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Third Grade Math Teachers' Perceptions of Their Preparedness to Teach the Standards for the STAAR Math Test

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Walden University

College of Education

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Diana Lynn Everman

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the review committee have been made.

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Dr. Jennifer Mathes, Committee Chairperson, Education Faculty
Dr. Edward Kim, Committee Member, Education Faculty
Dr. Kelly Hall, University Reviewer, Education Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2020

Abstract

Third Grade Math Teachers' Perceptions of Their Preparedness to Teach the Standards

for the STAAR Math Test

by

Diana Lynn Everman

MA, Walden University, 2010

BS, University of Texas at San Antonio, 1989

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Walden University

June 2020

Abstract

Teacher professional development (PD) is acknowledged as an effective approach for changing teachers' beliefs, practices, and behaviors to raise student academic achievement. A rural school district identified that 3rd grade math teachers felt inadequately prepared to teach the College and Career Readiness and Academic Standards (CCRS) standards for the state math assessment (STAAR). The purpose of this basic qualitative study was to explore third grade math teachers' perceptions of their preparedness to meet the demands of the new third grade STAAR math test. Vygotsky's constructivist theory from an adult learning perspective and Bandura's self-efficacy theory guided the study. The research questions focused on the teachers' perspectives regarding which specific math standards they needed additional understanding or support teaching. A basic qualitative study design was the methodological approach. Data was collected from 6 purposefully selected 3rd grade math teachers through semistructured interviews. STAAR data from the past 2 years was used to identify low performance areas and referenced during interviews and coding of qualitative data. Interview data was analyzed inductively using open and axial coding to identify patterns. The findings revealed that teachers wanted to extend their knowledge in mathematical reasoning with number sense and problem solving through professional development. A professional development workshop was created as the project deliverable based on these concepts. The project and study may yield social change among elementary math teachers to better prepare them to teach CCRS standards for the math STAAR test.

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Dedication

Thank you, Jesus, for giving me strength and courage to continue this journey when I thought I would quit. I want to thank my parents, my husband Jeff, and my two children, Brittany and Collin. Your unconditional love and support meant the world to me. I also want to dedicate this to my granddaughter Tinley Grace and my other grand babies yet to come. May you set your goals high and know that Gigi loves you always and forever! Never be afraid of working hard for your goals!

Acknowledgments

For the successful completion of this project study with much gratitude, I want to thank my chair, Dr. Jennifer Mathes, my second member, Dr. Edward Kim, and my URR, Dr. Kelly Hall for their scholarly guidance as well as the participating schools and school district. Without all your help, I wouldn’t be here today. I also want to extend my sincere gratitude to all my colleagues and mentors that have given me valuable support, guidance and prayers.

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Section 1: The Problem

Over the last 2 decades the public educational system has targeted the teacher as the determining factor for student academic achievement (Bigham, Hively, & Toole, 2014; Scher & O'Reilly, 2009). Because of this, continued professional development is regarded as a necessary investment to inform teacher's practice (Carpenter & Sherretz, 2012; Guskey, 2005; Sappington, Pacha, Baker, & Gardner, 2012). To raise teacher quality and student achievement, public school districts have spent extensive amounts of time and money toward professional development to cause teacher change to raise student performance in the everyday pedagogy of classrooms (Guskey, 2005; Sappington et al., 2012). While professional development aids teachers in their practice to raise student achievement, there was a disconnect in the educational and professional development system between what was effective training and what was ineffective training. According to Avalos (2011), research of teachers' professional development across various countries between 2000 and 2010, professional development is considered a complex process where the teacher is transformed through professional experiences both as a teacher and lifelong learner. However, it is also an ever-changing system where keeping up with the educational changes is a continuous challenge. Avalos stated that a school culture within the system emerges, where learning within and among others happens through observation and experiences inside teachers' practices. As a result, teachers themselves are transformed as the experts through collaborative work with others to raise student achievement (Avalos, 2011). Repeatedly, current research has shown that the most significant factor in a classroom for a student's academic success is the teacher. For this reason, the importance of relevant, professional development to support and inform teachers' practice in today's changing world, cannot be overstated.

Teacher change is associated with professional development that changes a teacher's beliefs, practices, and behaviors through social interaction with other practicing teachers (DuFour, 2014; Musanti & Pence, 2010). Professional training that focuses on specific content, collective school- and district-databased learning needs with student improvement plan goals as the main priority may assist teachers in changing classroom instruction to raise student achievement (Rubel & Chu, 2012; Sappington et al., 2012; Tournaki, Lyublinskaya, & Carolan, 2011). The allowance of time for teachers to practice professional development instructional concepts is an important element as is using best practices for improving quality instruction and student improvement (DuFour, 2014; Elmore & Fuhrman, 1995; Tournaki et al., 2011; Vaill & Testori, 2012). According to Hanushek, Piopiunik, and Wiederhold (2019), a highly effective teacher in the top 5% will help a student grow 1.5 years, whereas an ineffective teacher grows a student 0.5 year. The gap between a highly effective teacher and an ineffective teacher is large enough to make an impact of student achievement. Providing all teachers with relevant and ongoing professional development opportunities to cultivate their teaching is a responsibility of all local, state, and federal educational organizations. Stakeholders must unite to offer teacher professional development that combines with best practices and academic goals to make a sustained difference in student academic performance.

The Local Problem

A problem exists with the Peace ISD (Peace ISD is a pseudonym for a school district in the South United States) teacher training program and how it is preparing third grade math teachers to teach an ethnically and culturally diverse student population. Through examination of the Peace ISD third grade math state assessment scores by math standards and one-on-one semi formal third grade teacher interviews, I used the knowledge of teacher's perspectives from the interviews to develop a 3 day professional development staff development to inform and equip the third grade math teachers' with new research-based knowledge and strategies to raise student achievement for number sense and reasoning through mathematical word problems. Therefore, the goal of this qualitative research study was to assist in equipping the third grade math teachers with knowledge and strategies for teaching mathematical reasoning and number sense through math word problems to raise student achievement.

Peace ISD is in the southern part of the United States with 14,515 students and 887 teachers for the 20142015 school year. The school district boundaries extend over a 73-square mile area with 16 campuses. The district has grown in the new millennium from serving mostly rural youth to serving the needs of a culturally diverse student population. The demographic data provided by Peace ISD indicates that the student ethnicity for the 20142015 school year was comprised of approximately 43% White, 39% Hispanic, 11% African American, 5% Multiethnicity, 2% Asian, and 0.3% Native American respectively (DuFour, 2015).

The rationale for this study centers on the fact that the third grade math teachers need to be prepared to teach the new Career and College Readiness Standards to raise student academic achievement because success in elementary math is a good predictor of success in higher mathematics (Mongeau, 2013; National Governors Association, 2014). Although some campuses have offered limited third grade math teacher training specific to their campus, the State of Texas Assessment of Academic Readiness scores continue to diminish on the third grade STAAR state mandated test district wide (Texas Education Association, 2015b) prompting the focus of this study.

Rationale

For the last 3 years, the teachers from Peace ISD district have voiced their continual need for teacher professional development in the Workplace Dynamics Employee Engagement and Satisfaction Survey to assist them in raising student achievement and meeting the higher accountability standards (personal communication, August 2014). Although some professional development has been offered, teachers continue to feel the need for additional training to meet the needs of their culturally and ethnically diverse student population within their third grade math classrooms. Peace ISD district leaders want to examine the third grade teacher training efforts and initiatives to increase student academic performance on the third grade State of Texas Assessment of Academic Readiness tests (Smith, personal communication, August 2013).

Student performance scores over the last 4 years on the third grade mathematics supports this need for continuous effective professional development in Peace ISD to aid teachers in meeting or exceeding the growing demands of higher state and national student accountability standards on the STAAR test. Table 1 shows the performance passing percentages of all third grade students in math for Peace ISD across the last 4 school years. In the 2011-2012 school year, no test results were released because it was the first year of the increased cognitive College Readiness standards test, the State of Texas Assessments of Academic Readiness (STAAR) replaced the Texas Assessment of Knowledge and Skills Test (Texas Education Agency, 2015a).

Table 1

Peace ISD Third Grade Mathematical STAAR Percentage Passing Rate History

Year of Third Grade STAAR Test	Percentage of Students Passing
2011-2012	not released to public
2012-2013	74%
2013-2014	73%
2015-2016	not released to public

Table 1 shows that the Peace ISD third grade math percentage of students passing scores dropped from 74% in 2012-2013 school year to 73% in 2013-2014. It is the desire of Peace ISD administrators to examine and explore the current teacher training of third grade math teachers in a possible attempt to raise student achievement scores (Smith, personal communication, 2014). Professional development is acknowledged as a primary method for implementing new standards in any educational reform (Drits-Esser & Stark, 2016). From the data in Table 1, it is evident that the Peace ISD third grade math teachers could benefit from new or more effective mathematics teacher training to raise scores to meet the higher and more rigorous College and Career Readiness Standards assessed in the third grade STAAR math test. Professional training processes that meet the needs of the teachers and concerns of school officials are a critical component of educational changes (Rillero, 2016). Darling-Hammond and Rothman (2011) noted that the most important school related factor in raising student achievement is to improve teacher effectiveness (as cited in Gokalp, 2016). The problem investigated in this study was to examine Peace ISD third grade math teacher training to increase the scores on the third grade math STAAR test. Consequently, the problem centered on the Peace ISD teacher training program. The following research question guided the study: To what point is the Peace ISD teacher training program preparing third grade Math teachers to teach an ethnically and culturally diverse student population?

There may be many possible factors contributing to the decreasing third grade mathematics scores. Lee (2016) identified one possible factor may be ineffective or indirect professional training not related to the increased rigor of the new third grade STAAR test standards. The National Council of Supervisors of Mathematics (2008) stated that there is a considerable lack of understanding among teachers regarding teaching and learning mathematics in grades K-12, so much so that a lack of understanding may lead to the use of ineffective or incorrect teaching practices. Math teachers may lack content and instructional understanding to adequately teach problem solving effectively to diverse groups of students (De Kock & Harskamp, 2014). Research validates that teachers are the foundation of effective schools and improving teachers' skills and knowledge is one of the most important investments of time and money that local, state and federal government can make in education (Zakaria & Daud, 2009). Effective schools are schools that have high student academic performance regardless of any other intervening variables. The United States Department of Education (2009, 2012) identified teacher effectiveness as one of the four key elements in its *Race to the Top* competition. Thus, the problem being investigated in this study is centers on the Peace ISD teacher training program to increase the scores on the third grade math STAAR test. The purpose of this basic qualitative study was to explore third grade math teachers' perceptions of their preparedness to meet the demands of the new third grade STAAR math test.

Definition of Terms

Terms used in this project study are as follows:

Compression: A process of learning math whereby the brain uses a large amount of space for new concepts that are difficult to access and a small compact area of the brain for well learned concepts which are easily accessible (Delazer et al., 2005).

Content Standards: They are five strands of mathematical content that all students should learn: measurement, data analysis and probability; geometry; algebra; and number and operations (NCTM, 2014).

Effect Size: Researchers refer to an effect size to show the magnitude, size or given effect of an influence or technique according to student achievement (citation).

They help educators understand how powerful a given influence is on students' achievement (Hattie, 2009).

Growth Mind Set: When a person believes that their talents and abilities develop through effort, good teaching, and persistence it is called a growth mind set (Dweck, 2006). Recent neurological research supports the growth mind that 95% of all students are capable of success in high-level math given the right instruction and resources (Boaler, 2015).

Mathematical Mindset: It is a teacher's belief that students' high mathematical achievement will be impacted positively through fostering an environment that is growth minded, safe, discourse driven, challenging yet encouraging, flexible, where failure and mistakes are embraced (Boaler, 2015; Hattie et al., 2017; Fisher et al., 2017).

Meta-Analysis: It is a comprehensive study of many studies that identify effective and noneffective teaching practices with an effect number to indicate how powerful aa given influence is on student success (Hattie et al., 2017).

Precision Teaching: According to Hattie et al. (2017), precision teaching is knowing what high impact mathematics strategies to implement when for maximum student achievement impact.

Processing Standards: According to NCTM (2014), process standards are ways of acquiring and applying content knowledge.

Rigor: According to the Career and College Readiness Standards, a strong focus should be on rigor. It is an instructional shift between conceptual understanding, procedural skills and fluency, and application with equal intensity (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

Importance of the Study

This study has the possibility to affect many different stakeholders, including teachers, school and district administrators, third grade students and parents, the Peace ISD school board, and future teachers. Guberman and Gorev (2015) reported that mathematics has always been considered an important subject in K-12 studies because the more one succeeds at math, the higher likelihood of achievement for higher education opportunities. More specifically, it appears that examining third grade math teachers' perceptions of whether they are prepared to provide teaching strategies for the new STAAR math test could improve instructional best practices in third grade mathematical teaching practices to raise STAAR math test scores in third grade across the district.

The setting of the study is a public-school district in south Texas called Peace ISD. Peace ISD has seven elementary campuses with third grade teams. Each campus is composed of between four to nine third grade teachers. However, all seven of the campuses have third grade teams that have content specific subjects. This aspect means that not every teacher in third grade teaches every subject. For example, there may be four teachers at one campus that teach third grade, but only two of the four of the individuals will teach math. With this idea in mind, the collaborative community of practice within that campus is limited when there are only two teachers teaching the subject. According to Althauser (2015), collegial support helps transform instructional practices to align with research-based pedagogy. Darling-Hammond and Rothman (2011) stated that for the effective changes in teachers and student achievement, the professional development programs should include the classroom setting, process of teaching and learning and subject matter. The primary reason for conducting professional development is to increase student achievement (Reeves, 2010). Anwaruddin (2015) reported that a teacher is no longer seen as a receiver of information but instead a person who interacts within the school environment, socially constructing and reconstructing knowledge within this social world and with the participants inside a professional learning environment.

While there are studies in mathematical teaching practices of third grade, I found no studies related to the teacher preparedness toward meeting the higher demands of the STAAR math test or in the preparedness of third grade teachers in teaching the College and Career Readiness Standards necessary for the third grade STAAR test. This study will assist to fill the gap in information and research examining third grade teachers' perceptions of their preparedness to teach the new third grade math standards assessed on the STAAR third grade math test. The results of this study have the potential to make a social difference with many stakeholders, some of whom will be the current and future third grade math teachers, parents and students and ultimately the workforce in this region of Texas for 21st century.

Research Questions

Recent research studies regarding United States math and science student achievement has shown the United States behind other countries including Japan and Hong Kong (Organization for Economic Co-operation and Development, 2013). I explored and examined the perceptions of seven sample third grade math teachers from the eight elementary campuses regarding their preparation to teach the college and career readiness math standards tested on the third grade math STAAR test. The information was obtained through extensive one-on-one interviews, official STAAR third grade data reports, an open-ended questionnaire, and my researcher field notes. Two research questions guided this study:

1. What are teachers' perceptions about their preparedness in their practice to teach the standards for the STAAR third grade mathematics test?
2. What are the third grade math standards for which teachers identify as needing additional training?

Review of the Literature

I conducted this literature review using online and conventional libraries to gather the most current information regarding third grade teachers' perceptions of their preparedness to teach the standards for the STAAR math test. Walden University Library and Google Scholar were resources for databases used to locate peer-reviewed scholarly sources. Some of the databases I used through the Walden University Library were Academic Premier, Education Research Complete (ERIC), ProQuest Central, Education:

A SAGE full-text database and Thoreau. The search terms included in the search were *Mathematics Reform, STAAR Mathematics, Constructivism, Elementary Math, Elementary Math Teachers Perceptions, perceptions, teacher preparation, teacher, self-efficacy, teacher self-efficacy, Math Best Practices, Mathematical Knowledge, professional development, Texas Math,* and *No Child Left Behind.* I used Google Scholar to retrieve state and federal statistical information from sources such as Teacher Education Association, Texas State Board of Education, National Center for Education Statistics and U.S. Office of Education. Additionally, I extensively used journals and the website of National Council of Teachers of Mathematics.

To better understand the perceptions of third grade teachers regarding their preparedness to teach the third grade math STAAR test, one must understand the theoretical underpinnings of constructivism as well as the history of the mathematical reform movement. In addition, international studies were also used to inform current trends in education and other countries' models as related to teacher professional development and student achievement.

This literature review is organized by describing the conceptual framework of constructivism from an adult learning perspective as well as teacher self-efficacy and a description of how each theory will inform the study and its findings. The literature review covers a history of the mathematics reform, an overview of the College Career and Readiness Standards, best practices of a mathematics classroom, the teacher's role and eight effective mathematics teaching principles.

Conceptual Framework

The constructivist theory is the foundational theory for this research study as it is foundational to understanding much of adult learning and theory (Merriam & Bierema, 2014). Constructivism focuses on the vast amount of experiences that set adults apart from children. Candy (1991) noted that learning and teaching for adults is an interactive process involving construction and reconstruction of personally relevant experiences and meanings. Merriam and Bierema (2014) noted that the constructivist theory focuses on how a person's experiences shape his or her processing of the information within the sociocultural context of the learning. To find innovative problem-solving instructional techniques, the school can be considered an organization within its sociocultural context. Learning for adults tends to be contextually driven. According to Vygotsky (1978), learning occurs through social interaction, communication, and reflection, regardless of the age of the learner. An adult learner's knowledge is constructed within the context and culture of the organization and their experiences (Camargo-Borges & Rasera, 2013). Gergen and Gergen (2016) stated that meanings for adults are constantly changing based on social experiences and exchanges. Camargo-Borges and Rasera (2013) noted that this participatory, cooperative, and process-oriented thinking is generative and has produced innovative practices in the fields of education, health care and other community work. According to Mugambi, Mwove and Musalia (2015), one of the main objectives of learning through a constructivist theory is solving problems. Adult learners are at the heart of their own learning, building and revising experiences within the culture and context of an organization.

In this qualitative research study, the constructivist adult learning theory and the teacher self-efficacy theory conceptually informed the creation and evolution of the study as it related to the overarching question, *How is the Peace ISD teacher training program preparing third grade math teachers to teach an ethnically and culturally diverse student population?* In addition, I used the constructivist adult learning theory and the teacher self-efficacy theory to seek out the answer to these two main research study's questions:

1. What are teachers' perceptions about their preparedness in their practice to teach the standards for the STAAR third grade mathematics test?

2. What are the third grade math standards for which teachers identify as needing additional training?

The constructivist adult theory underpinned all educational practices in this qualitative exploratory research study as it provided the conceptual framework with which to view each teacher's individual knowledge, skills and attitudes toward their perceptions of their preparedness in their practice to teach the third grade math STAAR standards. In addition, the teacher self-efficacy theory informed the data collection and analysis as it was viewed holistically and through the perceptions of each individual teacher based on their own experiences. According to constructivism, individuals construct new knowledge through their interaction with previous skills, practices, and understandings socially and contextually driven (Merve, 2019). Thus, I approached the study of pedagogy comprehensively, looking at the data collectively through a socially and contextually driven lens. I evaluated the data using the contextual experiences and perceptions of the third grade teachers to inform the establishment of a 3-day professional development training. The creation of the 3-day professional training was based on the experiences and perceptions of each interview participant. In addition, the methods and instructional adult activities in the project were based on the constructivist theory that knowledge is socially and contextually driven. The project was developed with the understanding that every learner participates effectively and creates their own knowledge in a socially constructed student-centered environment. By solving a problem through a constructivist approach an organizational problem can be solved through socially constructed dialogue, reconstruction and meaning making within the context of the organization (Brooks & Brooks, 1999; Camargo-Borges & Rasera, 2013).

Self-Efficacy Theory

Studies have shown that self-efficacy belief is effective at various levels of academic life as well as an important factor in successful behaviors of all types (see Schunk, 2011). One area where self-efficacy has found to be especially effective is in mathematics (Yurt, 2014). Self -efficacy is an important factor in teaching and it plays a role in students' achievement (Guskey, 1988; Woolfolk & Hoy, 1990). A teacher's success depends on their ability to adapt to the changing needs of their students. According to Donnell and Gettinger (2015), teachers with higher self-efficacy are more willing to investigate new teacher instructional practices. Bandura (1997) identified self-efficacy as "people's beliefs about their capabilities to produce designed levels of performance that exercise influence over events that affect their lives (p. 2). Bandura stated, "Self-efficacy beliefs determine how people feel, think, motivate themselves, and behave" (p. 20). Liu and Koirala (2009) defined self-efficacy as one's belief in successfully fulfilling a given task while Gavora (2010) defined self-efficacy as one's conviction about their capabilities to carry out certain tasks in an effective way. Gavora also stated that a teacher's high self-efficacy enables a teacher to use their professional knowledge and skills to persevere, raising the likelihood that all types of learners will meet success. When a teacher has a high or low self-efficacy, their beliefs effect their ability to perform in the classroom either positively or negatively. There is a positive correlation for teachers between overcoming challenges within the classroom and their teacher self efficacy. This is especially true of mathematics' teachers because of the constantly evolving skills within our changing educational system.

Bandura (1997) noted that self-efficacy has four main sources: personal experiences, vicarious experiences, social persuasions, and physiological situations. Personal experiences are events that are individually based and affect future similar events (Bandura, 1997). Of the four experiences, personal experiences are the strongest and most important source of self-efficacy. Vicarious experiences are those experiences that are indirectly experienced like monitoring other people such as a sibling, peer, parents, and teachers (Bandura, 1997). These experiences have more of an impact on self-efficacy with performance when individuals have had a limited experience in that task.

Social experiences are those experiences that have been taken from close people like family, teachers, and friends (Usher & Pajares, 2009). Physiological states express the mood of the individuals. People who are under high stress or anxiety may not see themselves as competent to fulfill any given task (Bandura, 1997). The belief in one's personal ability to complete a task is a strong indicator of the completion of that task in the future especially if it involves personal experiences in the past.

Teacher Self-Efficacy

The other foundational conceptual theory I used in my exploratory qualitative research study was the teacher self-efficacy theory. A teacher with a strong self-efficacy has the determination to overcome and master a task even with challenges. Teacher self-efficacy beliefs are a crucial variable in increasing the quality of education to increase achievement through methods and strategies that increase student academic attitudes and achievement (Al-Alwan & Mahasneh, 2014; Tschannen-Moran, Woolfolk, & Hoy, 1998; Woolfolk, Rosoff, & Hoy, 1990). According to Garvis and Pendergast (2011), teacher self-efficacy is a crucial structure which shapes teacher effectiveness that promotes flexibility and potential to strive to meet all students. Garvis and Pendergast found this aspect to be true in their research study of teacher self-efficacy in early childhood where a positive relationship existed between a high teacher self-efficacy and the quality of education given to a student. More specifically, Gulistan, Hussain, and Mushtaq (2017) found teacher self-efficacy an essential factor teaching mathematics. A teacher's belief in their ability to overcome challenges in the classroom is a strong indicator of their ability to do so and this is particularly true in math. A teacher's self -efficacy is a solid indicator of a teacher's willingness to teach flexibly to meet the needs of all students.

According to Bandura (1993), "Teachers beliefs in their personal efficacy to motivate and promote learning affect the types of learning environment they create and the level of academic progress their students achieve" (p. 117). Teachers with high levels of self-efficacy are driven, express satisfaction in teaching, and are reported by various researchers to be a strong influence on student academic achievement (Curtis, 2017; Debusho, Sommerville, & Boakye, 2014; Klassen & Tze, 2014; Pinchevsky & Bogler, 2014). Furthermore, Woolfolk and Hoy (1990) noted that teachers who are self-efficacious are more likely to promote the same feelings in their students and teachers with a high sense of self-efficacy and are more willing to try innovative ideas and experiment with various teaching techniques for student success. Having a high level of self-efficacy is important as it motivates one to succeed in life. Zee and Koomen (2016) .in their synthesis of 40 years of teacher efficacy research. indicated that a teacher's self-efficacy impacted elementary students the most. Woolfolk, Hoy, and Kurz (2008) uncovered a substantial positive relationship in the elementary school context between academic optimism and student's achievement scores. In particular, four studies concerning math achievement propose that teachers who have high self-efficacy are more likely to facilitate students to develop their mathematical competence, than teachers with lower self-efficacy (see Allinder, 1995; Midgley, Feldlaufer, & Eccles, 1989; Throndsen & Turmo, 2013). More specifically, Throndsen and Turmo (2013) found a small but positive correlation between teacher self-efficacy and math performance at second and third grade. Dunn, Airola, Lo, and Garrison (2013) found that teachers who see new methods and instructional techniques as beneficial and seek collaboration for making data-driven decisions to improve student achievement also have a higher teacher self-efficacy. However, Zee and Koomen (2016) did note that a teacher's self -efficacy is part of a complex system of mutual interconnectedness between environmental forces, personal forces, and behavior influences. Research shows a strong correlation between a mathematics teacher's self-efficacy and a student's academic achievement. This self-efficacy tends to relate to a mathematics teachers flexibility to seek new methods and instructional techniques as well as collaborating with others in regards to making data driven decisions to increase a student's academic achievement.

