Bowl) Discussion
When will I need algebra in the real world?
What do we, as a society, really want our young people to learn in school?
Do we want the same things when we wear our parent hats as we want when we wear our employer hats? (Disclosure: I currently own neither hat.)
Given that there's only so much that can be crammed into a school day, what valuable lessons might need to be set aside in favor of even more valuable ones?

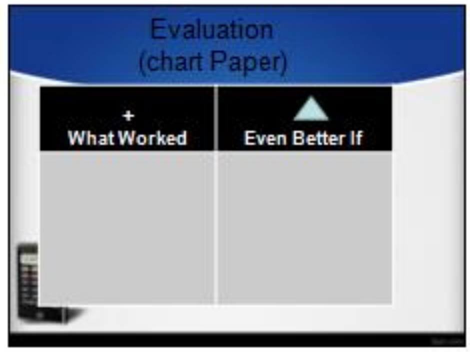

Socratic Seminar (Fish Bowl) Discussion
Closing Question:
Is the problem overall with education itself?


Mathematical Practices
What math practices do you see the Socratic seminar (fish bowl) activity applying to? Why or Why not?


Reflection
Complete your Baggage Check exit ticket and put it I the box at the front of the room.


Classroom Connection Reflection
How can you implement this lesson in your classroom?
Complete handout 10 and turn it in to the presenter.





Trainer Notes for Day 3

Hands-on Lesson Planning

Greet the participants to welcome them to the third and final day of the 3- day PD. The following notes are specific to the sessions for the third day, especially since most of the day will be mainly dedicated to teachers collaborating and planning together. The third day has been designed to focus on implementation plans. It is also a time when the trainer circulates, pairs up participants to collaborate and assists participants individually with lesson plans. The role of the trainer is one of the facilitator who will assist participants with their lesson planning efforts. The following notes relate specifically to the sessions in the order that they are scheduled. Please refer to the timeline for additional information about the specific times for sessions.

Session 1: Lesson Planning

In this session, participants will partner with a teacher who teaches the same subject as them. Please allow participants ten minutes to pair up with a partner. Each group will brainstorm and develop a lesson plan incorporating hands-on activities and cooperative grouping. The pairs will have to follow a specific lesson planning template and create all handouts that will be used during the lesson.

Session 2: Lesson Presentation

Once the lesson plans have been developed, the participants will present their lesson plans to the entire group. Next, the participants will engage in a carousel feedback activity where they will rotate from table to table to provide feedback on the lesson plans. The trainer will encourage groups to provide constructive feedback consisting of wows and wonders. After the carousel activity is complete, the trainer will allow time for participants to reflect on the presentations and feedback and on what benefits may have emerged from this activity.

This section will also capture data for the PD's summative assessment. Participants will write a response to six narrative questions.

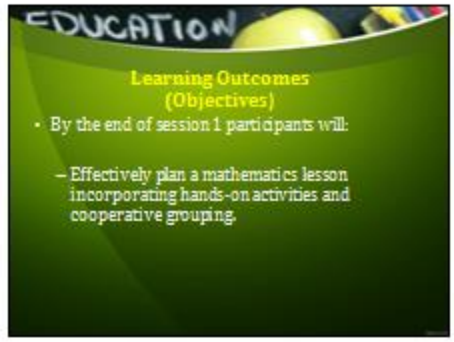
1. Did the presenter appear to possess substantial content knowledge and expertise in the content being presented?

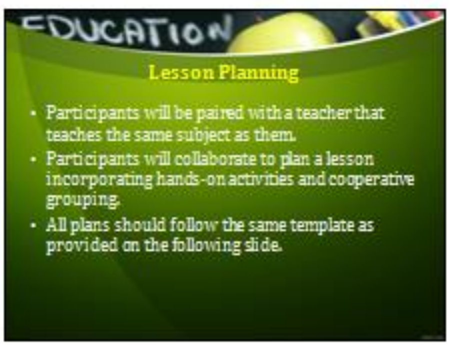
2. Do you feel you learned enough to be able to immediately implement the suggestions from this PD in your classroom?
3. Please explain what has been the most useful information you obtained during this PD session?
4. How can you use this content to enhance your instruction in your classroom?
5. How do you think the content learned will influence your instruction on CRQs?
6. If you could change anything about the sessions, what would it be and why?

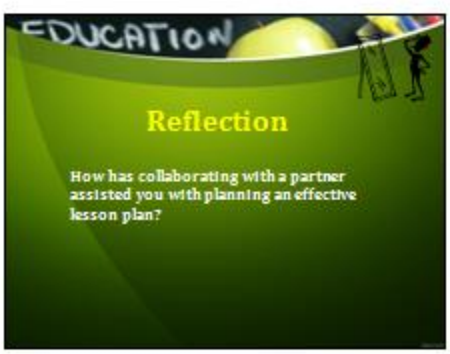
PowerPoint presentations are found for day 3 sessions 1-3 on the following pages of the appendix:

- Session 1: Lesson Planning, page 154
- Session 2: Lesson Presentations, page 156
- Session 2: Summative Evaluation, page 157

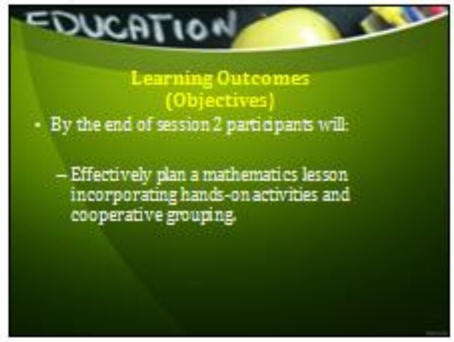
Presentation Handout (Day 3, Session 1)

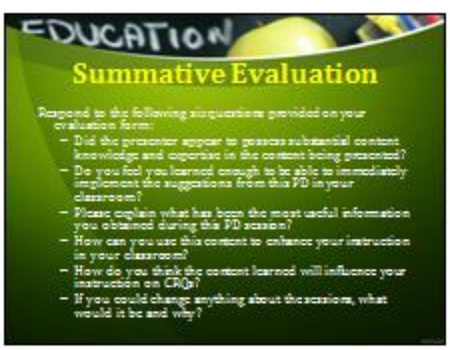






Presentation Handout (Day 3, Session 2)





Appendix B: Invitation Letter

Dear Teachers,

My name is Kenya Claiborne, a doctoral student at Walden University. I am conducting a study on perceptions of math teachers about improving student Performance on constructed response questions. The purpose of this study is to investigate the perceptions of math teachers about effective teaching strategies for improving student performance on constructed response questions. I am inviting teachers who are familiar with the Algebra 1 curriculum and who have at least 3 years of teaching experience to be in the study. If you agree to be in this study, you will be asked to participate in an interview consisting of eight questions and be observed twice during the semester when you are teaching students to answer constructed response word problems.

I will be conducting an informational meeting on Monday, January 18, 2016 at 3:30 p.m. at the MHS library for the purpose of providing information about the study. The requirements of the study will be explained.

Your participation will be voluntary. There will be no compensation for your participation. Any information you provide will be kept confidential. Your personal information will not be shared with anyone. If you choose to participate, please read the attached Informed Consent Agreement. If you decide that you no longer want to participate, you may withdraw at any time.

If you like to participate and/or have any questions, please do not hesitate to email me at kenya.claiborne@waldenu.edu or call me at 318-288-0908.

Thank you,
Kenya C. Roberts

Appendix C: Informed Consent Agreement

You are invited to take part in a research study of perceptions of math teachers about improving student performance on constructed response questions. The researcher is inviting teachers who are familiar with the Algebra 1 curriculum and who have at least 3 years of teaching experience to participate in the study. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by a researcher named Kenya Claiborne Roberts, who is a Doctoral Student at Walden University. You may already know the researcher as a Master Teacher, but this study is separate from that role.

Background Information:
The purpose of this study is to investigate the perceptions of math teachers about effective teaching strategies for improving student performance on constructed response questions. If you agree to be in this study, you will be asked to:

- Participate in an interview consisting of eight questions. The interview will last approximately 30 – 45 minutes. The interviews will be tape recorded and will take place in a private, secure room within the school facility. The member checking process will be 30-60 minutes per participant, and it will consist of each participant reviewing my initial findings and discussing with me in person any questions, concerns or comments.
- Be observed twice for a period of 30 minutes during the semester when you are teaching students to answer constructed response word problems.

Here are some sample questions:

1. Would you please share specific strategies that have elicited successful performance by students about how to answer constructed response questions?
2. When teaching students to answer CRQs, what specific approaches have you used to which students responded to successfully?
3. What kind of professional development sessions about teaching students to effectively answer constructed response questions would be most helpful to you?

Voluntary Nature of the Study:
This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at the rural School District will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind later. Declining or discontinuing will not negatively impact your relationship with the researcher. You may stop at any time.

Risks and Benefits of Being in the Study:
Possible risks would include minor fatigue such as encountered in a job interview, or workplace observation. The benefits of this study are that you may be able to see what strategies work with your students and which ones may need to be modified.