A mathematics teacher's self -efficacy is their belief or perception in their competence of teaching mathematics successfully. Gavora (2010) noted that a high sense of teaching self-efficacy is linked to positive teaching behavior. Likewise, teachers who accept new ideas and a willingness to try innovative teaching techniques and pay attention to low ability students were also more likely to have a higher teacher self-efficacy (Ross & Bruce, 2007). In addition, teachers who have a strong belief in their teaching tend to construct and reconstruct knowledge based on their social context and their experiences. Understanding the beliefs or perceptions of teachers concerning their abilities is essential in improving their professional development and or teacher training (Zuya, Kwalat, & Attah, 2016). Bandura (1993) implicated this idea when he said, “Teachers beliefs in their personal efficacy to motivate and promote learning affect the types of learning environment they create, and the level of academic progress their students’ achieve” (p. 117). Research has shown that teacher professional development affects teachers’ self-efficacy and choice of instructional method and classroom environment, which directly affects both student learning and student self-efficacy (Kahle, 2008). More importantly, this information means that the knowledge teachers gain from teacher professional training positively influences their belief in their teaching which directly impacts a students’ belief in learning of mathematics. Therefore, with the two theoretical frameworks of the teacher self-efficacy theory and the constructivism theory I explored third grade math teachers’ perspectives about their preparedness to teach the third grade math standards for the STAAR test.

An Effective Mathematics Classroom

Over the last several decades research has shown the large impact teachers have on students’ academic and lifelong success (Chetty, Friedman, & Rockoff, 2014). This is especially true about mathematics’ teachers as schools and districts work to meet the higher demands in Mathematics Career and College Readiness standards (United States Department of Education, 2002; Yoon, Duncan, Wen-Yu, Scarloss, & Shapley, 2007). Building a successful classroom of numeracy begins and ends with the actions of the mathematics teacher. Successful mathematical classrooms have teachers with mathematical mindsets, who foster an environment that is growth minded, safe, discourse driven, challenging yet encouraging, flexible, where failure, and struggle are embraced

(Boaler, 2015; Hattie et al., 2017). Mathematically minded teachers clearly communicate learning goals and success criteria, so students take ownership of their learning and data and formative assessment guides the daily math learning journey. Effective math teachers communicate to their students that everyone can learn to the highest level and that mistakes grow brains. Struggle, flexibility and failure are celebrated in an effective mathematics classroom.

Effective mathematics classrooms are places where students are practicing metacognitive thinking by asking questions of themselves, their classmates, and the teacher. Mathematical learning is deeply and creatively investigated through discovery of patterns in math that drive connections within and between concepts. Depth of content is valued over speed. The classroom is a communication hub where connections or lack of connections drive the discourse. Students understand that math is a conceptually driven sphere and one about learning, not performing. Effective mathematics teachers are purposeful and above all else know each student individually. These teachers understand the conceptual journey of the concepts they teach, so that they can maximize learning by using the most effective instructional technique with the highest student impact at each student's individual phase of learning. Lastly, effective mathematics teachers understand that "one of the greatest gifts they can give their students is their knowledge, insight and growth minded feedback about their mathematical proficiency" (Boaler, 2015, p. 165). Effective mathematics classrooms have teachers who embrace learning through making mistakes and a growth mindset. They understand that being an effective math teacher and making effective instructional decisions are child centered, not approach centered, to make the highest impact possible on student's academic performance.

Mathematical Proficiency Instruction

Effective mathematics instruction begins with effective teaching strategies or techniques where the focus is on learning. Many research studies over the last two decades agree on some essential elements necessary to guarantee all students equity and success in mathematics. Mathematical proficiency according to the National Research Council (2001) is made up of interrelated strands of conceptual understanding, procedural fluency, strategic understanding, adaptive reasoning and a productive disposition. Mathematics ability is about students building a conceptual understanding that is supported through algorithms or procedures (Boaler, 2015; Reid & Reid, 2017). One of the main elements of all great mathematicians is their ability to persist, enjoy the struggle, see growth of their learning as a means of seeking help and listening to others, solve problems and finally the persistent struggle in the pursuit of finding an answer to a problem (Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016). Effective mathematics' teachers emphasize depth of thinking and acknowledge praise, struggle, mistakes, creative thinking with perseverance, and the pursuit of finding an answer to a problem.

In 2014, the National Council of Teachers of Mathematics published *Principles to Actions: Ensuring Mathematical Success for All* which described effective mathematical teaching as "teaching that engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically" (NCTM, 2014, p. 5). Within this publication eight high-leverage teaching practices were noted to support meaningful mathematical learning. It was determined that establishing mathematics goals to focus learning as well as implementing tasks to promote reasoning and problem solving are critical for high level of mathematical thinking. Connection of mathematical representations, meaningful mathematical discourse, pose purposeful questions and building procedural fluency through conceptual understanding and supporting productive struggle were all considered high leverage teaching practices (NCTM, 2014). These eight teaching practices are like the 2012 National Research Council study that reported the essential features of instruction to promote students' attainment of 21st century competencies in mathematics, science and English/language arts. The National Research Council (2012) noted these 21st century best teaching practices consist of using varied challenging tasks with multiple representations and supportive guidance, while encouraging elaboration, questioning, and self-explanation and teaching with examples are all teaching practices supporting 21st century competencies for the workplace.

Although many of the suggested teaching practices appear on both lists above, the relative affect, or impact that each teaching practice has on student learning was up for debate. The book, *Visible Learning for Mathematics* (Hattie et al., 2017) goes beyond just identifying the most effective teaching practices and provide the relative effect, or impact, a teaching practice has on mathematical student learning in terms of an effect size (Hattie et al., 2017). Their research is a result of over 15 years of research involving more than 1,200 meta-analyses, with more than 70,000 studies and 300 million students. The study of studies identifies effective teaching practices with an effect number to indicate about how powerful a given element is in transforming achievement. Understanding a technique's influence can help teachers make a more informed decision that might lead to a higher likelihood of increasing a student's mathematical achievement. Time is a valuable resource for all teachers so having the knowledge of which strategies have the highest likelihood of producing high academic performance by students is critical in making the most of instruction.

Texas Mathematical Process Standards

Besides mathematical practices, internationally, states and countries have adopted mathematical process standards. Sometimes these processes are described as habits of mind that students must develop to be proficient in doing mathematics and there is agreement that these are general processes that should be used throughout the multiple strands of learning in mathematics. For example, in Texas, the mathematical processes are described 7 of the College and Career Readiness Standards (Texas Higher Education Coordinating Board, 2009). The first process standard is applying mathematics in the real world. Using a problem-solving model that incorporates analyzing, planning, determining a solution and justifying a problem for reasonableness is another process standard. Selecting appropriate tools for problem solving and using representations to organize, record and communicate ideas are the third and 4^{th} standards. Next is communicating mathematical ideas, reasoning, and using multiple representations and language in problem solving. Analyzing mathematical relationships to communicate mathematical ideas is the ninth standard. The final process standard is using precise language both in writing and orally to display, explain, and justify mathematical ideas and arguments (Chapter 111.6).

These mathematical processing standards are thinking skills or habits of mind for math. Although they are encompassing through all mathematical domains, they can be explicitly taught through direct instruction of all concepts. Each of the process standards is a way of using or thinking, of mathematical concepts that students may or may not discover on their own. Teachers who are effective understand that designing lessons and activities that naturally involve these practices is best practice. Each of these process standards must be experienced by students as they are working mathematically through problems. For beginning math students, these practices should be explicitly taught, intentionally, and through frequent teacher modeling (Hattie et al., 2017). By the teacher modeling these practices daily, students will begin to use them in their everyday mathematical problem-solving experiences. The modeling of the processes begins students' understanding at a surface level. The deeper level and transfer levels of the mathematical processes will emerge as the students use them cooperatively with others. Effective teachers understand that process standards are an integral part of doing mathematics and must be modeled and taught with all math concepts (Hattie et al., 2017). Processing skills are the backbone of every successful mathematical classroom. Effective teachers model and scaffold higher level thinking throughout all math domains with students interactively validating their depth of thinking in cooperative group activities.

Teacher's Mathematical Knowledge

Mathematics' teachers should have a deep level of mathematical knowledge to perform their jobs well. It is vital for mathematics' teachers to be equipped with strong subject matter and teaching content knowledge for the levels they are teaching to raise students' learning achievement and success in mathematics (Kani, Nor, Shahrill, & Halim, 2014; Shahrill, Abdullah, Yusof, & Suhaili, 2014; Shahrill & Clarke, 2014). Effective math teachers are equally balanced between math content knowledge and the application of that knowledge through pedagogy.

The teaching of mathematics is difficult. It requires teachers to not only have a deep understanding of the mathematical subject content, but that ability must be matched with a clear view of how student learning of concepts develops and progress across grades (NCTM, 2014). Teachers should have a deep understanding of mathematical concepts and the use of multiple ways to present and expand on those concepts. They are fluent with the procedures and understand students need for practice to succeed. Specific to mathematics, teachers need to be able to translate the math knowledge into effective teaching practices to promote student learning (Hill, Rowan, & Ball, 2005).

According to the National Council of Teachers of Mathematics (2000), teachers must understand deeply the math as well as be able to flexibly access it their teaching tasks. The concept of mathematical knowledge for teachers (MKT) (Hill, Schilling, & Ball, 2004) is derived from Shulman's (1986) model of pedagogical content knowledge (PCK) and is a part of both subject knowledge and pedagogy entities required to teach mathematics effectively (Loewenberg Ball, Thames, & Phelps, 2008). Validating the importance of these skills, studies have shown that teachers who integrate their knowledge of mathematics with their knowledge of instruction, are able to teach mathematics concepts with greater depth, have greater awareness of children's thinking, and conceptual understanding, and are able to analyze countless methods and select appropriate models for instruction (Boaler, 2002; Borko & Putnam, 1996; Hill et al., 2004). Charalambous (2010) found evidence of a positive relationship between MKT, the cognitive level of a task and the presentation of the lesson. Another study found that teachers with a higher level of MKT presented more mathematically challenging tasks and were more accurate in the presentation of mathematical concepts (Walkowiak, 2010). Others have found that teachers' content knowledge about mathematics can positively affect student achievement (Hill, Ball, Blunk, Masters, Goffney, & Rowan, 2007; Hill, Bicer, & Capraro, 2017). In contrast, Ottmar, Rimm-Kaufman, Larsen and Berry's (2015) study showed that focusing only on teachers' mathematical content knowledge (MKT) without helping teachers understand how to provide more supportive and effective instructional practices, may prove ineffective for increasing student academic success. Thus, to improve student math achievement, teachers may need a blended training in both mathematical knowledge and instructional practices.

Understanding Educational Research Effect Size

When determining how effective specific educational research strategies are, researchers sometimes reference the instructional strategy's "effect size" (Hattie, 2009;

Marzano, 2007). Hattie's (2009) *Visible Learning* was the first large educational meta-analysis of various educational strategies. The study of studies was completed over 15 years and from a database of more than 1,200 meta-analysis, with more than 70,000 studies and 300 million students (Hattie, 2009). Following the original version of Visible Learning, Hattie has since published one called *Visible Learning in Literacy* and *Visible Learning in Mathematics.* Hattie (2009) focused his research on synthesizing the meta-analyses. A meta-analysis is a statistical tool for combining findings from different studies with the goal of identifying patterns that can inform practice. (Hattie, 2009). The tool that he used to differentiate the information was an effect size. An effect size is the magnitude, or size, of a given effect. The magnitude of a strategy was now put into a measurable term (Hattie, 2009). Effect sizes help educators understand how powerful a given influence might be in changing student achievement. Minimally, one year's growth is expected for a student. Through Hattie's (2009) meta analyses, he determined that an average year of growth of achievement for a student has an effect of 0.40, which he called the hinge effect (Hattie, 2009). Hattie (2009) notes that the hinge point is not absolute, but it is starting point for discussion for all the factors that change an effect size and its impact on student academic achievement. With this knowledge, influences or strategies that yielded a stronger change, or more than one year in academic achievement were above 0.40. Likewise, those below a normal year's worth of growth were below 0.40. When given this knowledge, teachers can now be intentional in choosing to focus on specific teaching or learning strategies above the effect level of 0.40 to yield the higher likelihood that a student would meet mathematical achievement. Although effect sizes may guide mathematics' teachers, the teacher's ability to decide which strategy to use with each student and when, is still the application part of teaching.

Mathematical Instructional Approaches

Effective mathematical instruction is intentionally designed by the teacher and should always focus on impacting student learning. There has been an ongoing debate on what makes for good mathematics instruction. The first approach that has been debated is the traditional approach. This approach consists of explicitly teaching procedures and algorithms first and the students develop fluency through repeated practice. Sometimes people incorrectly label this approach direct instruction. However, direct instruction is much more than just showing and telling of computational skills as implied in the traditional approach (Hattie, 2009). It is an "intentional, well-planned, and student-centered guided approach to learning" (Hattie, 2009, p. 73). Explicit instruction uses direct instruction and is usually paired with student modeling and think aloud that make cognitive and disciplinary processes visible and accessible through classroom discussion (Reutzel, Child, Jones, & Clark, 2014). There is a considerable data base in mathematics that supports direct explicit instruction that is especially successful for struggling students or those that are in special education (Gersten et al., 2009; Jitendra & Star, 2012; Morgan, Farkas, & Maczuga, 2015; Powell & Fuchs, 2018). The other approach that is often discussed is known synonymously as inquiry based, constructive, dialogic approach and problem-based approach; where students wrestle with problems through dialogue in the real world for meaning making and conceptual understanding by learning through hands-on materials, procedures or skills. Regardless of the instructional approach, an effective teacher understands the determining factor is the student's readiness and understanding. A high yield instructional approach will not yield high academic achievement if the student is not conceptually ready in their mathematical thinking.

Hence, the important issue about effective research-based approaches is not about which approach should be used, but when and where in the learning cycle should each approach be used. According to the National Council of Teachers of Mathematics (2000) there is no one way to teach mathematics but instead common threads and research-based principles that define high-quality mathematics instruction, as well as common thinking about what defines poor mathematics instruction (p. 18). Ultimately, student success and achievement is based on the teacher's ability to use the correct instructional approach at the correct time (Hattie et al., 2017). It is a teacher's option based on the learning goals and where the student is along their own learning journey. Effective math teachers realize their instructional decisions are child centered, not approach centered, to make the highest impact possible on student's academic performance. Consequently, being an effective math teacher is both a science and an art (Marzano, 2007). Likewise, the more a teacher focuses in on the science and art of teaching, the more the experience will yield a higher likelihood that both will develop simultaneously. Decisions about educational practice always require judgment, experience, and reasoned argument from the teacher. (National Research Council, 2001). Ultimately, the instructional decisions a teacher makes is guided by values both educational and personal. Just as the famous American psychologist William James remarked, “the elements of the mental machine and their workings does not translate directly into a prescription for educational practice” (National Research Council, 2001). Education is an applied field and for that reason using theoretical knowledge and research is always reliant on the application of the knowledge by the teacher.

Matching High Yield Mathematical Teaching Practices to Learner

Effective mathematics teachers practice precision teaching. Precision teaching is knowing what high impact mathematics strategies to implement when, for maximum student achievement influence (Hattie et al., 2017). As a teacher, when planning for precision teaching, it is useful to think of learning in the three categories of surface knowledge, deep knowledge and transfer knowledge (Donker, De Boer, Kostons, Dignath- Van Ewijk, & van der Werf, 2014; Hattie et al., 2017).

Ideally, a student would follow the three phases sequentially. However, learning is a complex activity. Learning is a process. It is not linear. A student can move in and out of the levels of the learning phases multiple times based on the concept, day, or lesson. A large part of being an effective mathematics teacher is the ability to understand each student and where they are conceptually, within the learning phases. The teacher can differentiate instructional high yield strategies based on the student and the phase of learning, to propel the learner forward.

Surface knowledge in math is the early development of conceptual understanding. It is composed of two parts. The first part is the initial learning of concepts and skills. The second part is the time and space to consolidate the new learning (Hattie et al., 2017). Initial learning of concepts or skills is an early learning of a concept. Vocabulary and procedures are given in this phase to give some structure to the concept at a surface level. Surface level learning is not about shallow learning or rote skills (Hattie et al., 2017). Focus should be on procedures that are embedded in conceptual understanding but not at a deep level. In the second part of surface level learning, the concept is being rehearsed and explored but at a minimal level of understanding. In developing surface knowledge, students act in developing their initial understanding through practice where they investigate strategies to make connections that help build their metacognitive skills of the concept (Hattie et al., 2017). Specifically, in math, this toolbox is equipped with a variety of visuals or representations to use when solving different problems. Surface learning is the foundation for students to scaffold their learning. Learning can stop at this level, if new knowledge is not connected to an older concept or if time is not given to develop and practice the skill to make connections. Another way learning can be halted at this level is if procedures are being done without any conceptual understanding.

When a student can choose which tool to use from his toolbox of conceptual representations for a problem at hand, the student is entering the deep learning phase. In this phase students combine procedures and concepts to make deeper connections. This phase is often successfully accomplished through collaborating with classmates using academic language and representations with rich discussion. Students are in deep learning when they can plan, investigate, and elaborate on conceptual understanding and begin to generalize (Hattie et al., 2017). For example, a student might know how to find the area of a 12 by 4 rectangle on a basic level, yet not be able to list all the possible measurements of a rectangle with that area at a deeper level. Effective mathematics teachers understand the importance of helping students work through the levels of knowledge to reach the highest level of understanding of a concept. When teachers assign tasks that are open ended, inquiry and collaborative based, they force their students to convince or explain a concept deeply, propelling their students into deeper learning (Boaler, 2015).

The goal of every mathematics teacher is to teach students deeply so that they can transfer their knowledge to other contexts. Transfer of learning happens when students are self-directed and apply their learning in new situations (Hattie et al., 2017). At this level, students should be thinking about their own thinking. Close association between a familiar concept previously learned, and a new situation, is needed for students to transfer their conceptual learning. Effective mathematics' teachers teach with the intention of students acquiring and compacting their needed skills, processes, and metacognition that make self-directed learning possible (Hattie, et al., 2017).

Ensuring Equity in Learning

Effective teaching is dependent on interaction between the teacher, students, and the math classroom. Cohen and Ball (1999) referred to this process as an instructional triangle. The context refers to both environmental and situational elements. The environmental and situational elements include things like educational policies, school organizational structures, school leadership characteristics, the nature and organization of teacher's work, and the social world in which it is embedded. In addition, within this instructional triangle exists each students' opportunity to learn. A student's opportunity to learn can be influenced by other students, their teachers, school, and school district, and even the country's educational system. According to Berliner and Biddle (1995), a child's opportunity to learn is the single most important predictor of a student's achievement.

A student's opportunity to learn is contextually driven and include all factors related to a student's learning environment including equity and access to high standards for student academic success. According to Boaler (2015), the opportunity to learn simply means that if student spends time in classes where they are given access to high-level content, they achieve at higher levels (p. 111). Even though this concept is the most important condition of learning, students are denied opportunities to learn the content they need as they are placed into low level classes, sometimes at a very early age (Elmore & Fuhrman, 1995; Wang, 1998). The strong messages associated with tracking is harmful regardless of whether they are placed in the highest or the lowest groups (Boaler, 1997; Boaler, 2014; Macqueen, 2013). In the Third International Mathematics and Science Study, the United States had the highest variability in achievement, as well as being the country with the most tracking. Finland and China, two of the world's highest in mathematics performance, both reject ability grouping for all and teach high content standards to all students (Boaler, 2015). One of the five guiding principles for school mathematics stated in the National Council of Teachers of Mathematics publication, *Principles to Actions: Ensuring Mathematical Success for All* (2014) is Access and Equity. According to NCTM (2014), equitable access means adequate time, high expectations, consistent opportunities to learn, and strong support that enable all students to be mathematically successful. Effective teachers give all students equitable access by accommodating differences to meet a common goal of high levels of learning for all students, using the eight NCTM (2014) Mathematical Teaching Practices.

Effective Research Based Best Teaching Practices

Establish Mathematics Goals to Focus Learning

Effective mathematics teachers make learning visible by having teacher clarity through establishing mathematics goals to focus learning. Fendick (1990) defined teachers' clarity as clarity of teacher organization, explanations, examples, instruction, assessment, and the ability to communicate it between the teacher and the students (Fendick, 1990). The effect size for teacher clarity is 0.75 (Almarode et al., 2019). Teacher clarity involves instructional decisions to set learning intentions, for the lesson or unit as well as the success criteria for meeting the intentions (Almarode, et al., 2019). It also involves consistently evaluating where the students are in the learning process with a mathematical idea or concept. Learning intentions are sometimes called objectives or goals and are what the teacher wants the students to learn. Success criteria are declarations that explain what achievement success resembles when the learning goal is met (Almarode et al., 2019). They are concrete, quantifiable, and precise for students.

Student self-reflection and metacognition is promoted when teachers strategically use learning goals and success criteria to guide learning. By stating success criteria, the students and teacher actively look for evidence of learning and understand the instructional sense of urgency of learning. Knowing what one is learning in mathematics is crucial for math achievement (Almarode et al., 2019 Hattie, J., Fisher, D., Frey, N., Gojak, L, Moore, S., & Mellman, W.). One of the best ways to maximize learning is to use backward design (Wiggins & McTighe, 2005). Beginning with the end in mind, allows the teacher to focus on the success criteria while implementing the lesson for students' understanding. It also allows students to focus on the success criteria, while sometimes participating in unlearning or relearning material in order to reach the goal. In this way, students have ownership of their learning. This aspect means students will know what they are expected to learn, and what the goal will look like when they have learned it, having an idea of the strategies to get there and knowing what to do when they do not know what to do (Sitzmann & Ely, 2011). Having students' self-report their grades or understanding and predict their achievement has shown to have an effect size of 1.44 (Almarode et al., 2019). This means that students can describe their current performance accurately, whether their performance is high or low (Hattie, 2009). This process is the beginning of helping students' use self-regulation skills or metacognitive skills. Teaching metacognitive strategies to students have an effect size of 0.69

(Almarode et al., 2019). Effective mathematics teachers communicate good learning intentions with success criteria that set a sense of instructional urgency to their students (Hattie, 2009). Effective mathematics teachers understand the importance of making learning goals visible to students. Students that can state what they are learning and how they know they have learned it reach higher levels of academic achievement. On the other hand, students should be able to use metacognition to know when they are not understanding a goal or objective. Making goals and objectives visible through objectives and success criteria raises academic achievement of students.

Implement Tasks that Promote Reasoning and Problem Solving

Effective math teachers choose tasks that push students thinking forward and allow flexible, creative thinking in a real-world problem-solving environment. Mathematics is a critical thinking logical subject where students must make sense, use, and do mathematics. It is a complex subject in which problem solving and computational skills at the lower level are foundational for higher level understanding in order to make sense of relationships between concepts, operations, and reasoning (Bryant et al., 2016). According to McGinty, Radin, and Kaminski (2013), to promote brain dendritic growth, the brain must have “stimulation, novelty, and problem-solving activities” (p. 51). Applying conceptual understanding from one lesson to another requires students to use their brain’s ability to build new neural networks which is fostered by continual inquiry and a process of discovery (McGinty et al., 2013). Educators can use the brain’s natural problem-solving drive by creating problem solving lessons that use prior knowledge, make associations, connect emotionally, and foster curiosity (p. 50). Boaler (2015) suggests teachers choosing the mathematical tasks by using tasks that combine "curiosity, connection making, challenge, creativity and collaboration" (p. 57). She calls these the 5 Cs of mathematics engagement. When teachers are designers of their mathematical tasks, creating and adapting tasks that are problem solving based, they empower their students.

Teachers should develop mathematical problem-solving tasks using rigor. According to the Career and College Readiness standards, a strong mathematical focus should be rigorous. Rigor in mathematics is a balance between theoretical understanding, practical skills and fluency, and application with equivalent intensity (National Governors Association Center for Best Practices, 2014). Teachers must design tasks that are intentional and complex with a balance between concepts, calculation, and application. Effective teachers use their knowledge of students to guide their tasks to balance appropriately challenging problems to foster student's meta-cognitive abilities that reinforce being mathematically proficient.

According to NCTM (2000), problem solving means engaging in a task when a solution is not known ahead of time. A problem-solving learning environment allows student to learn mathematics deeply and gives students the opportunity of pursing their own mathematics passion (Schoenfeld, 1992). Hiebert and Wearne (2003) noted the process of problem solving increases and enhances a students' mathematical perception. Problem solving involves the integration of several cognitive and meta-cognitive processes like attention, memory, language, self-questioning, self-monitoring, and self-evaluation (Jitendra et al., 2015). Teaching through problem solving should be done through real contexts, problems, situations, and models. This means teachers have students solve problems in groups, stimulate their abilities to apply their mathematical thinking skills and support and challenge one another's strategic thinking (Artzt & Armour-Thomas, 2002). As students begin to make connections, more abstract concepts and problems can be added. The more comfortable the learning task gets, the more the rigor can be raised to increase conceptual understanding. Effective teachers use these problems to build conceptual understandings to develop learning through the phases of learning. Teachers should expect students to engage in real contextually driven problems to advance their creative and flexible thinking mathematical conceptual understanding. Students should enjoy these tasks as they tap into the brain's natural ability to connect with prior knowledge to solve a problem in a new context through their curiosity of the domain of math. Effective teachers understand that building student's problem solving through their stages of learning and their natural curiosity of the real world, strengthens their conceptual understanding in mathematics.

Facilitate Meaningful Mathematics Discourse

An effective mathematics' teacher recognizes that for problem solving tasks to be meaningful, they must be enhanced through productive rich class discourse. Guiding students' classroom math discussion takes skill and practice. The language, thinking, and reasoning in the class discussion contribute to the students' surface, deep or transfer knowledge. An effective teacher understands that quality discourse is facilitated through purposeful questioning, prompts, and cues. Purposeful questions encourage students to explain, elaborate, and clarify thinking. They can also reveal a student's understanding or misunderstanding (NCTM, 2014). Meaningful discussion is most helpful as daily formative assessment. Great teachers probe often for validation and knowledge of a student's level of understanding (Almarode et al., 2019). Discourse norms and expectations should be set during the beginning of the year when the classroom community is fostered through community building activities. It is equally essential to understand that norms and rules are not the same. Norms are the agreements of a group about how members will work together, and they usually describe four dimensions: trust, belonging, sharing and respect (Center on Disability & Community Inclusion, 2014). Purposeful anchor charts can be made to enhance and remind students of helpful sentence stems to respectfully challenge their classmates thinking. Teachers and students practice self-questioning and self-verbalization to extend metacognition. Building a safe environment is critical to building a classroom where rich mathematical classroom discussions will enhance students' mathematical understanding.

Pose Purposeful Questions

Utilizing questioning techniques to further students 'cognitive knowledge is another research based instructional method that effective teachers use. Wood (1998) stated that funnel questions occur when a teacher guides a student down the teacher's path to find the answer. On the other hand, focusing questions support students doing the cognitive work of learning themselves by helping to push their conceptual knowledge forward. In the NCTM book, *Principles to Actions (2014)*, it is made clear that funneling questions stifle students' thinking by using hints that steal a student's ability to connect cognitively. While, focusing questions bump the student's thinking forward to promote cognitive connections. Focusing questions scaffold students' cognitive growth. Effective teachers probe further so the student explains their thinking. Teachers should give themselves adequate think time to strategically think about posing purposeful questions for further communication and discourse amongst the students (NCTM, 2014). Other times teachers may use guided questioning. Guided questions are designed to help students make sense of what is going on in the classroom and make inferences and connections on their own (Almarode et al., 2019). Effective, rich discourse is facilitated by the teacher and the community of learners where norms are set to establish mathematical talk. An effect size of .64 was found for self-questioning and self-verbalization (Almarode et al., 2019). Effective rich classroom discussion is purposeful and can move learners through the phases of learning cognitively teaching meta-cognitive strategies for self-directed mathematical learners.

Building Mathematical Connectiveness in Students

Teachers should be creating classrooms where students see themselves as not only problem solvers but as flexible thinkers who search for patterns and relationships to make sense of their math world, conceptually. Children need to see math as concepts that build on each other. Math is a conceptual realm and not a subject of facts and isolated procedures to memorize (Boaler, 2015). For example, when students learn to count two sets of numbers, they learn the concept of a sum. As students learn to add equal groups, they develop the concept of a product. These concepts should be thought about and discussed deeply through comparing them and how they relate to each other. Learning math in the brain involves a process called compression (Delazer et al., 2005). New math concepts take up a large amount of brain space and must be thought about long and hard. The math concepts you have learned and know well, take up a smaller dense part of the brain which is easily accessed. However, the brain can only process a few uncompressed ideas at one time. Students who struggle in math often do so because they have not engaged in compression. The brain can only compress concepts, not rules and methods (Delazer et al., 2005). Effective math teachers help students make connections between mathematical concepts so compression of math concepts can be efficiently placed into long term memory to be recovered later. Therefore, students who do not engage in compression of math concepts, struggle to remember because the brain cannot organize and file methods and rules. This finding is why it is crucially important that teachers help students make connections conceptually. If students are not learning math conceptually, there is no way for them to retain and build on what they have already learned. Number talks are one of the best pedagogical methods for developing number sense and helping students think flexibly about the conceptual understandings of the nature of math (Boaler, 2015). Effective mathematic teachers understand that teaching mathematics involves helping students make connections between prior conceptual understandings and the new concepts.

When teachers help students connect mathematical concepts, students can compress new concepts in order to allow them to think flexibly about math and find relationships and patterns flexibly and visually. This process is sometimes known as number sense in the early years of school. Number sense is the foundation for all higher-level mathematics (Feikes & Schwingendorf, 2008). Number sense and mathematical mindsets develop together (Boaler, 2015). Number sense is the ability to work with numbers flexibly and conceptually (Boaler, 2015, p. 35). Using diverse pathways in the brain is the most powerful learning (Park & Brannon, 2014). The right side of the brain handles visual and spatial information while the left side processes factual and technical information (Park & Brannon, 2014). This research showed that mathematical performance and learning was maximized when the two sides of the brain communicated with each other. For example, when students work on multiplication problems, the strongest connections can be made when students use visual and intuitive mathematical thinking together to understand the formal abstract math. This approach builds new brain pathways from each side of the brain to solidify learning connections. Mathematical thinking and understanding becomes permanent when both sides of the brain communicate with each other. Effective mathematics' teachers work to build new brain pathways in their students by pushing them to see relationships between mathematical concepts, by fostering activities that help them see mathematics visually and flexibly.

Build Procedural Fluency from Conceptual Understanding

Compression of concepts must happen to retain math ideas. Therefore, teachers need to build procedural fluency through conceptual understanding. This process is one of the 8 high-leverage teaching methods noted by NCTM publication *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, 2014). Unfortunately, some people think that because some areas of math are factual, like number facts, they should be learned through repeated drills and practice (Boaler, 2015). However, this approach causes damage to young students and makes them think that math is about procedural methods and memorization (p. 37). According to research, math facts are best learned conceptually and then by using numbers in different and flexible ways. (Delazer et al., 2005) Being able to be fast with number facts does not make a good mathematician. The best way to encourage learning math facts is through the development of number concepts and activities that reinforce relationships. Brain researchers found that learning math facts through memory or through conceptual understanding both involved two distinct pathways in the brain, and both were good for lifelong learning. However, those that learned facts through strategies were superior to those that memorized procedures only because they showed a better ability to transfer the knowledge to new problems (Delazer et al., 2005). Consequently, it is more effective for mathematics teachers to teach students in learning basic facts with automaticity, by helping them connect relationships between numbers conceptually.

Supporting Productive Struggle and Perseverance in Learning Mathematics

Effective math teachers begin with a mathematical mindset that understands the importance of building a safe classroom environment that embraces mistakes, learning and a growth mindset. There are specific teacher behaviors that matter in the teaching of mathematics. Creating an enriched, safe, environment in the classroom is vital to brain growth; likewise, student achievement (McGinty et al., 2013). Enriched environments allow students to be active participants, non-threatening, and the ability to use their senses. Mathematics more than any other subject has the potential to crush students (Boaler, 2008). Mathematical classroom norms are set up with the students to cultivate a safe, risk taking environment where the students take ownership of their learning environment. These norms are then revisited daily by both the teacher and the students as they are being taught. For example, one norm is the belief that everyone can learn math to the highest level. Another norm might be that mistakes are a valuable learning tool. One of the most damaging myths in the Western world and homes, is that math is a gift and a person either naturally has it, or you do not (Boaler, 2008). This thinking is called a fixed mindset and is not supported by recent brain research, nor a productive belief in mathematics classrooms (Dweck, 2006). It is interesting to note that this fixed mindset idea is nonexistent in Eastern countries like China and Japan, that top the world in mathematics achievement (Organization for Economic Co-operation and Development (OECD), 2013). Recent neurological and brain research support the growth mindset and the educational research showing that about 95% of all students are capable of success in high-level mathematics courses given the right instruction and resources (Boaler, 2015). This aspect is an important finding as it shows the importance of teachers choosing the right instructional tools at the right time. When a person believes that their talents and abilities develop through effort, good teaching and persistence it is called a growth mindset (Dweck, 2006). Research support growth minded classrooms being successful mathematicians. Effective mathematics' teachers foster a culture of effort and growth in their classrooms to facilitate a productive learning environment.

When math teachers teach students that mistakes are positive and especially through challenging material, it empowers them. Students should be taught that mistakes cause the brain to spark and grow, and more so, when struggle is involved (Moser, Schroder, Heeter, Moran, & Lee, 2011). Piaget believed making mistakes was an important part of learning before research confirmed it. He believed true wisdom was a process of moving from equilibrium, where things fit together nicely, to disequilibrium, where the ideas do not fit, to a new state of equilibrium. Piaget called this process essential to learning (Piaget, 1964). What Piaget (1957) described as disequilibrium, is what is now identified as productive struggle within the learning cycle, which is one of the eight high leverage teaching methods published by the National Council of Teachers of Mathematics in *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, 2014). Challenging material in math is met with more success when students have a growth mindset, embrace mistakes and understand that working through productive struggle with effort grows their brain. This research was especially noteworthy because it showed that when a growth minded individuals' brain experienced enhanced brain reaction, and more attention to mistakes, it also was more active in correcting them (Mangels, Butterfield, Lamb, Good, & Dweck, 2006). This information is a critical component in learning and education because it tells educators that the ideas a person believes about themselves, change the working of their brain (Boaler, 2015). Consequently, effective mathematics' teachers should encourage mistakes and productive struggle in the learning process and promote a culture in the classroom where the students understand the important part mistakes play in their struggle to learn. When the connection is made for students, that struggling produces brain growth, it validates the feelings of disequilibrium that grows the brain through challenging material. This concept should be empowering to both teachers and students, ultimately relating to higher student achievement because the more a student believes they know or do not know, the more that student can validate or invalidate their thinking through learning.

Provoke and Use Evidence of Student Thinking

Teachers who are effective adjust instruction to reteach, extend, or support students by assessing student progress toward mathematical understanding Effective teachers understand the power in formative or day to day assessment. Formative assessment informs day to day learning (Boaler, 2015). Summative assessment is designed to summarize student's learning or give a final account of how far a student has gotten (Boaler, 2015). Perhaps a better word for along the way assessment is feedback. Brookhart (2017) defines feedback as "just in time information delivered when and where it can do the most good" (p. 1). Through student teacher conferences and writing samples a teacher can determine the level of knowledge a student has developed in a concept or concepts. Learning is a process. Feedback works best when given in terms of the growth model in line with where the student is along the continuum of the learning curve toward success criteria (Hattie et al., 2017). Feedback should boost a student forward. The student may seek more information, reconsider another approach, reason, choose a different path to use or validate their thinking to push them into thinking of another way to solve the problem. Formative instruction and feedback are about gathering in the moment data about where students are in their learning journey, and it is pivotal in making wise decisions about daily instruction (Hattie et al., 2017). The effect size for feedback is 0.75 when it is used to determine students' current level of performance, their expected level of performance or to see if the gaps have been closed in their learning. Grades are not considered feedback (Elawar & Corno, 1985). By teachers giving feedback to students, students strengthen their self-regulation and metacognitive skills. When feedback is delivered timely, students use the math talk their teachers used into their own self-talk. Feedback contributes to their overall math self-identity. Giving timely appropriate feedback to students is pivotal in moving students forward in their mathematical thinking, and effective teachers understand the importance.

Feedback ignites higher classroom student achievement. Effective teachers understand and give feedback, based on feedback about the task, the process, and self-regulatory feedback, or feedback about self (Almarode et al., 2019). Task driven feedback is the most common feedback. It is giving a student information on the task that was performed and if it was correct or if parts were missing. For example, if a student solved a word problem using subtraction but forgot to label the answer with the context, the student can be reminded that answers in word problems should be labeled. Process feedback to students is about the cognitive process they used. If a student showed a multiplication problem correctly using a ratio table, then the teacher could ask the student to show it with a different visual representation like an array. Metacognitive feedback from a teacher to a student might involve reminding a student to reread the question to be sure the solution answers the question given in the problem. The last kind of feedback is direct feedback to the student regarding their effort or quality of work. It is important to understand that effective feedback is fueled by errors or mistakes as well. Mistakes are chances for learning. Effective teachers understand that impacting student's learning means using formative assessment to know what is working, what needs to be re taught or what is misunderstood. It is a tool no effective teacher can do without, when it comes to raising student academic achievement. Effective mathematics' teachers understand that assessment measures our progress as a teacher too. The importance of daily assessment feedback by the teacher, for each student cannot be overstated.

Implications

This study provided an understanding of the perspectives of third grade teachers experiences with teaching the Career and College Standards for the STAAR third grade math test. The collected data informed the professional development training project to assist in the instructional strategies for developing student mathematical reasoning in areas of number sense and problem solving. Teachers who are better prepared to teach their content often make 20% more progress over a 10-month school year than teachers who feel they are not prepared to teach (National Council for Accreditation of Teacher Education, 2011). If the third grade Career and College Readiness Math Standards are being taught and achieved, students will not fall behind, and upon graduation, the students will be competitive in seeking placement in a college, university or workforce. Educational challenges for teachers must be met with adequate math professional development training sessions to guarantee equity, high standards and student academic success for all students regardless of diversity (Bayar, 2014).

Summary

The purpose of this qualitative study was to explore the third grade teacher perceptions of their preparedness to teach the College and Career Readiness Math Standards for the third grade STAAR test. The findings from the study informed the specific professional staff development training to assist the third grade math teachers in learning research based instructional teaching strategies or understandings to raise student mathematical achievement levels for developing reasoning for problem solving and number sense. The teachers' perceptions were explored through six one-on-one semi-structured interviews, my field notes, and the examination of the official state STAAR third grade math district documents. The data analysis was done inductively and through emergent themes and patterns. Section three is the project or professional development 3-day training specific to the findings from the third grade math teachers' perspectives.

Section 2: The Methodology

Research Design and Approach

Identifying the perceptions of teachers regarding their preparedness to teach the new third grade math standards tested on the third grade STAAR test was the focus of this study. According to the Peace ISD school district, examining third grade teachers' training was desired to increase the third grade district math scores (personal communication, 2014). This study was one way to examine the perspectives of a sample of teachers about their preparedness to teach the third grade math STAAR test. Using a basic qualitative study allowed investigation of the following research questions:

1. What are teachers' perceptions about their preparedness in their practice to teach the standards for the STAAR third grade mathematics test?
2. Which third grade math standards do third grade teachers identify as needing additional training to teach?

By using a basic qualitative study, it allowed for the exploration of the perceptions of third grade math teachers concerning their preparedness to teach the third grade math STAAR test. A qualitative research design was appropriate for this research study because according to Creswell (2014), a qualitative approach works well when the variables of the research problem are unknown. The variables were unknown as to the perceptions regarding how prepared or unprepared the third grade math teachers felt in teaching the third grade standards for the STAAR math test. Patton (2002) stated that qualitative research is about a study of issues in depth and detail without any predetermined attributes or categories. Yin (2014) noted that qualitative research studies are appealing to current research practices and are now more accepted due to the contextual richness associated with the subjects in the study. A basic qualitative study was the preferred method of study because of the exploratory nature of the research questions to explain a phenomenon to inform an effective outcome (Merriam & Tisdell, 2015).

I considered but rejected other qualitative research approaches because they would not have examined the research problem effectively or appropriately. The ethnographical study was considered but rejected because it focuses on a “cultural description” rather than the perceptions of a bounded group (Merriam & Tisdell, 2015, p. 28). Narrative analysis was also considered but rejected because it focuses on first account stories and meaning of the experience had on the “researcher” rather than the perceptions of the teachers from the bounded system (Merriam & Tisdell, 2015, p. 32). Therefore, a basic qualitative research design was most suitable for this study to inductively uncover unknown variables to address the question and offer solutions to the problem.

Participants

The inclusion criteria for this study consisted of third grade math teachers who had at least 1 year completed of teaching third grade math under the new College and Career Readiness standards. third grade math teachers in Peace ISD were appropriate as participants for this study because their job duties require them to teach the third grade math standards to prepare students for the STAAR test given every year by the state of Texas. Also, there have been limited research studies on third grade math teachers' perceptions of their preparedness to teach the standards for the third grade STAAR math test. In addition, the research questions were specific to the phenomenon of the study within Peace ISD and as a result necessitated the use of the purposeful sampling method. According to Creswell (2014), purposeful sampling is described as a situation where participants are selected based on a characteristic. Thus, purposeful sampling allowed for more in-depth interviews with the participants because the intent was to explore in greater depth the third grade teachers' perceptions of their preparedness to teach the math standards for the STAAR test. Participation in this research study was voluntary.

Participants were invited to the research study through an email, signed a consent form to participate and were interviewed and recorded. Prior to conducting the study, I gave a written explanation of the proposed study to Walden University's Institutional Review Board (IRB) and Peace ISD (see Appendix B). The IRB approval number was 05-15-18-0165592. Before collecting the data, I contacted the district review committee for Peace ISD to gain permission to conduct the study and fill out the required approval form.

Upon receiving the necessary approvals and consent forms from the IRB Board and research site, I collected data from each participant through one on one interviews. I recorded field notes (See Appendix E) after each interview to assist in drawing conclusions concerning the third grade teachers' perceptions about their preparedness to teach the math standards for the STAAR third grade test. Additionally, I examined official Peace ISD STAAR third grade math data reports exploring the math standards that the third grade students scored below 70%As a qualitative researcher, I analyzed data inductively, using each of the interviews, field notes (See Appendix E) and official data STAAR math reports to draw conclusions. According to Merriam and Tisdell (2015), conducting interviews is the most common strategy in qualitative research. Patton (2002) stated "The purpose of interviewing then is to allow us to enter into the other person's perspective" (pp. 340-341p. Interviewing participants allows for the phenomenon to be studied through the perspectives of their lived experience. This allows for detail rich data to study.

I invited 22 third grade math teachers from four campuses to volunteer for the research study. My goal was to have at least 10 volunteers to complete the interviews and three to do the pilot study of the questions. I wanted 10 volunteers in case anyone dropped out. However, I did not anticipate principals not allowing me to ask for participants from their campus. In the end, only three of the eight campuses had participants who participated in the research study, and the interview participants ranged from 4 to 27 years of teaching experience.

By interviewing six third grade math teachers in this research study, I was able to explore each third grade teacher's perspective about their preparedness to teach the third grade math standards for the STAAR test. All interviews were from 45 to 90 minutes long using an interview protocol. The interviews took place off contract hours and in the teacher's classroom after school hours and with the door closed to ensure privacy. One main concern for a researcher is to explore participants in their natural setting (Lodico, Spaulding, & Voegtle, 2010). One on one interviews are preferred when the participants can freely speak and articulate their ideas clearly (Creswell, 2014). The interview protocol was sent to each volunteer 1 week before the scheduled interview. The interview protocol served as a reminder of the questions for me 2014). The interviews were all recorded so I transcribed and listened to them after each interview many times to analyze the data and identify themes, patterns, and categories of response (See Appendix D for interview protocol).

Access to Participants

Participants were invited to the study, signed a consent form to participate and were interviewed and recorded. Prior to conducting the study, I received approval for the study from Walden University's IRB and Peace ISD (Appendix F). Walden's IRB approval number for this study was 05-15-18-0165592. Initially, the district review committee for Peace ISD was contacted via email to gain permission to conduct the study. I filled out the required approval form to conduct the study within Peace ISD and was granted approval to contact principals at each of the 8 elementary campuses for permission to ask for participants at their campus.

Participants' Rights

A strict code of ethics was used with all participants regarding informed consent, protection from harm and ensuring confidentiality (see Lodico, et al., 2010). Each participant was emailed a letter of participation after district and campus permission was approved. The letter included information about the nature of the study and benefits, how and why the participants were selected, and the length of the study and the commitment to protecting confidentiality. Following the initial e-mail contact to each elementary third grade math teacher, the selected participants returned the signed informed consent. The informed consent consisted of an explanation of who would be conducting the research and directions on returning the form. The participants were told that their participation is voluntary, and they may withdraw at any time without any repercussions. Permission for audiotaped interviews and on-on-one interviews were obtained on the consent form for each participant. Each volunteer was informed that collected data would in no way jeopardize their jobs or be reported to the school or district administration. All data will be kept in a locked file for the required 5-year period. Informed consent lets the participants know "before the research study begins what measures and treatments will be done" (Lodico et al., 2010, p. 149). Add summary and synthesis to fully conclude the paragraph.

Each participant was assured of strict confidentiality and protection from harm (Lodico et al., 2010). I explained to the participants that pseudonyms would be used to protect their identities, the school, and the school district. I made it known that I would not identify them by name, years of service, gender, racem or any other identifiable characteristic (see Lodico et al., 2010). Each volunteer understood that I would be the only person to review the data collected. I did not offer any tangible gifts or rewards to the participants to influence their participation in the study (Lodico et al., 2010).

Researcher-Participant Working Relationship

The research participants knew me as a colleague. I taught in the district for 12 years. Due to this existing collegial working relationship, a respectful comfortable relationship of support and trust was easily formed. Thus, establishing that we had common interests as professionals enabled a safe mutually trusting environment for the interviews. It is important to establish a good rapport with each participant by maintaining a relaxed, nonjudgmental environment during all interactions (Rubin & Ruben, 2012). According to Lincoln and Guba (1985), the relationship that develops between the researcher and participant is extremely important. At the completion of each interview, I gave each participant the opportunity to read and revise their transcriptions to ensure accuracy and make any corrections (see Creswell, 2014). One way to do this is through a transcript check. As a district employee myself, my understanding of the elementary teaching processes and the relationships among all stakeholders involved in educating elementary math students in the district, enabled a mutually trusting comfortable interviewing environment.

Protection of Privacy

Protecting all stakeholders in the research process is a legal ethical nonnegotiable. Confidentiality is an important part of building a trusting relationship (Rubin & Ruben, 2012). To protect the privacy of all participants, I made and continue to make every effort to keep the data confidential and secure. I am the only person to know the identities of each participant and I lock up consent forms and all other records when not being used by me. I gave participants many opportunities to ask questions about all parts of the research study. I exchanged contact information with the participants with the first contact so they could contact me regarding any questions or concerns during the research study. Each person has been protected by a pseudonym, as mentioned previously, and then by coding procedures. Each third grade math teacher was assigned a letter from A to F to ensure their privacy. I coded each teacher and their transcript with a color and a letter, not a name. As interviews and transcripts were compiled and analyzed from the collected data, they were always locked in a filing cabinet off campus or on my password-protected database on my private computer at my residence, where they will remain for the next 5 years and will then be destroyed.

Role of the Researcher

When interviews were conducted, I was a fourth grade math teacher at one of the elementary campuses in Peace ISD. As a teacher, I did not have any position of authority over any of the participants. I taught third grade with one of the math teachers at my campus who was a volunteer participant, but it was prior to the new math standards. During the research study, I did not evaluate or report any of their teaching practices. As is typical in qualitative research, I was the main instrument interacting and collaborating with the participants and I was the only person responsible for the collection of the data (see Creswell, 2014). I acted as an observer and reporter of the information that may help to understand the elementary teachers' perceptions of their preparedness in teaching the math STAAR standards for the third grade math test.