Privacy:
Any information you provide will be kept confidential. The researcher will not use your personal information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in the study reports. Data will be kept secure by being locked in a file cabinet. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact the researcher via email at Kenya.claiborne@waldenu.edu. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 612-312-1210. Walden University's approval number for this study is **IRB will enter approval number here** and it expires on **IRB will enter expiration date.**

Insert the phrase that matches the format of the study:
The researcher will give you a copy of this form to keep.

Statement of Consent:

I have read the above information and I feel I understand the study well enough to make a decision about my involvement. By signing below, or emailing the statement "I agree to the terms" to the researcher, I understand that I am agreeing to the terms described above. Only include the signature section below if using paper consent forms.

Printed Name of Participant	______________________________
Date of consent	______________________________
Participant's Signature	______________________________
Researcher's Signature	______________________________

Appendix D: Interview Protocol

Teacher: _______________/Grade Level: _______
Date: ___________________ Time: ____________

Interviewer: Kenya Roberts

Topic of Study: Perceptions of Math Teachers about Effective Teaching Strategies for Improving Student Performance on Constructed Response Questions

The purpose of this interview will allow me to gather information related to my doctoral study topic of effective teaching strategies for improving student performance on constructed response questions. Participation in this study is strictly voluntary. The data collected and the respondent will be held in the highest confidentiality. I appreciate your participation in this study and your willingness to be interviewed. This interview will last 30 – 45 minutes and, with the permission of the participant, will be recorded. Recording the interview is to ensure a nonbiased approach by the researcher and to accurately depict the responses of the participant. Do you have any questions for me before we get started?

The following questions are derived from research question #1. *What are the teaching strategies that teachers currently use to teach students to answer CRQ?* :

1. Would you please share specific strategies that have elicited successful performance by students about how to answer constructed response questions?
2. Have you had the opportunity to collaborate with teachers within the school district who have been successful in helping students effectively answer constructed response questions? Describe some of the successful approaches that have been shared.

The following questions are derived from research question #2. *What are the perceptions of teachers regarding their current practices in teaching students to answer CRQ in this local district?* :

3. When teaching students to answer CRQs, what specific approaches have you used to which students responded to successfully?

4. What obstacles have you encountered when trying to teaching students to answer CRQs?

5. How have you overcome these obstacles?

The following questions are derived from research question #3. *What professional development opportunities could enhance teachers' instructional delivery to support CRQ instruction?* :

6. What kind of professional development sessions about teaching students to effectively answer constructed response questions would be most helpful to you?

7. If you have attended professional development sessions, what was the most useful information you gained?

8. Do you think better professional development sessions are needed for all teachers in your local school district? Please explain why or why not? Will you please share your perception of a "perfect" professional development session built around this topic?

Thank you for your time. Do you have any questions for me before we leave?

Appendix E: Classroom Observation/Walkthrough Form

Teacher___________________________ Subject/Period_________________________

Date/Time_______________________ Observer Kenya C. Roberts

The purpose of this observation will allow me to gather information related to my doctoral study topic of effective teaching strategies for improving student performance on constructed response questions. Participation in this study is strictly voluntary. I will conduct two observations of each participant. I will collaborate with the teachers through email to determine the days of the week on which they focus on CRQ. I will be specifically looking for examples of teacher modeling steps needed to answer a constructed response question. I will provide a check mark next to the steps I see and provide verbatim language and examples for specific evidence. The observations will last 30 minutes. Thank you for your participation.

Constructed Response Steps	**Is there evidence of this step? (Provide a**	**Evidence/ Notes**
1. **Understand the Problem** Carefully read the question and highlight important vocabulary. 2. **Ask Questions** What do I need to know? (UNKNOWN)What do I already know? (KNOWN). What connections can I make? **(please see below for possible connections)** 3. **Paraphrase & Devise a Plan (please see below for problem solving methods)** Put the problem in my own words and plan what problem solving method to use to solve the problem. 4. **Solve by carrying out the plan, Support & Self-Check** Did I answer all parts? Does my answer make sense?		
Student Engagement:		

What Connections can I make?

Top ten problem solving methods

Connections:

Visual/drawing
Terms
Operations
Skills/Concepts
Equations
Inequalities
Multiple Representations
Similar Problems

Top 10
Problem Solving Methods:

1. Estimate
2. Work Backwards
3. Use an Equation
4. Make a Table, List, Graph or Diagram
5. Use a formula
6. Guess & Test
7. Use Logical Reasoning
8. Look for a Pattern
9. Set up a proportion
10. Choose an operation