Bias from the researcher is always a consideration. Member checking and triangulation helped me in separating my own opinions and perspectives from the participants' thoughts and beliefs (see Creswell, 2014). As a qualitative researcher, I allowed the data to unfold from the data collection processes to construct the findings and the answers to the research questions regarding the third grade teachers' perceptions about their preparedness to teach the math standards for the third grade STAAR test.

Data Collection

I used purposeful sampling in this research study to select the research participants. Patton (2002) states that purposeful sampling supports the idea that "the logic and power lies in selecting *information-rich* cases for study in depth" (p. 230). Purposeful sampling was used for recruiting the participants. Purposeful sampling, according to Creswell (2014), is described as a situation where participants are selected based on a characteristic. I elected to use purposeful sampling to conduct fewer, more in-depth interviews with the identified participants because the intent was to examine in greater depth the third grade teachers' perceptions of their preparedness to teach the math standards for the STAAR test. Participation in this research study was voluntary.

The participants were taken from the third grade Peace ISD math teachers with the school district and having taught third grade math in Peace ISD at least one complete school year under the new College and Career Readiness Standards and from the elementary campuses in which permission was granted from their principal. It was preferred that the participants have different background experiences, levels of education, and teaching experiences. In addition, it was preferable, but not mandatory that as many participants as possible represent different elementary campuses within Peace ISD. After recruiting the third grade math teachers in the district, only three elementary campuses out of the eight were represented in the interviews done for this qualitative research study.

During data collection, I created a table to organize and analyze the transcribed data. According to Merriam (1988), data should in organized to make it more manageable. Yin (2014) suggested a database for researchers to use when collecting and analyzing data. Consequently, I designed an Excel spread sheet to organize and track each step in the data collection and analysis process as advised by Yin (2014).

Qualitative One-on-One Interviews

Six third grade math teachers were interviewed for the research study. Two third grade math teachers were interviewed for the pilot study. No changes were suggested by either volunteer. Semi structured interview questions were used in the study to answer the research questions. Each teacher received the interview protocol questions a week before the actual interview was scheduled, along with a list of the third grade math standards to reference. The questions were open ended which allowed for each teacher to express their own feelings and concerns in their own tones (Creswell, 2014). The interviews each took place after school hours and in each teacher's classroom with their door closed to ensure privacy. Each participant chose their interview location and time.

Before beginning each interview, I asked the participant if they consented to me using a digital recorder to support the written consent form they had signed. Each participant gave their permission to be digitally recorded to guarantee the interview questions and responses were accurate. No more than one interview was scheduled in a week and each interview varied in time, averaging about 50 minutes an interview. The volunteers ranged from a 4-year teacher to a 27-year teacher and representation from three different elementary campuses across Peace ISD.

The interview protocol questions were directly aligned with the research questions for the research study. The research protocol was developed by the researcher.to explore the problem in the research study. A pilot study was conducted, prior to the 6 interviews and no changes were suggested or made to the interview protocol based on the feedback from the two pilot participants. The first four questions on the interview protocol were there to record basic information regarding each teacher's years of experience and their current role at their campus. Then the protocol was divided into three sets of interview questions. The first set of questions were written to obtain data about the perceptions of the teachers' preparedness to teach the standards for the STAAR third grade math test. The second set of questions were designed to gather information about their perceptions of the third grade standards the teachers identified as needing more training. Finally, the last set of questions were designed to acquire the teachers' perceptions about what type of training would be most effective in supporting the teachers to meet the demands of teaching the skills required for the third grade math STAAR test.

Field Notes

Field notes (see Appendix F) were taken after each interview. I used reflective field notes to record personal thoughts that related to the interview participant such as insights, or broad ideas or themes that emerge following each interview (Creswell, 2014). The notes were also kept lessening biases. The field notes were helpful in supporting the findings of the study.

Official STAAR Math Documents

I conducted a review of the third grade STAAR math test from the last 2 years to desegregate data to determine the math standards with the lowest performance percentages across Peace ISD. Low performance was considered as those percentages below 70 percent for any one standard across the district. I added the standards on the spread sheet in the data base which assisted in analyzing the data using open coding and thematic analysis.

Data Analysis Procedures

Data analysis in qualitative research involves making sense of the data by moving back and forth between concrete bits of data and abstract concepts with reasoning from thick description to an interpretive state (Merriam, 1988). In a qualitative study, Merriam and Tisdell (2015) note that the process is “emergent, recursive and dynamic” (p. 169). The qualitative research process began the moment I finished the data collection for each interview. Data collection and analysis is a complex process involving "consolidating, reducing, and interpreting what people have said and what the researcher has seen, and read-it is a process of making meaning" (p. 176). Merriam (1988) cautions that without ongoing analysis, one may end up with data that is unfocused, repetitious, and overwhelming. Yet, Merriam (1988) notes that data analyzed along the way can be "parsimonious and illuminating" (p. 125). Each interview transcript and field notes were analyzed following each interview so that coding and conceptual abstract meanings could be uncovered. Creswell (2009) states that data analysis is an "interactive process where various stages are interrelated" (p. 7).

The purpose of this study was to explore the Peace ISD third grade math teachers' perceptions of their preparedness to teach the new third grade standards tested in the third grade STAAR math test. Data was collected from individual interviews. Patton (2002) cautions that the human element in qualitative inquiry is both a strength and a weakness as it allows for human insight, but not so heavily dependent that the findings become "dependent on the researcher's skills, training, intellect and creativity" (p. 513). A skilled qualitative researcher should be able to get out of the way and let the data tell the story (Patton, 2002).

After interviewing each teacher and taking field notes, I transcribed each audio interview using a sound organizer software. The software can import from MP3 files for easy playback and transcription. Each teacher's identifying information was kept private.

Next, I reviewed each interview transcription by reading the transcribed data and listening to the audio recording at the same time. This technique was helpful in correcting possible transcription errors. I used open and axial coding inductively (Miles, Huberman, & Saldaña, 2014).

Each interview transcription was printed on a different colored paper for each interview and coded for primary core content. During this step, each interview was organized into a narrative story, coded for primary classifying and labeling to search for reoccurring patterns. Field notes were continually read to make sense of the concepts and codes within the data. As I identified patterns and developed the categories, these were entered on the actual transcriptions and then entered onto the data spread sheet. Each teacher was given a letter A through F. As the data was analyzed, each concept was given a color and two or three letters to represent that concept. For example, NS was coded orange and stood for number sense while reasoning was coded purple and was represented by a capital R. After each transcription was coded, I made sure to reread the transcription with the coding to validate that the codes were correct.

Data Analysis

Validity

I followed important procedures and methods to ensure the research met the test for validity. According to Rubin and Ruben (2012), in depth interviews are a primary tool of qualitative researchers. Each interview was conducted using an interview protocol. The interview questions were tested with two third grade teacher participants. Neither participant had any suggestions for making the interview protocol better. Each interview followed the same sequence of questions allowing for probing as needed. In addition, the field notes with my insights from the interview questions on the teachers' perceptions regarding their preparedness to teach the STAAR third grade math standards were noted in the blank space for later consideration. After finishing each interview, the audio recording was transcribed, read many times by myself and double checked for accuracy through member checking.

After finishing the checking of the transcribed interviews, each interview was analyzed to identify themes, patterns, and categories of response. I followed these steps according to Creswell (2014) 1) exploring the general sense of data; 2) coding the data; and 3) specifying the themes. According to Patton (2002), streamlining and making sense of the raw transcripts and field notes is the challenge of content analysis.

Analysis of Field Notes

The field notes taken after each interview with my impressions following the interviews, helped me construct meaning. Patton (2002) states that "field notes are the most important determinant of later bringing off a qualitative analysis" (p. 320). Nothing should be left to recall for later use. The field notes taken after the interviews should be as descriptive as possible based on the context and setting of the research study. The field notes were "descriptive, concrete and detailed" (Patton, 2002, p. 303) According to Yin, (2014) the most important part of field notes is that they are "organized, categorized, complete and available for later access" (p. 125).

Transcript Review

Transcript review happened within a week after interview transcription. According to Creswell (2014), this was an important step in accuracy and provided the research volunteers a chance to examine their transcripts and make any corrections or feedback to their important data. All research volunteers validated the transcriptions were accurate and no changes were necessary.

Data Analysis Results

The purpose of this basic qualitative study was to explore six third grade math teachers' perceptions about their preparedness to teach the standards for the STAAR third grade mathematics test, their training needs, and type of training that would most effective to improve test scores. I used one-on-one interviews and field notes for analysis.

At the beginning of each interview I introduced myself and established a connection and relationship with each participant. I then explained the interview process and discussed the confidentiality agreement. Lastly, I asked for their permission to start the recording process and begin each interview. The data collection lasted 4 months in the spring of 2019 with each interview lasting an average of about 50 minutes.

The constructivist theory of adult learning guided the study as the teachers were interviewed concerning the interactive process of teaching experiences that shape their learning within their sociocultural context. The other conceptual theory that guided the exploratory study was the teacher self-efficacy theory which is found to be especially effective when teaching mathematics. A teacher's ability to meet success depends on their beliefs about their capabilities and professional knowledge. In addition to these foundational conceptual theories, these three research questions guided the study

1. What are the teachers' perceptions about their preparedness in their practice to teach the standards for the STAAR third grade mathematics test?

2. What are the third grade math standards for which teachers identify as needing additional training?

In the open coding process, I categorized each chunk of data generated by underlining and highlighting words and phrases to pinpoint all possible themes within each interview transcript. According to Merriam and Tisdell (2015), open coding is the practice where the research is open to every possible data occurrence. I then studied and considered the emerging themes from each interview. In addition, I converted the codes into themes assigned to a specific color and assigned that theme an abbreviation. For example, number sense was assigned orange and the abbreviation NS. I then wrote above the quotes on the transcript the abbreviation in the assigned color. Each page number where each theme appeared in the transcript was then entered onto the excel spreadsheet. After analyzing all six transcripts with field notes, three significant themes emerged from the data collected. The three themes were number sense, problem solving and reasoning. These three themes were used to create the professional development project to assist in the third grade math teacher's preparedness to teach the standards for the third grade math STAAR test. I present results by research question and then by theme.

Research Question 1

What are the teachers' perceptions about their preparedness in their practice to teach the standards for the STAAR third grade mathematics test? When the participants were asked about their perceptions of their preparedness to teach the third grade math standards for the STAAR test, I found mixed responses. Participant A, C, and F reported no formal trainings from Peace ISD except what the participants choose to seek out on their own. Participant B reported none except the Peace ISD beginning of the year university trainings. Participant D and E reported being involved in the extensive Texas Mathematics Regional Collaborative for two years.

Research Question 2

What are the third grade math standards for which teachers identify as needing additional training? This question yielded the most detailed responses and the three themes as described below which are number sense, problem solving, and reasoning.

Number Sense. Number sense was discussed in every one of the interviews. It emerged as the most prevalent theme. The overall feeling was that third graders want to do algorithms and number problems but can't explain their choice of operations or if the answer makes sense in the context of the problem. Each teacher reported needing different or additional professional training to meet the students' needs in understanding number sense. Participant A stated:

> I think if I was well versed in number sense and all teachers were provided knowledge in the Career and College Readiness Standards education and the

number system and all things, we are asked to do with the Texas Essential Knowledge and Skills would unfold more naturally. But we are building on a weak foundation. The students that are struggling and most honestly don't really understand place value. They don't understand our system. Each place is ten times the place before it. I think all grade levels should be provided professional development on number sense.

Participant B stated:

I could use more understanding in helping them understand number sense. We show them so many ways to do things and I feel like it's overwhelming to them. To me, it's so they can understand why they are doing it, so that they can apply it to all sorts of different situations. It's so that you can take this idea and use it multiple ways, and there is not just one way to get the answer. They struggle a lot with what to do with numbers. I don't know if maybe because they've been hitting addition and subtraction so much that they just want to add everything together. They just don't know what to do with numbers.

Participant C stated,

They don't have our number system down. They should be able to look at a hundred chart and be able to go to what's 10 more. If you say 12 more, they should be able to go down 10 and over two. They don't have that number sense when rounding. Just to be able to come up with the two tens that a number is between and which is it closest to. A lot of kids are just stuck on the rules. I feel like I need to have a conversation vertically about number sense strategies so there is a connection piece. What language or verbiage does kinder, first and second grade use when referring to and background knowledge? I need to know that because that is the way the brain learns. You’re going to add, subtract, multiply and divide the rest of your life. If you’re going to spend time somewhere, spend time developing number sense, not necessarily reading a word problem. Look at all the TEKS that involve word problems. But if they don’t have number sense, they can’t do them.

Participant D stated:

Number sense is an issue. We do number talks on Monday and you can tell right there, that they still have trouble just getting to ten. Or subtracting. Sometimes when they start, you say, nine plus five, they don’t go, nine, okay, 10, 11. They start at one, two. That’s way low. They don’t even get one-to-one correspondence. So that’s been kind of eye opening. They use the hundreds’ chart and their fingers but then they say, I have no more fingers. They don’t come knowing it all, and so we’re filling in the gaps from that and then we must move on to a lot of new things.

Participant F stated:

I think number sense is probably the number one thing we don’t know about the kids. You only know if they get it if you sit on the floor with them and they’re talking to you while they’re getting math. I think number sense for sure is what I

> need additional or different strategies to teach. I had a response to intervention group that were having trouble making ten, so I had to go back and teach myself what number skills they were teaching in kinder and first, which honestly helped the whole group. I'll ask, why are you doing this in the problem? They don't know. They are going to add the numbers just because they are going to add the numbers.

Problem Solving. When asking participants about areas of need, problem solving came up as the second most needed area of need. Participants shared the continuous struggle students have with understanding how to read a word problem and understand the operation or action in the problem. The participants discussed needing additional training in helping students with one-and two-step word problems. Participant A stated,

> My students that can't do multiple step word problems or can't process using data in a story problem are usually that way because they don't know how to go about solving it. If it's a word problem, they don't connect with what they are being asked to do. Am I combining, separating, is this equal groups? Then once they are told, they don't instantly solve it.

Participant C stated,

> The one TEK I feel has the most emphasis and I could use more training on is
>
> 3.1B, using a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, evaluating the problem or process, and the reasonableness of the

solution, because you're constantly having to work on it. If you give them the regular computation, they can do it but when it's in a word problem form, where they must pull out the information, understand what they're asking you to do and even if it's a two-step problem, it's even more hard. I've done a lot of logical thinking stations to help them think logically. I think our chunk of TEKS is too much. Having more training to understand what to teach and what's appropriate for them. What really is my lane? What two step problem approach should I teach them? Part of the problem is that I don't have the comfort in teaching those four things, the actions. Addition, if joining and subtraction of doing this because I was taught keywords and you know keywords you can't teach anymore. I don't have the relationship with the actions. I looked for keywords. Show me the problems and what they look like. Let me really see them without those words tied to them and can I really put them in where they go. I can look at a problem and tell you why you would multiply and why you would divide but using the verbiage that goes with that like joining equal size groups.

Participant D stated,

I could use a different way to teach or more understanding with word problems in general. That's just something they really, really struggle with and it doesn't matter how long you do it for, if you put it into everything. They just struggle all year long. So, for second grade, I would like to say what we really need you to focus on is word problems and place value.

Participant E stated,

> I think teachers need to have the awareness of how important and the differences when you say key actions. I'm not referring to key words, and I just think the overall knowledge of our staff, because we do come from a lot of different places.

Participant F stated,

> So, there are several things that I feel I don't know. Two-step problem solving and numbered paired tables. I know the level of complexity in 4th is exponentially bigger with word problems. And so, I think it's hard to kind of really get them ready for 4th to walk in the door because they weren't completely ready coming to us with those things.

Reasoning. When participants were asked about areas of additional training or different teaching techniques, helping students understand and reason through word problems and mathematically. The participants agreed that their third grade students have a disconnect between reasoning through words and numbers to make sense of a real-world problem.

Participant B stated,

> I'm going to say reasoning because I feel like for the kids who get it, or they finally, are developmentally ready for it, it just comes naturally, and they can picture it. But for some of these struggling kids, that's typically what they're in RTI for, is for the reasoning portion. So maybe how to figure out a different approach to it.

Participant E stated,

> I think we need more awareness of how important and the differences when you say key actions I'm not talking key words and I just think overall knowledge of key actions in word problems.

Participant F stated,

> I would say interpreting the information that you are given. It's those things that you wouldn't think of. And a lot of it comes from understanding the question. Understanding how to answer a question. I want them to understand the relationship between the operations.

Throughout this qualitative study and data analysis, the Constructivist Adult Learning Theory and Teacher Self-Efficacy Theory continually guided the development of the study's three-day professional development project. During the collection of the data, third grade math teachers shared their perceptions on their preparedness to teach third grade math students the standards for the STAAR math test and their perceptions were documented. When teachers construct their own learning from prior knowledge it shapes what and how they learn (Oleson & Hora, 2014). Constructivist place the learner at the heart of the learning experience as the learner constructs their own knowledge actively with an importance on the learner's viewpoint. When teachers make their own judgements about what they are learning, their motivation increases.

Increased motivation is a critical idea as it is directly related to teacher self-efficacy and student achievement. For that reason, creating professional development programs geared toward the learning needs of the teachers can positively impact the professional development's effectiveness (Gordozidis & Papaioannou, 2014). Research shows that a teacher's self-efficacy is strongly correlated to student academic achievement. For a student to reach a high level of math achievement, the self-efficacy of the teacher must be high as well, as the teacher is the most important part of their education (Sahin, Gokkurt, & Soylu, 2014). Therefore, by considering a teacher's perspectives and beliefs, you are validating their prior knowledge and increasing their motivation to learn from and through staff development that is based on their beliefs.

Contextual social learning experiences are pivotal in the constructivist adult learning theory. This knowledge supported the importance of understanding the value of developing and constructing teacher knowledge through relationship-based methods in the professional development trainings. (Chapman & Muijs, 2014). Transformative professional development for teachers must involve active learning methods. Adult learning from a constructivist adult learning theory model involves using teacher's perspectives, their prior experiences and current identified problems and classroom practices in professional development trainings.

Teachers' perceptions of their own competence are one of the most important factors that affect teaching (Sahin et al., 2014). The significance of this is especially true in mathematics teaching, as it has evolved with the changing world (Krishnan, 2016). The belief in ones' ability is directly related to their effort and ability to overcome difficulty (Peker, Erol, & Gultekin, 2018). A teacher's self-efficacy is also related to a teacher's perception toward changing teaching approaches which often results in increased student achievement (Cheon, Reeve, J. Lee & Y. Lee, 2018; Whitworth & Chiu, 2015). With the guidance from both the Constructivist adult learning theory and the teacher self-efficacy theory, a three-day professional development training was designed where teachers are active participants in a collaborative environment to ultimately raise student achievement.

Limitations

There were four limitations to this basic qualitative study research. Only Peace ISD third grade teachers who volunteered and had taught third grade math at least one year under the new College and Career Readiness Math standards was interviewed. Not every elementary third grade elementary was represented. Lastly, only six participants volunteered to be part of the research study.

Implications

Educational leaders in Texas are under increased pressure to demonstrate students' mathematical growth and achievement on the standard based STAAR third grade mathematics test to ensure students are getting equal and full access to future learning and job advancement in the Career and College Readiness Standards. Because the state of Texas and federal government measures students' mathematical progress through this high stakes STAAR test, it is important to investigate teacher's mathematical best practices. Though many changes have been suggested for improvement of mathematical achievement over the last decade, there is little research into the best mathematical practices used by third grade teachers in Texas (DuFour, 2007). This exploratory qualitative research study was created with the goal of attempting to fill that gap in the educational research.

This study could assist in informing districts and the state on how professional development efforts might best service teachers to ensure a higher level of achievement as demonstrated by students. Teacher change is linked to professional development that changes a teachers' beliefs, practices and behaviors through social interactions with other practicing teachers, In addition, this exploratory study may provide more information to add to the base of knowledge about teachers' perceptions about math and how those perceptions may influence their students' achievement. This information may be useful to better understand how teachers' perceptions about the math standards they teach impact their teaching and consequently students' learning and achievement. District and state educators might potentially use this information to inform professional development decisions to impact the teachers' ability to teach mathematical standards at third grade. In conclusion, this study has the potential to inform educators across Texas concerning teachers' perspectives on improving students' third grade mathematical achievement to fill the gap in the educational research.

Section 3: The Project

Introduction

The purpose of this basic qualitative study was to understand third grade elementary math teachers' perceptions of their preparedness to teach the standards for the third grade STAAR Math test. For this study, I collected and analyzed data from semiformal, one-on-one interviews and field notes. The findings of my study showed that teachers needed PD that increased their knowledge in problem-solving strategies to enhance student's abilities and instructional ways to develop number sense and reasoning and raise student achievement. These findings informed the PD plan I developed to support the third grade Peace ISD math teachers with preparing to teach the STAAR math CCRS standards to improve students' understanding and achievement in mathematical reasoning for solving math word problems and building number sense.

In this section, I provide rationale for choosing to develop a PD project for third grade math teachers and a literature review related to professional development, problem solving, and professional learning communities, as well as how the project will address social change. A project description that addresses the potential resources and existing support, potential barriers, proposal timelines, and implementation of the PD project is then presented as well as the project components. Finally, I explain the roles and responsibilities of the facilitator and participants and provide a brief dialogue about the evaluation plan for the project and how the project has the potential to create a positive social change for the stakeholders in Texas at the campus, district and state levels.

Documents are included in the appendices to give readers a better understanding of the project design and intentions.

Rationale

This project was selected as a result of the findings from this basic qualitative research in which third grade math teachers in Peace ISD demonstrated a need to receive more support for teachers in delivering instructional strategies for building mathematical reasoning in teaching number sense and problem solving. The one-on-one interviews showed a need for more or different professional development to assist the third grade math teachers with evidence-based strategies to raise student's academic achievement. The lack of continuous training in research-based strategies could be hindering the third grade math teachers in Peace ISD in achieving maximum levels of academic achievement in their students' math levels in reasoning with number sense and problem solving. Furthermore, a lack of content knowledge regarding implementing effective math strategies could be another reason the third grade math teachers have not assisted the third grade students in meeting higher levels of academic achievement.

Professional development for teachers plays a pivotal role in assisting teachers to stay current on instructional teaching practices in mathematics. Attending professional development specific to teacher's deficits can improve teacher's pedagogy knowledge and provide instructional support as well (citation). The one-on-one interview participants indicated that they needed training to enable them to teach math effectively and assist students in reaching higher levels of academic achievement in reasoning, number sense and through problem solving.

Previous professional development math Peace ISD sessions have been limited due to resources and time. Therefore, new knowledge regarding the College and Career Readiness Math Standards has lacked consistency among teachers. From the data gathered during this research study, it is evident the third grade teachers feel that additional training would benefit their ability to teach building reasoning through number sense and problem solving to raise their students' academic achievement.

I will act as a facilitator and will share evidence-based research strategies through a collaborative community of professional learning environment so the instructional strategies can be implemented in the teacher's classrooms. Teachers indicated that learning new best practices for teaching number sense and problem solving would be helpful for their professional growth. Effective modeling and practicing the various strategies presented will be integrated into a 3-day professional development training.

I believe this 3-day PD will provide teachers with substantial knowledge to improve their own content knowledge and instructional pedagogy to raise student's academic progress. Professional development trainings can support teachers by targeting specific goals needed for their students and is especially helpful when the teacher's specific requests have been used in developing the professional development, as is the case in this research study (see citation). Thus, teachers will benefit from this collaborative professional development because they will be receiving direct content and instructional knowledge regarding strategies to raise their student's academic success and their feedback informed the sessions.

Review of Literature

The data from this exploratory qualitative research study showed a need for third grade math teacher training to raise the academic achievement of third grade students in Peace ISD. This literature review will give the research base to support the development of the research project that is a professional development across 3 days. The teachers shared a need to have professional development that informs them of effective research-based strategies in building reasoning for number sense and mathematical problem solving to improve student's academic achievement levels. In this literature review, I focused on how professional development was helpful in improving teacher efficacy and the knowledge to increase student academic achievement. I also substantiated that best practices in teacher professional math development happen when teachers work in collaboration with others in a professional learning community. I searched Google Scholar and the research databases EBSCO Host, ProQuest, and Sage for significant literature. The literature was used to define key terms including, *professional development, teacher efficacy, teacher collaboration, teacher pedagogy,* and *student achievement.*

Professional Development and Student Academic Achievement

The most important variable in student achievement is the teacher's knowledge (citation). One of the most effective ways to raise student achievement is through professional development. Allowing teachers to have a voice in what is presented in professional development sessions leads to a greater chance of directly addressing the needs of the teachers and students within the context of the school and district (Mizell, 2010). Consequently, these successful professional development sessions have a better chance at changing teachers' beliefs and practices, eventually leading to higher academic achievement for students (Griffith, Plummer, Connery, Conway, & Wade, 2014).

Teacher learning has gone through a reform movement over the past decade as beliefs link high-quality professional development to higher-quality teaching and higher-quality teaching to student achievement (Debusho et al., 2014; Desimone & Garet, 2015; DuFour, 2015; Grosemans, Boon, Verclairen, Dochy, & Kyndt, 2015). The Texas College Career and Readiness Standards for Mathematics in Texas require changes to traditional instructional practices for mathematics. Studies in teacher quality effort have shown that many teachers lack the appropriate training for their designated contractual teaching positions (DiPaola & Wagner, 2018). The literature confirms that reform attempts either succeed or fail depending on the quality, quantity, and timing of professional development support provided to teachers (see Guskey, 2003). Gokmenoglu and Clark (2015) noted that successful educational restructuring is dependent on value and competence provided to teachers through an effective professional development program. Professional development programs that consider classroom challenges within context specific teaching situations are more successful (Myers, 2014). Thus, during an era of educational reform, teaching quality improvement goes hand in hand with teacher professional development improvement and performance.

Ongoing current professional development for teachers is pivotal in raising student achievement. According to Ferreira (2015), when professional development focuses on raising student achievement and developing teachers' pedagogical knowledge, there is usually a positive effect on teacher practices and an increase in student learning. It is known that teacher professional development informs the quality of the school system, which cannot exceed the quality of its' teachers (Desimone & Pak, 2017; Jacob, Hill, & Corey, 2017). Educators must have support within the school system to continue their learning to enable them the ability to implement current evidence-based strategies into their teaching (Holm & Kajander, 2015; Stein, Smith, Henningsen, & Silver, 2016). Add summary and synthesis.

Significance of Professional Development in Mathematics

Academic achievement of students is dependent on teachers' content and pedagogy knowledge (citation). Professional development for teachers is a nonnegotiable for all teachers (citation). This is especially true of mathematics as it has gone through major reforms across the last decade. According to Hill et al. (2017), when teachers attend a professional development that pertains to their subject matter and places an emphasis on student academic achievement, it has a significant impact on student learning. The focus of mathematical proficiency at all grade levels is on reasoning and problem-solving skills critical as measured in national assessments (Krawec, 2014).

These higher order process skills permeate all areas of mathematics. Problem solving and mathematical reasoning are essential skills necessary for college preparedness, trades, and job readiness for all students in the 21st century. Without proper training, teachers might lack pedagogical and instructional math skills to meet the diverse needs of students from different cultural, ethnic, and linguistic backgrounds (De Kock & Harskamp, 2014). Many teachers have limited access to professional development with evidence-based research instructional strategies, technology, and assessment methods (NCTM, 2014). When math teachers are given the opportunity to attend math professional development, they solve and study math problems, student learning, and materials which deepen their conceptual understanding and raise the likelihood that they will positively impact student academic achievement. Professional development that is math specific allow teachers the opportunity to study and practice math specific pedagogy and instructional strategies.

Professional development that promotes best practices for teaching mathematics provides opportunities for teachers to understand math standards and use research based instructional current methods to impact students' academic achievement (citation). New instructional content and methods are not always easy to implement; however, when teachers attend math based professional development, it increases the possibility that recently acquired instructional skills will be used in the classroom to influence student achievement (Onsrud, 2015). To develop math teachers successfully, recent research suggests that professional development be provided on a consistent and constant basis ensuring new knowledge is being utilized and practiced (see Soine & Lumpe, 2014). Add summary and synthesis.

Ongoing mathematics professional development assists in nurturing teacher's professional growth and developing their knowledge in math (Carpenter & Linton, 2016). According to Colwell and Enderson (2016), professional development can help teachers who are not confident enough in their preparation to teach mathematics. In this example, effective professional development in mathematics provides scaffolding, while providing practice with newly related information used in instructional methods. According to Gaumer Erickson, Noonan, Brussow, and Supon Carter (2017), this kind of professional development helps teachers focus in on the ways to teach students, instead of the content. In a study done by Sevis, Cross, and Hudson (2017), 22 elementary teachers attended a professional development 2-week training for two different summers where they solved problems word problems like those assigned their students. This study involved exploring ways to enhance teacher's teaching quality and their mathematical content knowledge. Teacher takeaways from this study was that they learned different strategies in solving math problems and experiencing a comfortable challenge to build grit through the math work as they expect from their own students (citation). By collaborating with peers, they learned multiple perceptions and approaches in solving each problem. This enabled them to learn constructively multiple solution pathways as a learner. The findings from the study revealed that the teacher's content knowledge increased and by constructing their own knowledge through their personal experiences, it allowed them to make better connections and to develop a better understanding of the math tasks they were teaching to their students (citation). In conclusion, the study showed this collaborative mathematical professional development method, ultimately resulted in the improvement of teacher's mathematical practices. Add summary to fully conclude the paragraph.

Professional development content specific for teachers is helpful in informing teachers' practices in the classroom (citation). Effective math teachers are knowledgeable about current instructional techniques which increase their teacher effectiveness. Teachers using current mathematical evidence based instructional strategies is one of the greatest indicators of student achievement (Steinberg & Sartain, 2015). Professional development in math has the potential to positively impact the teacher's instructional ability and consequently student academic success.

Professional development for mathematics' teachers is especially beneficial when encompassing mathematical reasoning. One continual area of weakness in math students is their ability to critically think and reason through problem solving. Academic needs in math surround problem solving and reasoning and should inform professional development trainings for teachers. A student's reasoning ability is closely related to problem solving which includes basic thinking, critical thinking and creative thinking (Holisin, Ainy, & Wikanta, 2019). Many researchers agree that the focus on math critical thinking professional development should be continuous and meaningful (Asgharheidari & Tahriri, 2015). According to Selling, Garcia, and Ball (2016), most elementary teachers lack instructional strategies that target critical thinking skills in mathematics.

Hence, elementary teachers can benefit greatly from professional development experienced by teachers constructing their own knowledge in a socially collaborative learning inquiry community, where the shared knowledge informs their context and practice in teaching mathematical reasoning and problem-solving skills to raise academic achievement (DuFour, 2014).

Professional Learning Communities

If effective schools are to produce more powerful learning on the part of students, teachers must be offered more powerful learning opportunities. There has been a change of focus of professional development from programs designed to change teachers, to a focus on facilitating professional learning within a community of learners (Boylan, Coldwell, Maxwell, & Jordan, 2018). Collaboration is one of the essential elements of effective professional development. It is critical for student achievement, school improvement and teacher development (Chapman & Muijs, 2014). In addition, there has been more sustained new practices like professional learning communities and lesson study (Cheng & Lee, 2011). Professional Learning Communities are defined by researchers as a method of teamwork where teachers come together and meet with respect to their content to discuss curriculum, goals and objectives, and areas of specific need using student data (Callahan & Sadeghi, 2015; DuFour, 2014; DuFour & Reeves, 2016; Onsrud, 2015). Unless teachers are offered sustained learning opportunities at all stages of their careers, they will not be able to meet the changing demands new standards for student learning (Feiman-Nemser, 2001).

The International Network for Education in Emergencies (INEE), which transpired from the Teacher Professional Development in Crisis online forum developed seven major recommendations for International standards for professional development (International Network for Education in Emergencies, 2020). The first 5 recommendations consisting of focusing on developing teachers in fragile contexts as professionals, learners and individuals, creating professional development opportunities that promote collaboration, investing in high-quality teacher educators as well as providing ongoing support. The last two were building instructional leadership at all levels of the educational system as well as using Information Communication Technology (ICT) to provide access to content, professional development, and professional learning communities (p 39-152). As noted above in the International Professional Development Training recommendations for teachers, collaborative sustained professional learning communities are highly suggested universally in educational reforms to assist teachers in meeting various challenges. Teacher effective professional development created for positive change in student mathematics achievement needs to focus on improving teacher content and pedagogical knowledge, teaching best practices and understanding of students' thinking to help teachers meet the rigorous Career and College Readiness Standards for Mathematics (Althauser, 2015). Ideally, professional development programs designed to improve mathematics education would model and practice reform efforts, expand content knowledge, acknowledge student thinking, and engage in reflective practice.

When professional development for teachers is done in a professional learning community, it positively impacts student's academic performance. Ermeling and Yarbo (2016) noted that a team approach through collaborative learning can have a positive effect on the type of instruction that is presented in the classroom if there is a connection with the provided professional development. Professional development performed within a classroom context enables teachers to apply the methods and it increases the likelihood of teachers continuing the change in their teaching practices (Franke & Kazemi, 2001). Thus, rigorous, continuous cooperative professional development focused on content is more likely than intermittent training to improve teacher knowledge, classroom instruction, and student achievement (Darling-Hammond & Ball, 2004; Desimone, Birman, Porter, Garet, Yoon, & Birman, 2002; Guskey, 2003; Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). Collaborative professional development trainings allow teachers to learn with and from other teachers.

One way to align high performing learning communities is to align professional development trainings based on district goals (Anderson, 2003). The National Staff Development Council (NSDC) has recommended the alignment of learning communities with district goals to produce more valuable teacher learning. This arrangement also serves as a transformative way to create changes in teachers to promote student changes because the main goal of professional development is to increase student achievement (Guskey, 2003; Reeves, 2010). When districts use data-based feedback from their teachers and students to design their district professional development trainings; it is an advantageous decision for both the teachers and students.

Relationship between Student Achievement and Teacher Self-Efficacy

It is a win-win situation when districts use data-based teacher feedback to create math staff development trainings. If teachers are given collaborative professional development opportunities to inform their practice in raising student achievement, it directly impacts a teacher's self-efficacy which is another determining factor in academic achievement of students. Teachers must work to improve students' academic mathematical achievement through professional development to raise student achievement (NCTM, 2014). Battista (1999) found that there was a relationship between student achievement and teacher self-efficacy. A teacher's perception of their own teaching is one of the most important factors that affect their teaching (Curtis, 2017; Kim & Seo, 2018; Pinchevsky & Bogler, 2014; Sahin et al., 2014). Bandura (1993) explained that self-efficacy determines how people are motivated, think, and behave. In addition, Battista claimed that teachers' quality and persistence was related to their belief that effective teachers can produce positive academic performance unrelated to outside obstacles (Guskey, 1987). A teacher's belief in their ability to affect a student's learning is especially important when looking at mathematics teaching and learning because mathematics has evolved within our changing world. Change is not always easy to embrace when it changes the way a teacher does their job every day. For this reason, the belief of teacher self-efficacy is also one of the strongest factors impacting effectiveness of the aspect of teaching math (Peker et al., 2018). The more practice teachers receive from professional development trainings developed within the context of their classrooms and within a community of teachers, the better chance the instructional strategies will be utilized to improve student's academic achievement.

A teacher's self-efficacy can affect their willingness to try new innovations, their persistence with a wider variety of techniques like math tools, and meaningful text that contribute to a student's conceptual understanding (Gore et al., 2017). A teacher's lack of belief in their ability directly impacts their instructional ability to increase student performance. It is important to remember that self-efficacy is not simply a matter of how capable a teacher is, but a belief in how capable they believe they are. Teachers with a low belief in their teaching abilities tend to use more teacher directed methods whereas, teachers with a high belief in their teaching skills tend to use inquiry, constructivist, student centered methods (Hoy, Tarter, & Hoy, 2006). Teachers obtain new skills, perspectives, and subject content knowledge from formal and informal professional development. Consequently, this continuous, job embedded, socially constructed professional development has the potential to raise a teacher's self-efficacy and consequently, a student's academic mathematical achievement.

Project Description

Potential Resources and Existing Supports

The team responsible for making sure this planned professional development occurs will include me as facilitator and the district elementary math support leader. I will meet with the Peace ISD elementary math leader to determine a time, date and location for the professional development. During the meeting, I will suggest that the 3-day training be done during the summer over consecutive days. I will also let them know of the materials I will need for the professional development training. I will provide whatever materials the district does not provide. Teachers will need to bring the first 9-week Math Instructional Focus Document and their laptop.

Potential Barriers and Solutions

I do not anticipate any barriers that will keep the professional development project from taking place. COVID 19 could potentially change the initial plans. Technology will be utilized so there is always a chance that the district network internet connection could be broken. Another possible barrier that may affect the project is teacher's attendance. I am hopeful that district will offer the third grade teachers an incentive for attending the 3-day professional development training to encourage participation. Another possible barrier could be teachers not wanting to collaborate with their peers. There could be some resistance in sharing and planning with other third grade teachers because they may feel uncomfortable in front of their peers. As a facilitator, I will do my best to set up a safe, risk free learning environment where everyone is learning from each other. I also anticipated this as a possible barrier and tried to plan varied engaging activities during the 3-day professional development.

Proposal for Implementation and Timetable. The professional development will be a 3-day professional development offered during the summer and would count toward the following year's professional development hours. Many adult education tools will be used to keep participants engaged during the professional development. Some of the tools used will be PowerPoint presentations, small and whole group discussions, ice breakers, small group varied activities, and collaborative planning time. Teachers will use their math Instructional Planning Document and pacing calendar for the first 9 weeks to inform their collaborations for preparing lessons for number sense and problem-solving lessons.

Copies of the PowerPoints in note format will be given each day and will include various topics such as research based instructional strategies to use when teaching reasoning for number sense and solving word problems as well as norms and goals for each day. Additional handouts will be shared daily to assist participants in understanding and practice of the daily research strategies that are shared. On day 1, I will introduce myself as the facilitator and give information regarding the research study and the data that informed the 3-day professional development training.

Project Evaluation Plan

The professional development will have daily formative evaluations completed at the end of each of the 3 days. As the facilitator, the formative daily feedback will be utilized to change the following day's sessions to enhance the learning if it is possible. By completing each daily evaluation, it will allow me to assess the effectiveness of that day's professional development and give me the chance to change the following day's activities, design or pacing of the professional development to meet the needs of the participants. The results from the 3 days of evaluation could result in continuous professional development conducted by district leaders throughout the year. These evaluations are necessary because it will allow me to improve any future professional development sessions that I may facilitate. The findings will be discussed with the district professional learning leaders at Peace ISD.

Project Implications

This 3-day professional development project addresses instructional research-based strategies that the third grade teachers can utilize to improve their student's academic achievement in math reasoning in number sense, and problem-solving activities. Teachers will benefit from this professional development because they will be constructively engaging, practicing, and collaborating with real evidence based mathematical problem solving to help improve their content knowledge and their ability to instruct students. This will lead to a positive change for all third grade teachers who attend the 3-day professional development sessions. This could potentially positively affect all elementary math teachers if the professional development was viewed as beneficial and the district decides to expand the professional development beyond just the third grade teachers. When teachers deliver effective evidence based instructional strategies to students, the students become more academically successful. It is anticipated that the third grade student's math scores will improve after the teachers attend this professional development. If student data shows an increase in academic achievement for third grade math students, the district stakeholders may want to implement this number sense and problem solving 3-day professional development for other grade level math teachers in the district.

Section 4: Reflections and Conclusions

Project Strengths and Limitations

One strength of this professional development is that the sessions were developed based on the data from the one-on-one teacher interviews in this explorative qualitative research study. The sessions were designed to enhance teacher's pedagogy knowledge of the third grade math teacher participants. The participants communicated their need for more professional development regarding instructional strategies for assisting students in building their reasoning for number sense and problem solving. Participating in this 3-day professional development allows all participants to personally construct mathematical knowledge by engaging in mathematical instructional strategies while collaborating with their peers. After attending the 3-day professional development, the third grade teachers will leave with tools and resources they can use with their students in teaching reasoning for number sense and problem solving. After participating in the 3-day staff development, each participant should understand the research base that supports utilizing visual representations and schematic word problem structures when teaching reasoning for number sense and problem solving.

This professional development has three possible limitations. One possible limitation of this project will be providing time for teachers to plan effective lessons when using what they have learned from the professional development sessions. The district would need to find a time and place for these planning sessions to take place because the sessions are third grade math teacher specific. Even though some time is allowed for teacher collaboration and preparation of lessons regarding the information presented, teachers will need additional time to implement these instructional strategies. Because effective planning is regarded as a critical component in implementing the strategies, more time must be given for the teachers to implement the tools and resources presented in the sessions. Another possible limitation is the sessions must fit into the district summer staff development calendar as well as participant's desire to attend the sessions. Lastly, COVID 19 may postpone or change the modes of presentation for the 3-Day professional staff development

Recommendations for Alternative Approaches

One suggestion for an alternative approach for teachers to meet to plan and collaborate would be for the leaders of the district to use half day planning days across the district to allow the third grade math teachers to plan according to the math pacing guide throughout the year. Another possible approach would be for district leaders to assign 1 week a month as a district planning day after school instead of campus-based faculty meetings. This would allow for district wide collaboration across grade levels. This time could be used to discuss student samples of work and collaborate for upcoming sessions in number sense and problem solving. Another idea would be to survey district teachers to see what their suggestions are for implementing additional district wide planning and collaboration time. The district could set up a google classroom for subject and grade specific teachers to share their teaching strategies, successes and struggles across the district. The last alternative idea is that after this implementation of the evidence-based strategies presented in this professional development, the district could choose two or three third grade teachers to present the number sense and problem-solving strategies to other specific math grade levels throughout the district.

Scholarship, Project Development and Evaluation, and Leadership and Change

Many factors have resulted in my professional growth as a student, teacher, and leader. One factor is my journey toward pursuing my doctorate degree. During this time, I developed my math knowledge through setting a priority to attend as many math specific meetings as I could. By focusing on math, I volunteered to represent the campus and district

in math leadership. I served as a grade level district representative for designing assessments to correspond to the district instructional focus document and pacing calendar. I also served as the leader of a campus math committee to vertically plan effective math school wide initiatives. Throughout this journey, I learned the importance of formative assessment and data to guide classroom instruction and the academic achievement of students. I am also passionate in personally using the instructional strategies that I learned about to improve student academic achievement and love to share with other teachers.

In a pursuit of choosing a research topic, problem, and project, I learned how data and district surveys guide district leaders in making decisions about professional development and student academic progress. As a student in my early years of school, I found math to be a subject of procedures and did not understand or enjoy it. However, math has now become my favorite subject to teach and I have a passion to help all students understand they can learn and be successful regardless of their past mathematical experiences. By focusing on math professional development and saturating myself with mathematical teaching content research knowledge and pedagogy, I have grown professionally and personally. This scholarly journey has developed a passion in me to positively influence my own students, other teachers and their students, and parents regarding learning math. As a result, I have provided support for teachers in using evidence based instructional strategies to help all students become successful.

This doctoral journey has not been easy while teaching full time and being an adjunct instructor online. During this journey, I experienced a major life event that almost caused me to quit. The research and process has been a difficult journey in part because the experience has been online and in part because I did not always understand the process and expectations for each step in the process. My doctoral journey extended beyond the timeline because I encountered obstacles. I also took a night job to finance the last two semesters. This experience has built my grit and perseverance. Lastly, I have gained a new respect and understanding for the writing and research process.

The interviewing process in this research study has been especially valuable. As I explored the qualitative research data, the themes and important ideas emerged. The process is rigorous and at times overwhelming. However, it is also rewarding. One rewarding experience is experiencing the moment of saturation when delving deep into the literature review regarding mathematics and professional development. My ability as a researcher grew as I learned to provide additional questions to gain elaboration from interview questions. Through the interviewing process, I was able to understand teacher's perceptions regarding their instructional practices and preparedness to teach the College and Career Readiness Standards for the STAAR math test. During the data analysis process, I learned about educating teachers from an adult school district learning perspective. In conclusion, I am thankful for the knowledge and skill set I have gained through adult learning theories and best practices. I feel this will be a great foundation for possible future leadership positions in adult education.

Project Development and Evaluation

This dissertation and project were created based on Peace ISD data and the analysis of the research I conducted. I learned that the third grade teachers in Peace ISD understand that they are the most important variable in the classroom regarding the academic achievement of their students and have a desire to learn new strategies and grow as a professional. The third grade math teachers expressed feeling an additional amount of pressure for their students to perform at a high level because it is the first elementary year elementary students are tested in mathematics. They feel responsible for making sure each student is making mathematics academic progress in third grade, regardless of where the student is academically at the beginning of the third grade year. Being able to meet each student's individual academic math needs requires a teacher to use research-based evidence strategies because of the short amount of time each teacher is given to help each student. In every interview, the teacher's passion and desire to meet the needs of each student was evident. Teachers expressed the varying academic needs of their students and their desire to have professional development to inform their practice with additional instructional strategies to implement.

The feedback from my chair, committee member, and university research reviewer helped me to organize and write a well-developed project. My project was developed based on the themes that emerged from my data analysis. During the planning of the project, I also reflected on my own experiences with professional development as an adult learner. I created a project that would be varied in activities and collaborative in nature. This included prioritizing the most important articles or concepts and how to present in a way that I was facilitating the knowledge. I created each day's activities based on the objectives for that day. After reflecting on my own adult learning professional development experiences, I determined that afternoon sessions need to be the most interactive. I considered the themes that emerged and developed the scope and pacing that made the most sense, conceptually. I also looked at the levels of the mathematical thinking that is being taught and planned activities that would match or exceed these levels so that teacher's experience the rigor first as a student and then as a teacher.

A teacher's time is valuable and should never be taken for granted. When developing the project and evaluation, I constantly reflected on what I know and think about what teacher's value in professional development. As I created the evaluation, I wanted to give an opportunity for participants to determine the effectiveness but also give open ended feedback opportunities regarding improvements. The participant's evaluations are regarded as highly valuable. It is only through honest feedback that I can improve as an adult instructor. I want to be flexible and if needed after each day, I can modify the professional development plans to meet the participant's needs. An effective teacher regards feedback as pivotal in the teaching process.

Leadership and Change

As an adult learner, and possible adult learning leader in the future, I have a new-found respect for adult learning leaders who conduct professional development. I am now always looking for new interactive ways to present information and especially with technology. I have learned that it is one thing to understand the content, but quite another to present the content to adult learners who need to constructively own the information on their own. Teaching and learning are interwoven and interdependent. While working on my project I wanted to make sure that I support teachers in helping them support their student's academic achievement by respecting and addressing their desires for what they wanted in a professional development training. By grounding my teaching in research based instructional strategies, I have grown my leadership skills as a classroom teacher and instructional leader. Secondly, by personally utilizing instructional best practices in my own classroom, I can assist others in their journey toward becoming a more effective mathematics teacher. Gaining respect from other adults is crucial if you want to genuinely help other adult learners. Through this research, I have been able to identify with other math teachers in their quest to help all students succeed, despite the limited professional development subject related training the district has supplied. I have also learned to listen attentively when teachers are talking about their practice and their struggles. Listening is an important skill as an adult leader and one I desire to continue to improve in. A good adult leader knows what to say but a wise one knows when to say it.

This professional development project has great potential to provide a social change because it will afford third grade math teachers with the support and tools needed to support their content math knowledge and their student's academic achievement through research based instructional strategies. Teachers will have time to collaborate with other teachers who teach third grade math and create lessons use the research based instructional strategies. This professional development will inform teachers of research based instructional methods to use and practice in collaboration with other peers. Through this peer collaboration and sharing, teachers will raise their teacher self-efficacy which in turn will raise student academic achievement. As student academic levels increase in number sense and problem-solving reasoning, other stakeholders will be interested in knowing the cause of the improved academic achievement across third grade district math scores. Finally, the change in raising student's academic progress will contribute to further encourage collaboration with other math teachers in other grade levels to evaluate math practices in number sense and problem solving to better support teachers and consequently, students at all math levels.

Reflection on Importance of the Work

As I reflect on my research study, I acknowledge that I have felt many different emotions along this journey. There were many times when I felt anxious and discouraged. I used to think that people who earned their doctorate degree were the most intelligent people. However, I soon realized that although intelligence is important, it takes much more than intelligence. Perhaps the most important skill I learned in this eight plus year journey is perseverance and grit. I feel sure that most doctoral students can tell of a time when they felt overwhelmed or thought their goal might not be realized. I soon learned that setting small goals along the way was more productive for me. As I continued to work hard and meet the small goals, I begin to see the bigger goal at the end of the doctoral road. Here at the end, I begin to prioritize and put my personal life and leisure activities on hold. My favorite part of the journey was the research and project development mostly because I could see a direct impact on learning for both the teachers and the students. This passion to help others fueled my need to finish my dissertation. Since beginning the doctoral journey, I have built my leadership abilities and roles in my profession. I credit the pursuit of my doctorate as being pivotal in finding a passion in helping adult learners. I have developed my communication skills by acknowledging and learning to be a better listener than speaker. I have learned to utilize and value experience of adult learners. This experience has also taught me to understand that learning is a process and in today’s world I learn along with my students, regardless of their age. This dissertation has grown my professional knowledge and has grounded me in the importance of using research based instructional strategies. Finally, the importance of this work cannot be ignored. It is my love for learning and people that fuels my passion to help others learn.

Implications, Applications, and Directions for Future Research

In the 21st century, change is inevitable. Each decade brings new curriculum changes, teaching expectations and technology advances. As researchers seek out new data on the most effective instructional strategies, teachers seek to learn and implement them. It is through continual professional development that teachers will focus on current best practices to raise student academic achievement. As technology changes so does the need to harness it to teach students. Districts and campuses will always face challenges to meet the needs of teachers to match or exceed the needs of their students. Thus, administrators and leaders will always be looking for current and better ways to provide teachers with the knowledge to meet the diverse needs of their students.

There are varying possibilities for future research. This qualitative study is significant to third grade mathematics teachers who teach reasoning skills for number sense and problem solving. Although this study is specific for third grade teachers, the study could be adjusted to inform instructional practices used in kindergarten through 8th grade involving reasoning in number sense and problem solving. This research study explored third grade teacher's preparedness to teach the College and Career Readiness standards in math. Future research could explore the perceptions of 4th or 5th grade teachers regarding their preparedness to teach the College and Career Readiness

Standards as well. Future research could also explore the perceptions of third grade math teachers across the state of Texas instead of just one district. This research could be replicated using a larger population of teachers because this study was limited to only six third grade teachers.

Conclusion

Math skills are necessary and important for students to learn and utilize to function in today's world and throughout adulthood. Teaching mathematical reasoning for number sense and problem solving is not an easy task but is especially difficult when teaching students who struggle. However, what we know if that strategies that help students that struggle will help all students regardless of their diversity. Regardless of the decade, there will always be a need to improve as an educational leader. In our constantly changing world, teachers will always continue to seek new in depth updated professional development training to meet raise student academic achievement. Even though completing this dissertation is the most difficult thing I have experienced in my life, it has been a life changing learning experience. I have learned about the rigorous process of researching both through practice and the written work. As a result, I created a professional development project that supports third grade teachers with research based instructional strategies in teaching mathematical reasoning in number sense and problem solving to improve student academic achievement.

This qualitative study also focused on third grade teachers' perceptions of their preparedness to teach the College and Career Readiness standards for the third grade math STAAR test. With limited funding and time, teachers voiced a concern for professional development to inform them of instructional math strategies to meet the varying needs of their students in mathematical reasoning for number sense and problem solving. This professional development project provides teachers with three days of professional development using research based instructional number sense and problem-solving strategies through small and large group discussions, interactive group activities and collaboration to improve their students' academic achievement. This professional development project meets the critical need of supporting teachers to meet the diverse abilities of their students. It is my hope that other educators will utilize the evidence-based strategies presented in this project, and that will improve equity for all math students regardless of their diverse needs

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Appendix A: Project

Implementing the 3-Day Professional Development Training for Elementary Third Grade Mathematics Teachers

The 3-day professional development is entitled, "third grade Math Problem Solving and Number Sense Instructional Strategies for Higher Student Achievement". The goal of the project is to educate third grade math teachers on pedagogical and instructional high yield strategies for mathematical problem solving and number sense which can help to increase a culturally diverse student population academic achievement. The professional development trainings will begin at 8:00 a.m. and end at 3:00 p.m. on three in-service days during the summer.

Purpose

The purpose of the PD training is to provide third grade math teachers with knowledge of current research and best practices in use for developing lesson plans and activities that can increase students' problem solving and number sense mathematical abilities. Participants will learn best practices for teaching problem solving, number sense, and reasoning with instructional high yield strategies to create lesson plans to use during the academic school year. The lesson plans will be used as a guide for math problem solving and number sense instruction to yield an increase in higher academic achievement level of the culturally diverse student population.

Target Audience

The target audience for this PD training is the third grade math elementary teachers in Peace ISD. Participants are third grade regular education teachers in Peace ISD.

Goals for Professional Development Training

1. The participants will increase their understanding of the mathematical problem-solving process.

2. The participants will increase their understanding of how number sense is learned and developed.

3. The participants will enhance their effectiveness in teaching mathematical reasoning for number sense and problem solving that will result in academic achievement for all students regardless of their diverse needs.

Learning Outcomes

The learning outcomes for this PD training enables participants to understand the mathematical processes involved in teaching and developing mathematical problem solving and number sense to develop a highly successful mathematically proficient community of learners. Teachers will have the opportunity to develop standard based problem solving and number sense instructional activities to support the district's instructional pacing guide. These outcomes are critical to ensure teachers can provide equity and effectively plan, instruct and support a culturally diverse population. In addition, the methods, resources, and collaborative planning sessions provided during the

PD will enable teachers the opportunity to construct knowledge and create problem solving and number sense lessons and activities in a professional learning community to utilize in the third grade classroom.

Timeline

The timeline for this PD is three consecutive days during the summer break. The training will take place from 8:30 a.m. to 3:30 p.m. each day. Lunch and scheduled breaks are provided throughout the training. The teachers will engage in whole group and small group sessions each day. On day 1, entitled, The Brain & Number Sense, the third grade math teachers will learn about the researcher's study, the relationship between the brain, number sense, and fluency as well as instructional number sense strategies. These concepts will be learned through short video clips, collaborative reading of an article, a station rotation of number sense activities, and discussions. At the end of the day, the teachers will complete a brief large group discussion and a written evaluation. On Day 2 "What's the Problem?" will encompass the teachers completing a problem-solving pretest, facilitator presented Power Point describing the evidence based practices for teaching problem solving to facilitate reasoning, with small and whole group collaborative breakouts, short video clips of effective problem solving and the reading of an article called "*A Problem-Solving Alternative to Using Key-Words".* On day 3, teachers will participate in the last session, Problem Solving Structures & Applications. The learning will be accomplished through a Power Point presentation, short video clips and manipulatives, ending with a collaborative problem solving and or number sense lesson plan session to correlate to the district's Instructional Planning Document and pacing calendar. The participants will then participate in a written evaluation of day 2.

3-Day Building Number Sense & Problem Solving

Professional Development Training

Day 1: The Brain & Number Sense

8:30-9:00 Participants will sign in, receive agenda, and nametag

Ice Breaker: Facilitator and participants introduce themselves. Ice Breaker using pictures of mathematical symbols or words, Participants move to the symbol or word representing how they are feeling, share ideas with small groups

Set Norms and Expectations for the day -Power Point

Explain to participants regarding "Parking Lot" chart

9:00-9:30 Facilitator introduces the research study, the findings and need for PD training on number sense and problem-solving strategies.

9:30-10:30 Participants watch 3-minute video on "What is Number Sense?"

https://www.youtube.com/watch?v=wxE2Kur4AHc

- Using sticky notes and markers participants write on a sticky note an answer to each of two questions (on anchor charts):
  - What is number sense?
  - What skills are necessary for success with number sense?
  - What part does fluency have in number sense?

Facilitator presents information on What is number sense? Characteristics of good number sense, components of number sense and What part does fluency have in number sense?

What are the characteristics of good number sense?

- ➢ Fluency and estimation in judging magnitude
- ➢ Ability to understand reasonable results vs unreasonable results
- ➢ Flexibility with numbers with mental computation
- ➢ Ability to use multiple visual representations and to choose the most appropriate one

What does research say about best practices for teaching number sense?

- ✓ Develops over time through exploration of numbers and visualization of numbers in a variety of contexts
- ✓ Key to helping children develop number sense is providing students with activities for making connections, exploring, and discussing concepts quantitatively, and following an appropriate sequence of concepts (Griffin, 2004).

What are the important components of number sense?

- **Quantity and Magnitude**

    - ❖ word problems teach through modeling of quantity, not key words or division of fractions teaches through considerations of portion size

- **Numeration**

    - ❖ Number System based on 10

- **Equality**

    - ❖ Equality is not "same as" it is equal in value

      (Example: two trucks in weight is same as an elephant's weight but they are not the same as) X=Y means here are two things that are not the same as exactly, but they are equal in value)

- **Base Ten**

    - ❖ Powers of 10

      (Example: 600 = (6 x 10 x 10) so that when they see 6.15 = 6 x 10 (squared)

- **Forms of a Number**

      (Example: simplifying expressions, combining like terms, converting mixed numbers to improper numbers, utilizing the distributive property, factoring)

- **Proportional Reasoning**

    ❖ Involves comparing quantities within and between numbers to see relationships to develop proportional reasoning

    (Example: in elementary math students explore to develop "diagram literacy" like ratio charts and input/output charts (Deizmann & English, 2001)

- **Algebraic & Geometric Thinking**

    ❖ This is perhaps the long-term goal for number sense.

    (Example: elementary understandings of equality affect algebraic thinking; proportions create deeper understandings in geometry)
    (Example: An Algebra teacher might remember to explain slope with proportional pictures or diagrams before converting them to a symbolic form) (Faulkner, 2009)

Facilitator Note: Leave charts up to refer to throughout the training. Ask a speaker to share aloud a few of the thoughts that were gathered on the chart.

10:30-10:45 Break

10:45-11:45 Participants read "Seeing as Understanding: The Importance of Visual Mathematics for our Brain and Learning" by Jo Boaler and Lang Chen Groups will jigsaw the article to present to the large group. Each small group will read and create an anchor chart for their section to present to whole group

- ✓ Group 1: Introduction and What Does Brain Science Say?
- ✓ Group 2: Mathematical Understanding and Fingers
- ✓ Group 3: Embodied Cognition and Implications for Classrooms and Home
- ✓ Group 4: Conclusions: Three Recommendations for Teaching and Parenting

Facilitator walks around and assists as needed, Groups share aloud and create anchor chart to place on wall

11:25-11:45 One speaker from each group presents main ideas for their group's portion

11:45-12:45 Lunch on your own

12:45-1:00 Number Sense Teaching Activities Rotation

- ✓ Rotation 1: Classroom Games/Stations (Close to 100, Shut the Box, Race to $1.00)
- ✓ Rotation 2: Technology Activities for students (NCTM illuminations) and teacher resource websites to reference
- ✓ Rotation 3: Subitizing Activities (Dot Cards)
- ✓ Rotation 4: Number Talks

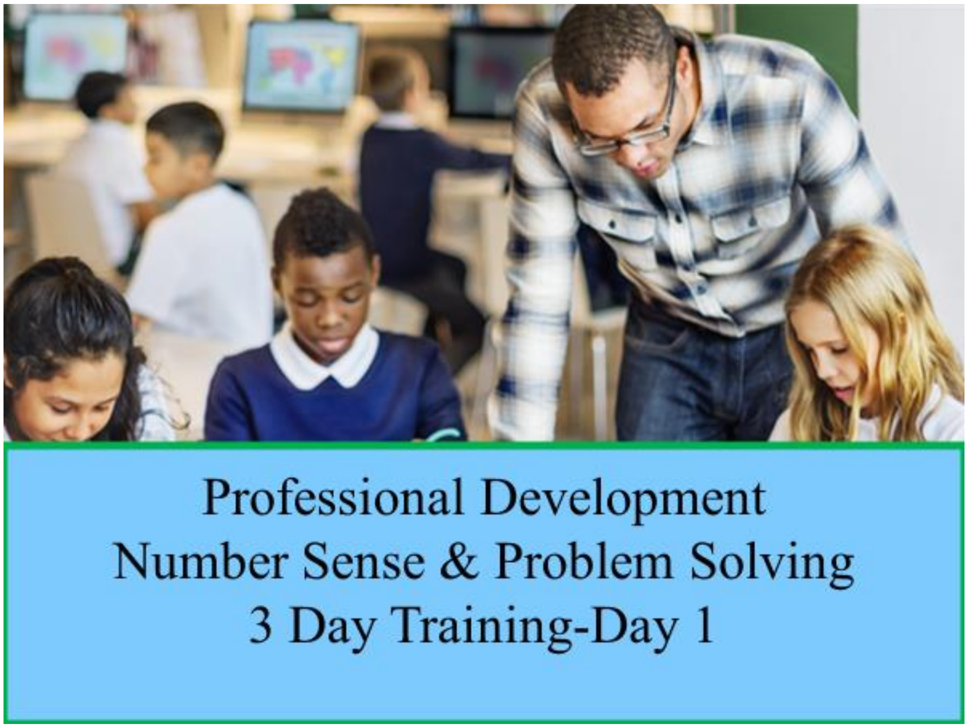
Handout provided with Developmental Progression of Subitizing and Sample Instructional Tasks

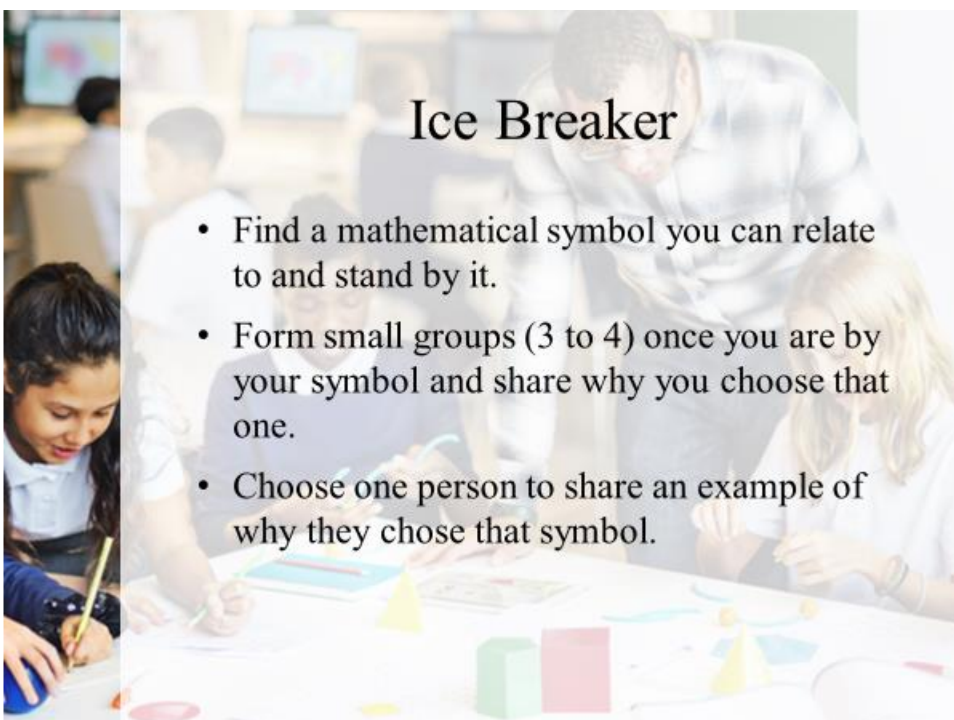
Facilitator: Groups go through three rotations of Number Sense activities 15 minutes for each station

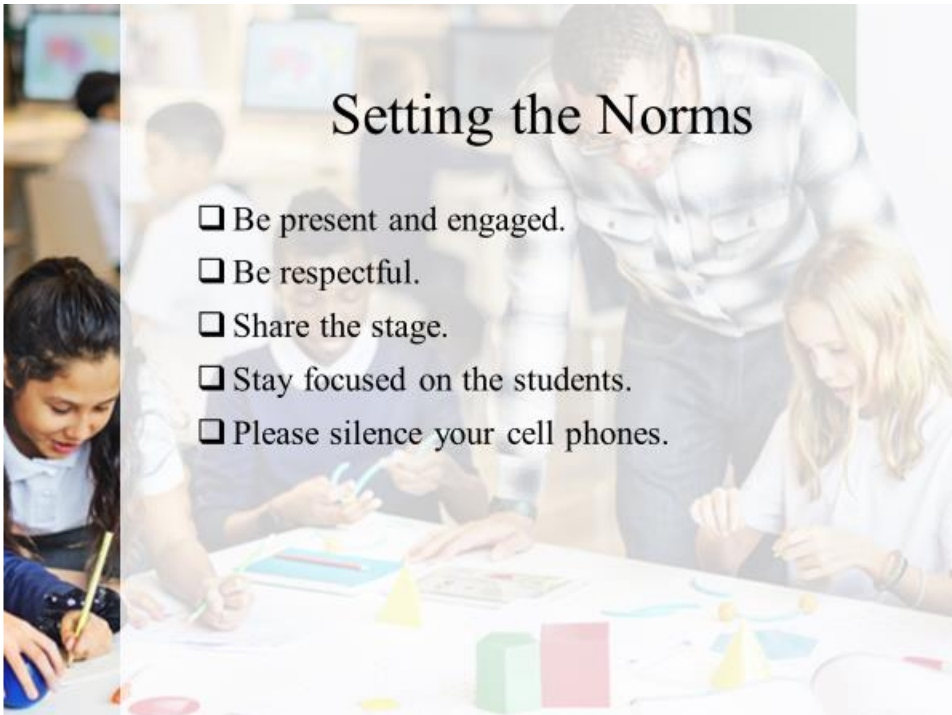
2:15-2:30 Break/Restroom

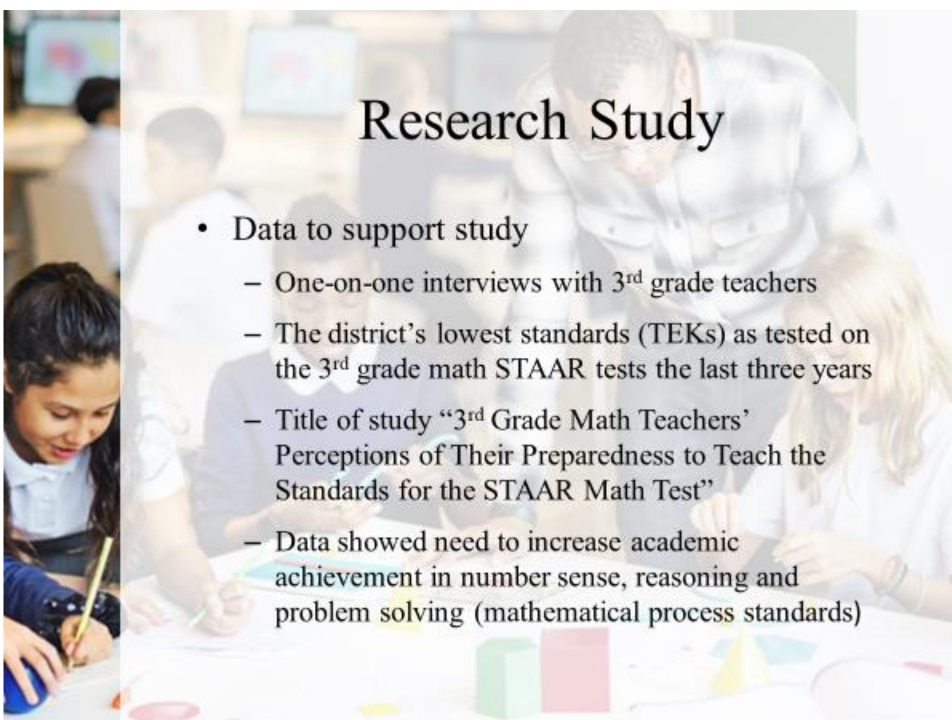
2:15- 2:40 Facilitator debriefs on rotations in whole group. Participants share what they learned

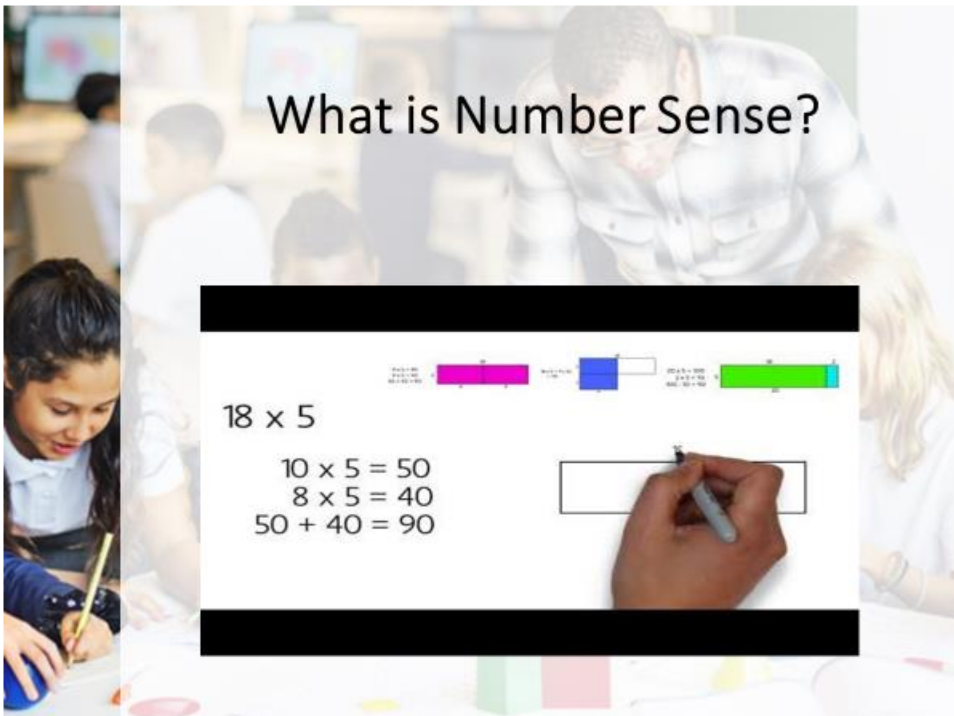
2:40-3:30 Individuals fill out Day 1 evaluation

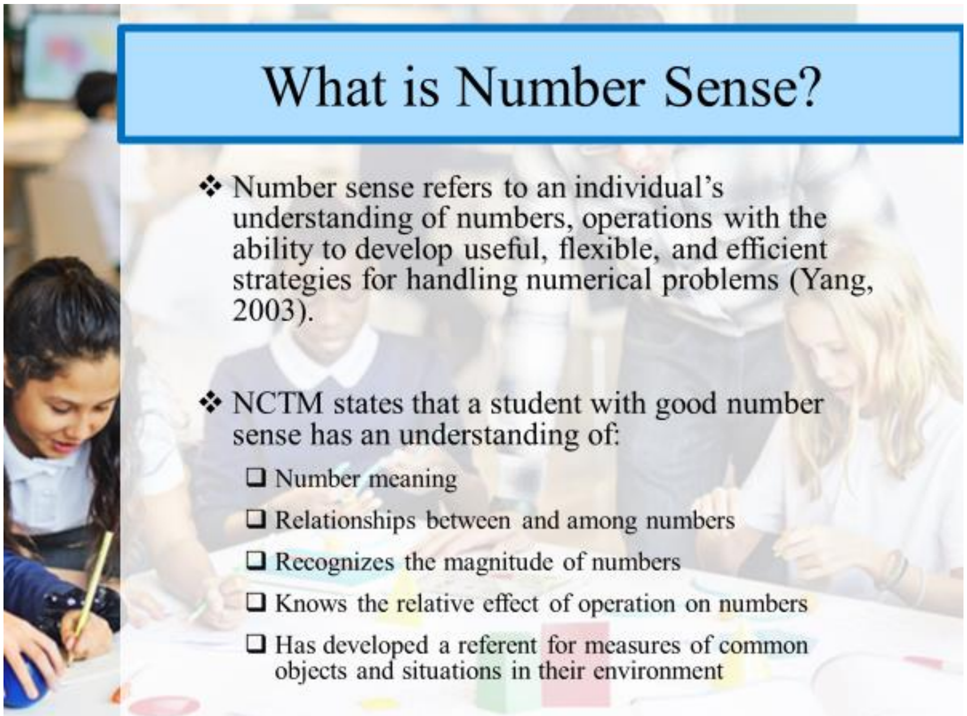

Professional Development
Number Sense & Problem Solving
3 Day Training-Day 1

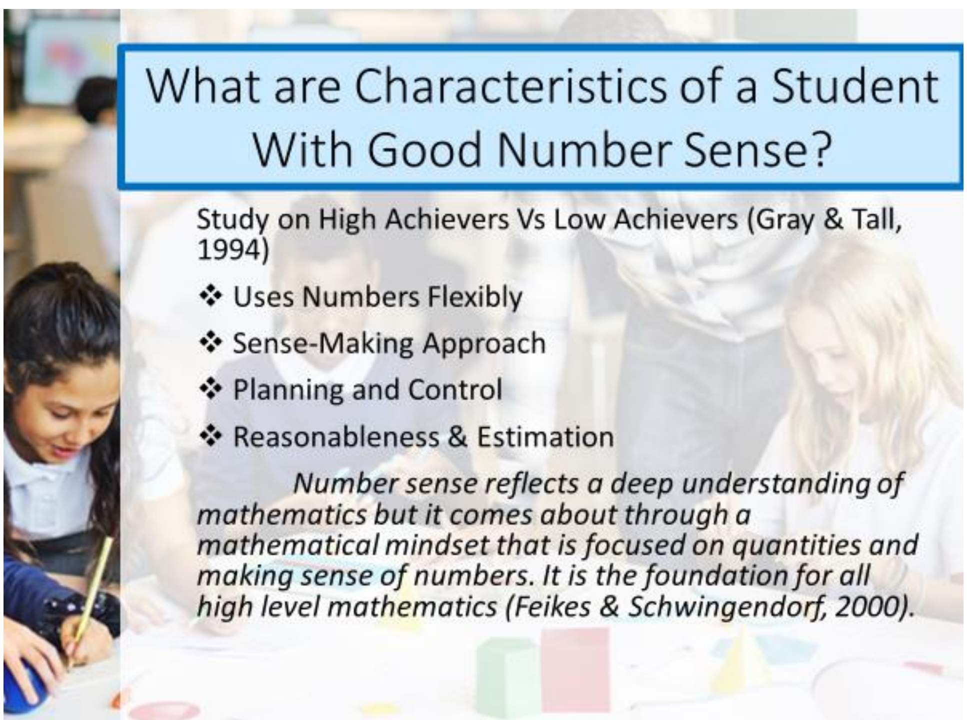

Ice Breaker
• Find a mathematical symbol you can relate to and stand by it.
• Form small groups (3 to 4) once you are by your symbol and share why you choose that one.
• Choose one person to share an example of why they chose that symbol.

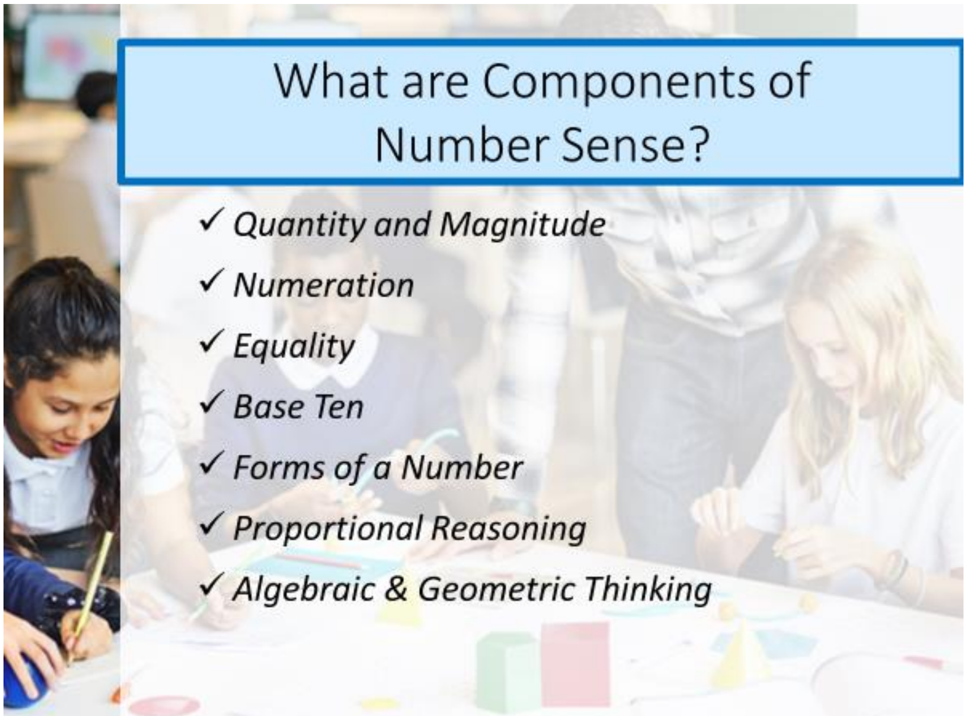

Setting the Norms
❑ Be present and engaged.
❑ Be respectful.
❑ Share the stage.
❑ Stay focused on the students.
❑ Please silence your cell phones.

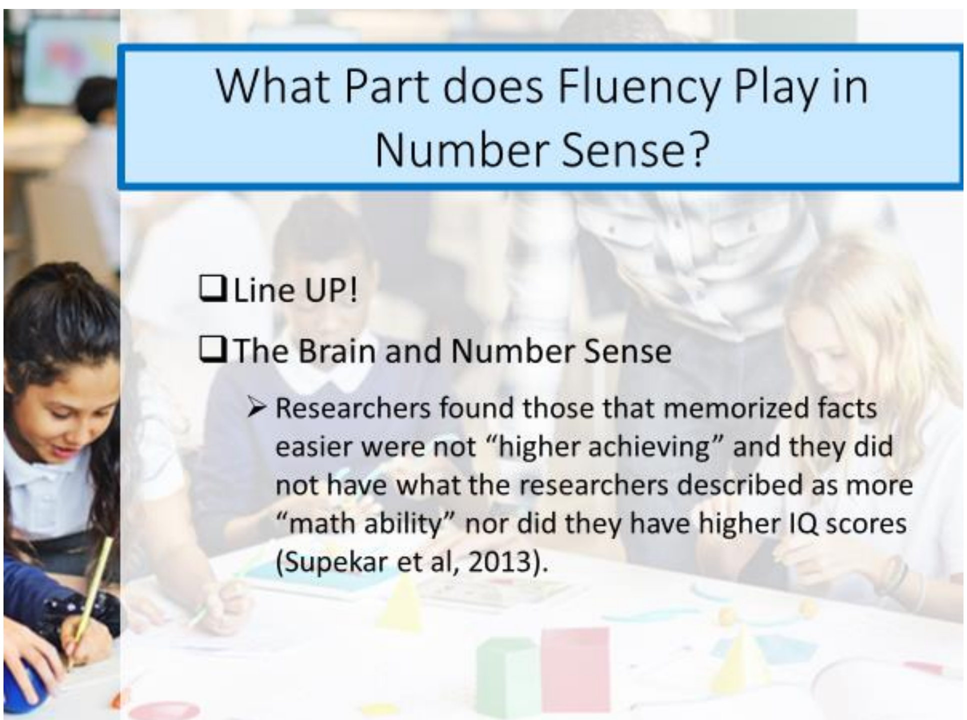

Research Study
• Data to support study
– One-on-one interviews with 3rd grade teachers
– The district's lowest standards (TEKs) as tested on the 3rd grade math STAAR tests the last three years
– Title of study "3rd Grade Math Teachers' Perceptions of Their Preparedness to Teach the Standards for the STAAR Math Test"
– Data showed need to increase academic achievement in number sense, reasoning and problem solving (mathematical process standards)

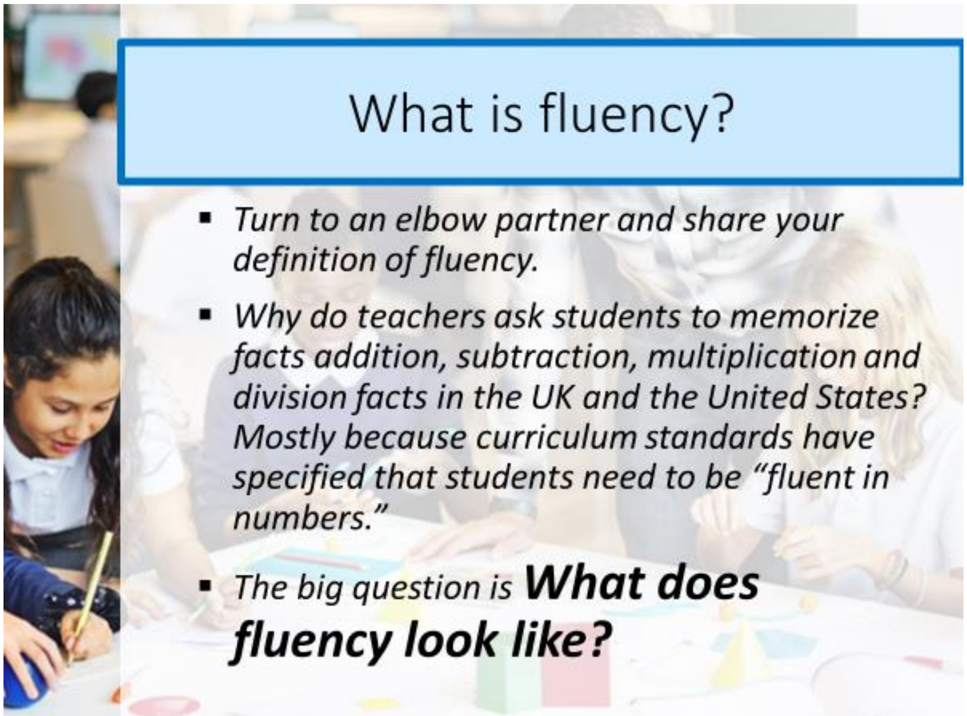

What is Number Sense?
18 x 5
10 x 5 = 50
8 x 5 = 40
50 + 40 = 90

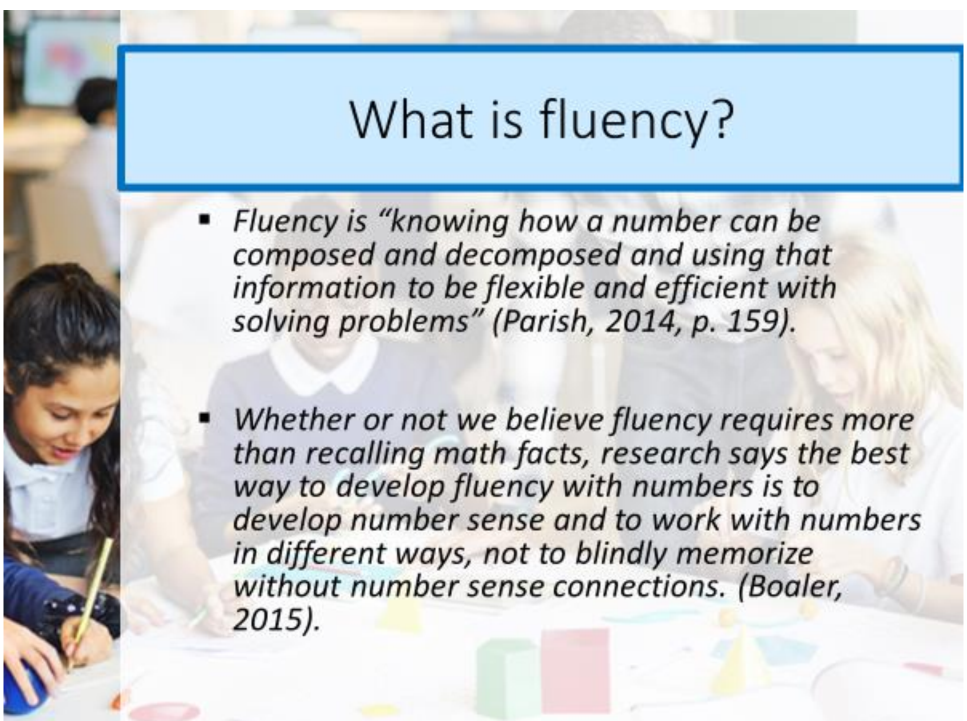

What is Number Sense?
❖ Number sense refers to an individual's understanding of numbers, operations with the ability to develop useful, flexible, and efficient strategies for handling numerical problems (Yang, 2003).
❖ NCTM states that a student with good number sense has an understanding of:
❑ Number meaning
❑ Relationships between and among numbers
❑ Recognizes the magnitude of numbers
❑ Knows the relative effect of operation on numbers
❑ Has developed a referent for measures of common objects and situations in their environment

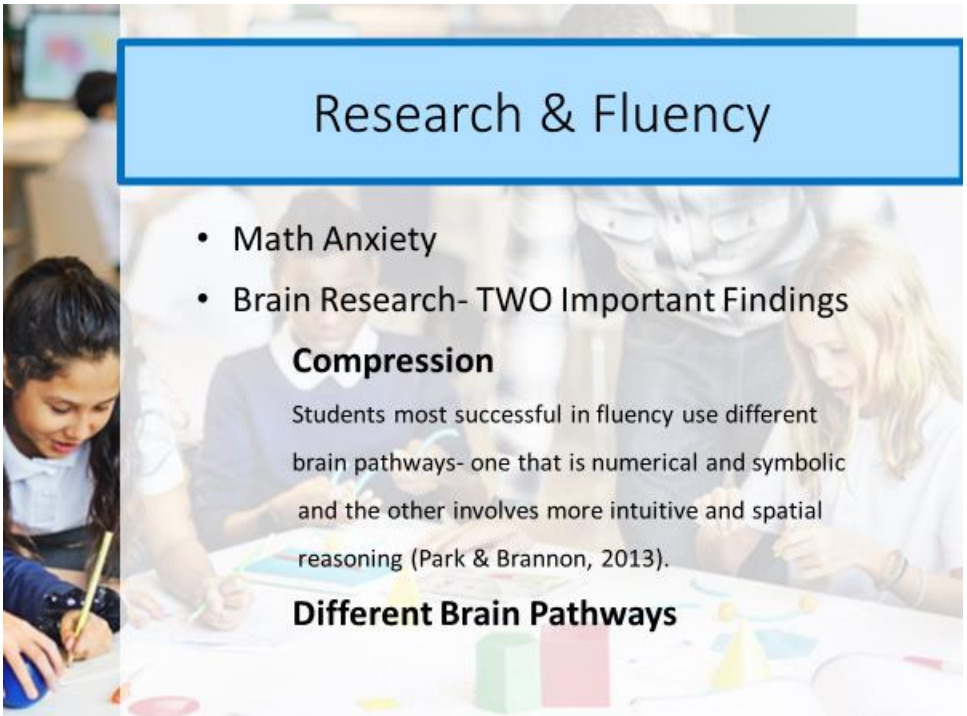

What are Characteristics of a Student With Good Number Sense?
Study on High Achievers Vs Low Achievers (Gray & Tall, 1994)
❖ Uses Numbers Flexibly
❖ Sense-Making Approach
❖ Planning and Control
❖ Reasonableness & Estimation
Number sense reflects a deep understanding of mathematics but it comes about through a mathematical mindset that is focused on quantities and making sense of numbers. It is the foundation for all high level mathematics (Feikes & Schwingendorf, 2000).

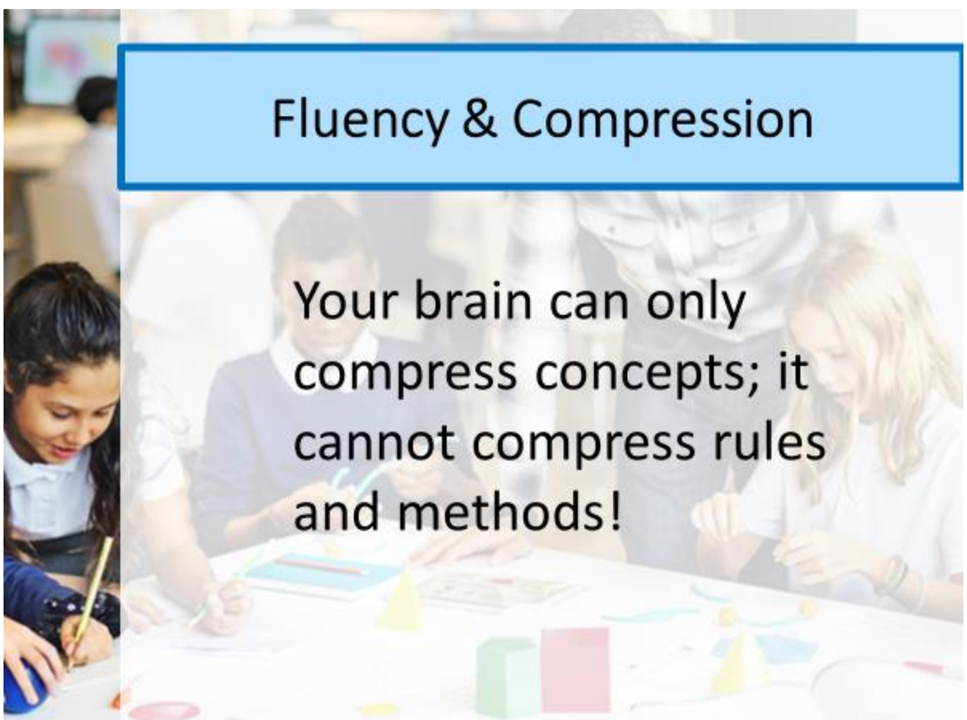

What are Components of Number Sense?
✓ Quantity and Magnitude
✓ Numeration
✓ Equality
✓ Base Ten
✓ Forms of a Number
✓ Proportional Reasoning
✓ Algebraic & Geometric Thinking

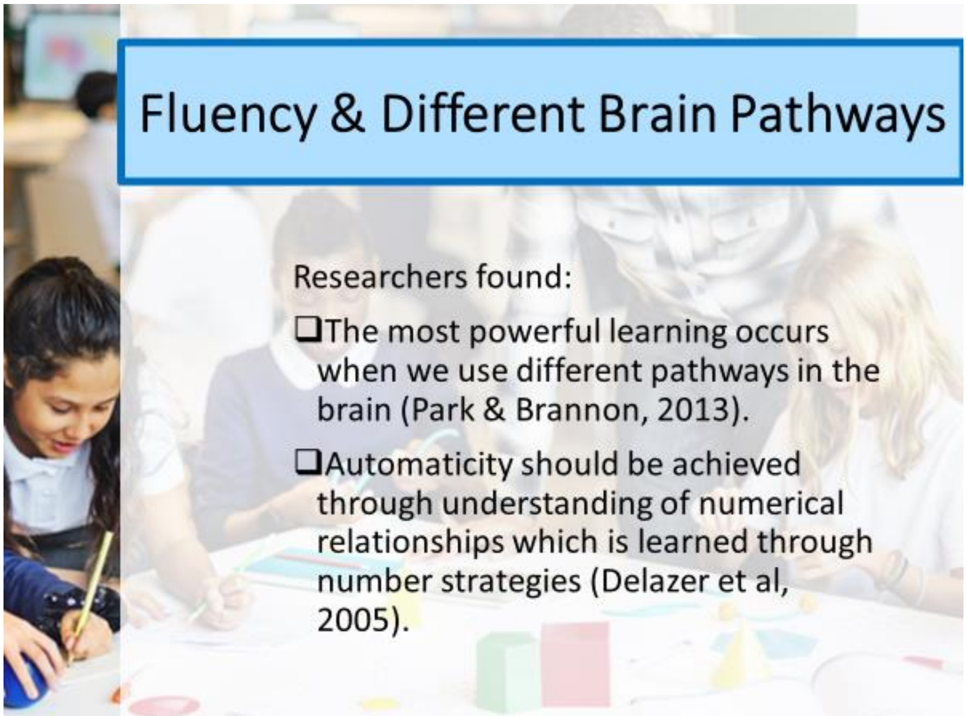

What Part does Fluency Play in Number Sense?
❑ Line UP!
❑ The Brain and Number Sense
➢ Researchers found those that memorized facts easier were not "higher achieving" and they did not have what the researchers described as more "math ability" nor did they have higher IQ scores (Supekar et al, 2013).


What is fluency?
Turn to an elbow partner and share your definition of fluency.
Why do teachers ask students to memorize facts addition, subtraction, multiplication and division facts in the UK and the United States? Mostly because curriculum standards have specified that students need to be "fluent in numbers."
The big question is What does fluency look like?

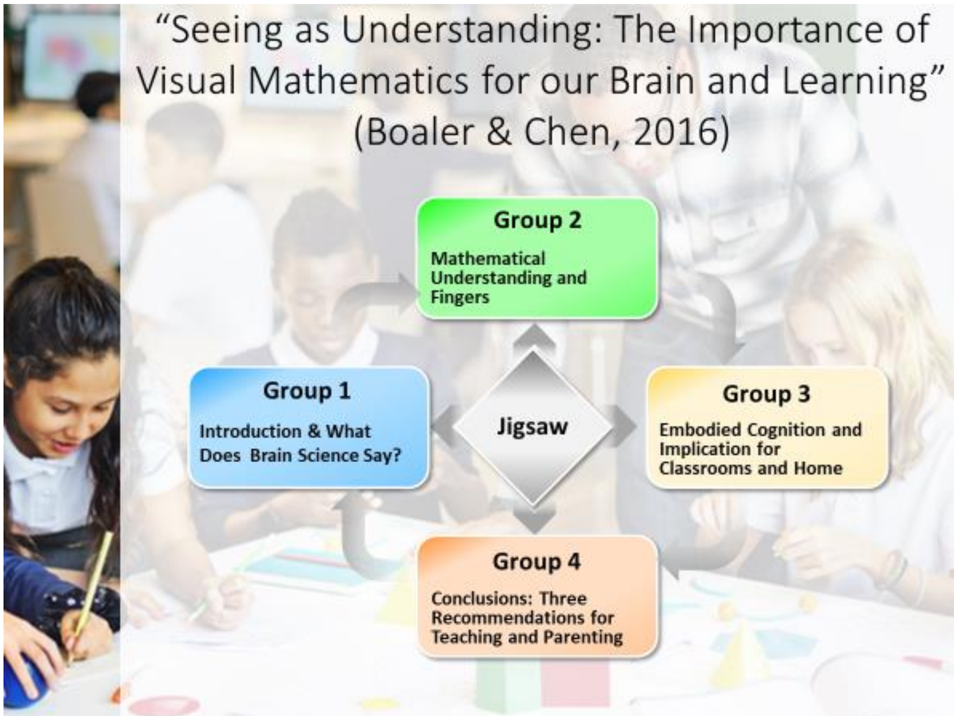

What is fluency?
Fluency is "knowing how a number can be composed and decomposed and using that information to be flexible and efficient with solving problems" (Parish, 2014, p. 159).
Whether or not we believe fluency requires more than recalling math facts, research says the best way to develop fluency with numbers is to develop number sense and to work with numbers in different ways, not to blindly memorize without number sense connections. (Boaler, 2015).

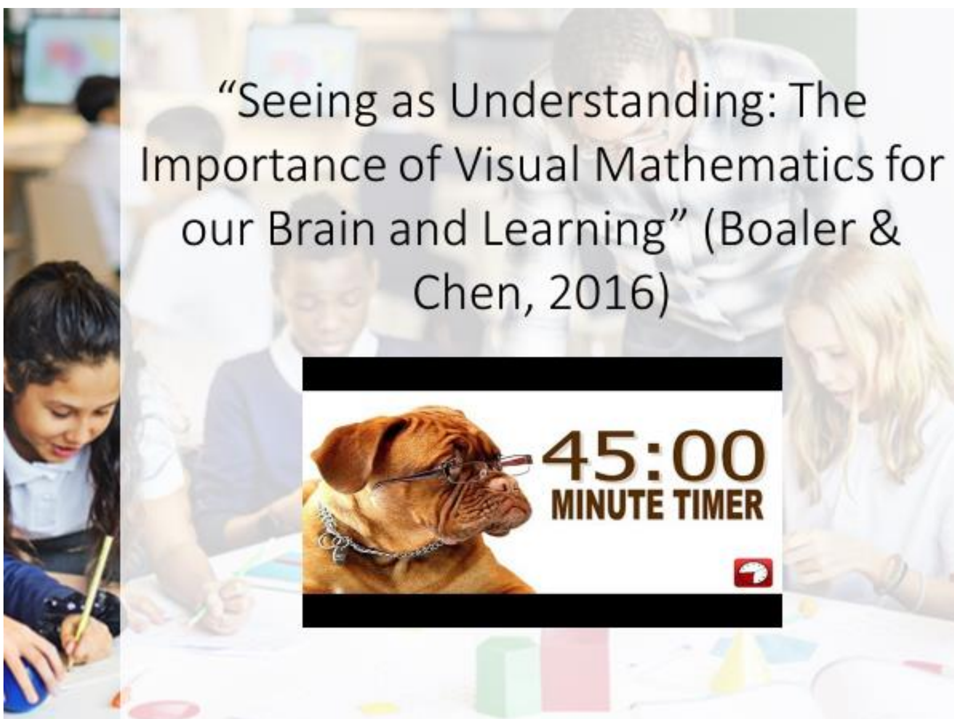

Research & Fluency
• Math Anxiety
• Brain Research- TWO Important Findings
Compression
Students most successful in fluency use different brain pathways- one that is numerical and symbolic and the other involves more intuitive and spatial reasoning (Park & Brannon, 2013).
Different Brain Pathways

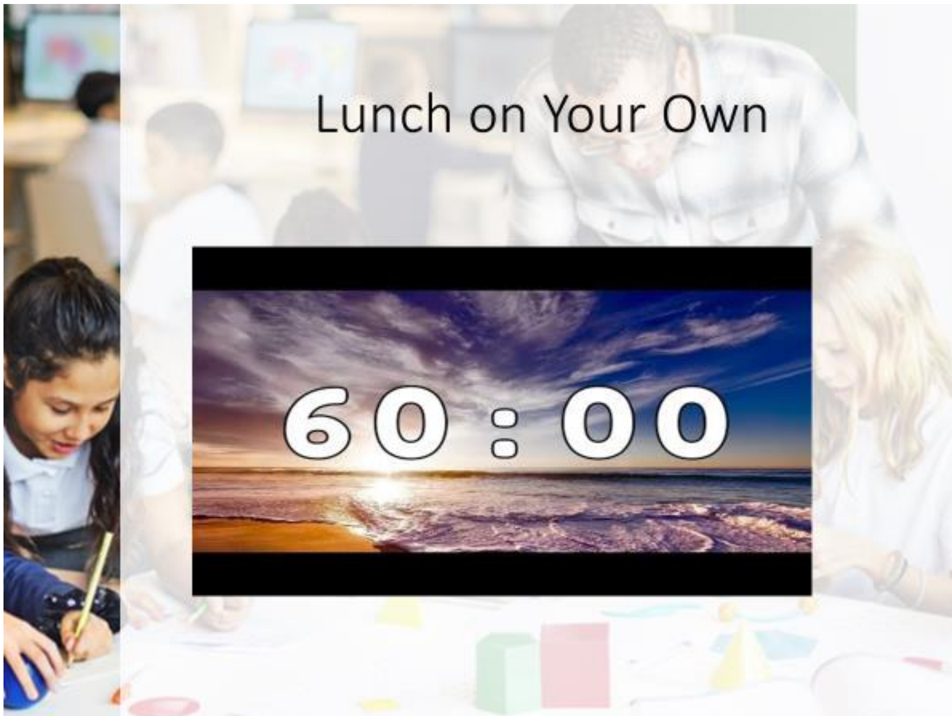

Fluency & Compression
Your brain can only compress concepts; it cannot compress rules and methods!


Fluency & Different Brain Pathways
Researchers found:
❑The most powerful learning occurs when we use different pathways in the brain (Park & Brannon, 2013).
❑Automaticity should be achieved through understanding of numerical relationships which is learned through number strategies (Delazer et al, 2005).


Break
15:00


"Seeing as Understanding: The Importance of Visual Mathematics for our Brain and Learning" (Boaler & Chen, 2016)
Group 2
Mathematical Understanding and Fingers
Group 1
Introduction & What Does Brain Science Say?
Jigsaw
Group 3
Embodied Cognition and Implication for Classrooms and Home
Group 4
Conclusions: Three Recommendations for Teaching and Parenting


"Seeing as Understanding: The Importance of Visual Mathematics for our Brain and Learning" (Boaler & Chen, 2016)
45:00
MINUTE TIMER

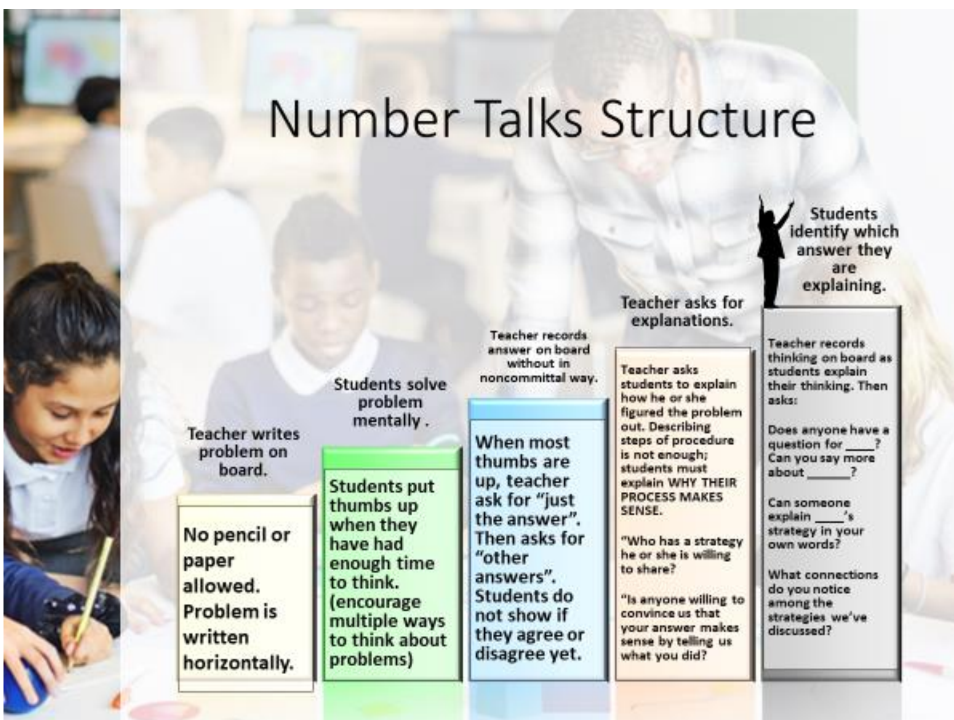

Lunch on Your Own
60 : 00


Number Sense Activities Rotation
• Rotation 1 (Classroom Games/Stations)
– Close to 100, Shut the Box, Race to $1.00
• Rotation 2 (Technology Activities)
– NCTM Illuminations and teacher resource websites for resources
• Rotation 3 (Subitizing Activities)
– Dot Cards & various quick image resources
– Handout provided with Developmental Progression of Subitizing and Sample Instructional Tasks (Standards for Preparing Teachers of Mathematics)


Rotation 1
20:00
MINUTE TIMER


Rotation 2
20:00
MINUTE TIMER


Break
15 Minute Timer
15:00


Number Talks Structure
Teacher writes problem on board.
No pencil or paper allowed. Problem is written horizontally.
Students solve problem mentally .
Students put thumbs up when they have had enough time to think. (encourage multiple ways to think about problems)
Teacher records answer on board without in noncommittal way.
When most thumbs are up, teacher ask for “just the answer”. Then asks for “other answers”. Students do not show if they agree or disagree yet.
Teacher asks for explanations.
Teacher asks students to explain how he or she figured the problem out. Describing steps of procedure is not enough; students must explain WHY THEIR PROCESS MAKES SENSE.
"Who has a strategy he or she is willing to share?
“Is anyone willing to convince us that your answer makes sense by telling us what you did?
Students identify which answer they are explaining.
Teacher records thinking on board as students explain their thinking. Then asks:
Does anyone have a question for ____?
Can you say more about ______?
Can someone explain ____'s strategy in your own words?
What connections do you notice among the strategies we've discussed?

Number Talk Example

Let's watch a Number Talk!

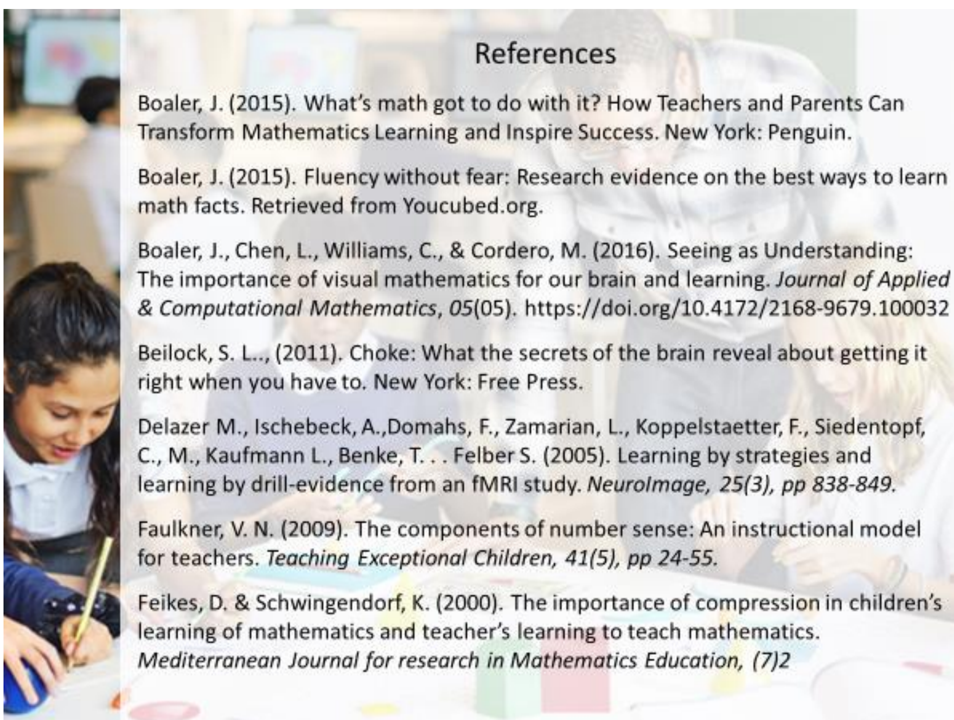
- https://www.insidemathematics.org/classroom-videos/number-talks/3rd-grade-math-one-digit-by-two-digit-multiplication/number-talk-part-1# (4:56)
- https://www.insidemathematics.org/classroom-videos/number-talks/3rd-grade-math-one-digit-by-two-digit-multiplication/number-talk-part-1 (5:25)
- https://www.insidemathematics.org/classroom-videos/number-talks/3rd-grade-math-one-digit-by-two-digit-multiplication/number-talk-part-3 (4:32)
- https://www.insidemathematics.org/classroom-videos/number-talks/3rd-grade-math-one-digit-by-two-digit-multiplication/number-talk-part-4 (7:03)
- https://www.insidemathematics.org/classroom-videos/number-talks/3rd-grade-math-one-digit-by-two-digit-multiplication/post-talk (3:05)

(University of Texas Dana Center, Insidemathematics.org Video Library, 2020)

Number Talk Principles (Parrish, 2014)

1. Each Number Talk should have a purpose. You may want to consider where you are in the curriculum and or what you want your students to think deeply about.
2. Number Talks are used with all ages of learners, even high school!
3. Be comfortable with plenty of thinking time.
4. Encourage specific academic language during student's sharing time.
5. Keep encouraging students to talk to one another and not through you as a facilitator.
6. Use multiple answers to help students see different strategies to arrive at the same answer.
7. Know when you need to guide or facilitate your way into a Number Talk. Intervene as necessary when students are stuck or need your prompting.
8. Help students to move beyond traditional procedures.
9. Embrace mistakes as opportunities to learn.
10. Create and facilitate a safe environment where all students feel safe.
11. Remember that mathematical understandings happen over time.


Questions?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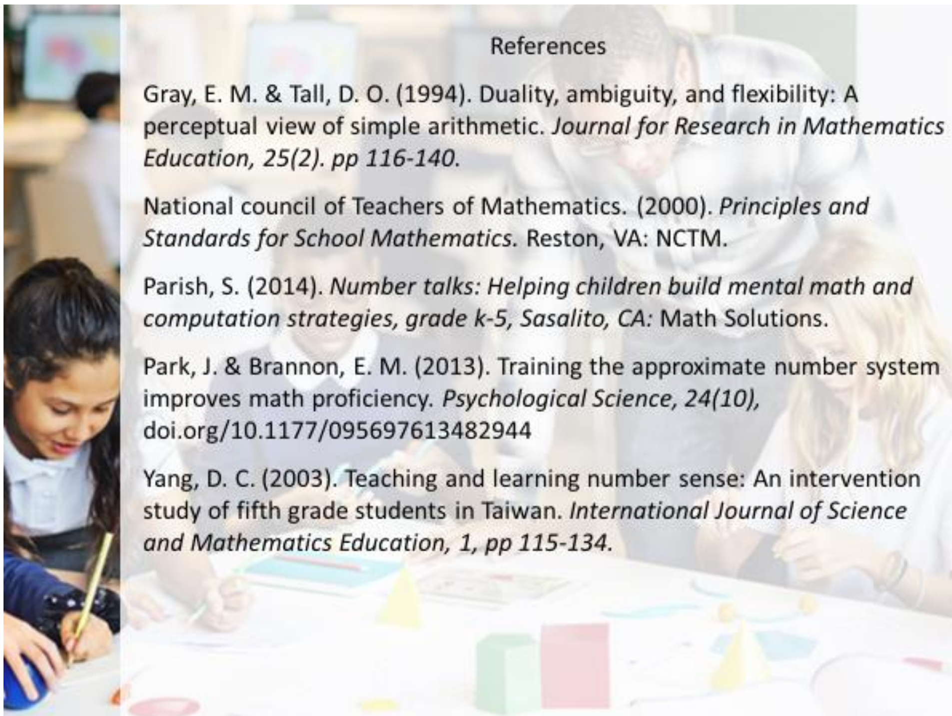
Boaler, J. (2015). Fluency without fear: Research evidence on the best ways to learn math facts. Retrieved from Youcubed.org.
Boaler, J., Chen, L., Williams, C., & Cordero, M. (2016). Seeing as Understanding: The importance of visual mathematics for our brain and learning. Journal of Applied & Computational Mathematics, 05(05). https://doi.org/10.4172/2168-9679.100032
Beilock, S. L.., (2011). Choke: What the secrets of the brain reveal about getting it right when you have to. New York: Free Press.
Delazer M., Ischebeck, A.,Domahs, F., Zamarian, L., Koppelstaetter, F., Siedentopf, C., M., Kaufmann L., Benke, T. . . Felber S. (2005). Learning by strategies and learning by drill-evidence from an fMRI study. NeuroImage, 25(3), pp 838-849.
Faulkner, V. N. (2009). The components of number sense: An instructional model for teachers. Teaching Exceptional Children, 41(5), pp 24-55.
Feikes, D. & Schwingendorf, K. (2000). The importance of compression in children's learning of mathematics and teacher's learning to teach mathematics. Mediterranean Journal for research in Mathematics Education, (7)2


References
Gray, E. M. & Tall, D. O. (1994). Duality, ambiguity, and flexibility: A perceptual view of simple arithmetic. *Journal for Research in Mathematics Education, 25(2). pp 116-140.*
National council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics.* Reston, VA: NCTM.
Parish, S. (2014). *Number talks: Helping children build mental math and computation strategies, grade k-5, Sasalito, CA:* Math Solutions.
Park, J. & Brannon, E. M. (2013). Training the approximate number system improves math proficiency. *Psychological Science, 24(10),* doi.org/10.1177/095697613482944
Yang, D. C. (2003). Teaching and learning number sense: An intervention study of fifth grade students in Taiwan. *International Journal of Science and Mathematics Education, 1, pp 115-134.*

Day 2: "What's the Problem?"

8:30-9:00 Facilitator introduces self and norms and agenda for day 2, goals

Remind participants of "Parking Lot" for questions

Participants use a sticky note and markers to list ways they teach students to problem solve

9:00-9:45 Participants take the math word-problem pretest "Just Do It!" The purpose of the pretest is for participants to use their own knowledge of math problem solving strategies for discussion of their experience.

Facilitator Note: Share and discuss reasons for pretest and what they experienced while completing it.

Facilitator Note: Pass out sticky notes for each person to write at least two things they experienced during the pretest or are wondering about

Sticky notes are placed on the large chart in front, Facilitator shares some of the thoughts placed on the chart.

9:45-10:00 Ice Breaker/Rock, Paper, Scissors Rally

Participants are arranged in groups of 4, Play "Rock, Paper, Scissors"

Winners advance and play other winners, Losers are "cheerleaders" to the person that beat them. The rally continues until there are only two participants left and each participant has their own cheering squad.

10:00-10:15 Break/Bathroom

10:15-10:45 Goals for Day 2, What is problem solving? What skills are involved in problem solving?

Is fluency a part of problem solving? If so, how is it related?

What are some strategies you use in your classroom to teach problem-solving? Why is math problem solving difficult to teach?

Facilitator: Participants take a walk (3 to 5 minutes per chart) around the room and using markers and hanging charts write or draw their answers for each question. Charts are spread around room with one question for each chart. Music playing in the background and when music stops the participants move to the next chart. After rotations, facilitator takes a few minutes to debrief and share thoughts from each chart in the large group

10:30-10:40 Facilitator shows short video on Types of Problems & Problem Solving Strategies (free educational psychology video)

https://www.youtube.com/watch?v=ftgtzFaHFGE (8:42)

10:40-10:50 Facilitator presents What is problem solving? Power Point

- ✓ What is problem solving?
- ✓ What is involved in Problem Solving? (Frame 10)
- ✓ What is Problem Solving in Mathematics? (Frame 11)
- ✓ TEKS Mathematics Process Standards (Frame 12)
- ✓ Universal Beliefs About Effective Teaching of Mathematics

10:55-11:00 How does a Student Learn to Problem Solve? (Frame 14)

11:00-11:40 Why is Problem Solving Important? (Frames 15-16)

Why is Teaching Problem Solving Difficult? (Frames 18-21)

11:40-12:40 Lunch

12:40-1:40 In groups Participants read article entitled, “A Problem-Solving Alternative to Using Key-Words” by Lisa L. Clement and Jamal Z. Bernhard, *Mathematics Teaching in the Middle School, NCTM article.* Participants highlight important ideas as they are reading through the article independently. Then in groups each group is assigned a different question to answer on an anchor chart.

Facilitator asks participants:

- ✓ What is wrong with teaching key words?
- ✓ What alternative do they suggest using instead of the key words approach?
- ✓ Explain the “Quantitative Analysis” approach?
- ✓ What are the two main parts of the Quantitative approach?
    - All the quantities
    - The relationship between and among those quantities

✓ What are the instructional implications of using the Quantitative Analysis approach? Students can be encouraged to ask themselves:

- What quantities are involved in this situation?
- What quantities am I trying to find?
- Which quantities are critical to the problem at hand?
- Are any of the quantities related to each other? If so, how are they related?
- Do I know the values of any of the quantities? Which ones?
- For which quantities do I not know the value?

  Are these quantities related to other quantities in the situation? Can these relationships help me find any unknown values?
- Would drawing a diagram or enacting the situation help me to answer any of these questions?

1:15-1:40 Groups share their anchor charts, present to large group

1:40-2:00 What Does Research Say About Problem Solving Instructional Strategies?

Frames 24-28 What is an Attack Strategy?

2:00-2:15 Break/Restroom-Frame 29

2:15-2:30 What is Schema Instruction for Problem Solving? Frame 30

Research Based Problem Solving Best Practices-Frames 31

What does research say about most effective problem-solving strategies? -

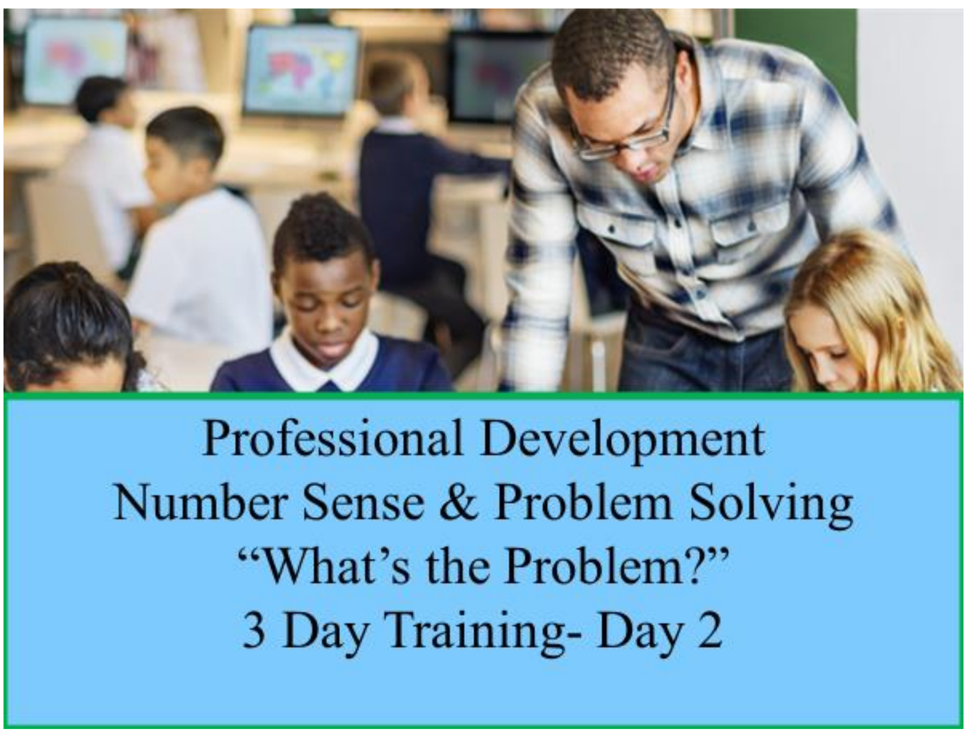
Frame 32 http://dwwlibrary.wested.org/resources/1142

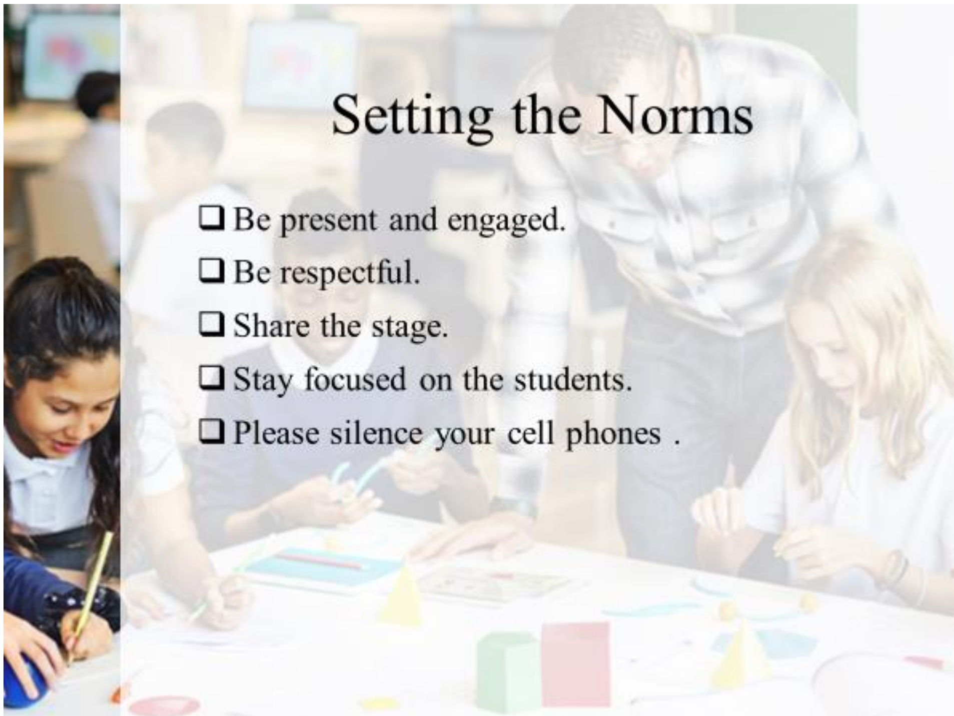
Did you know?-Frame 33

2:30-3:20 Teacher Exploration/Collaboration on Resources for Problem

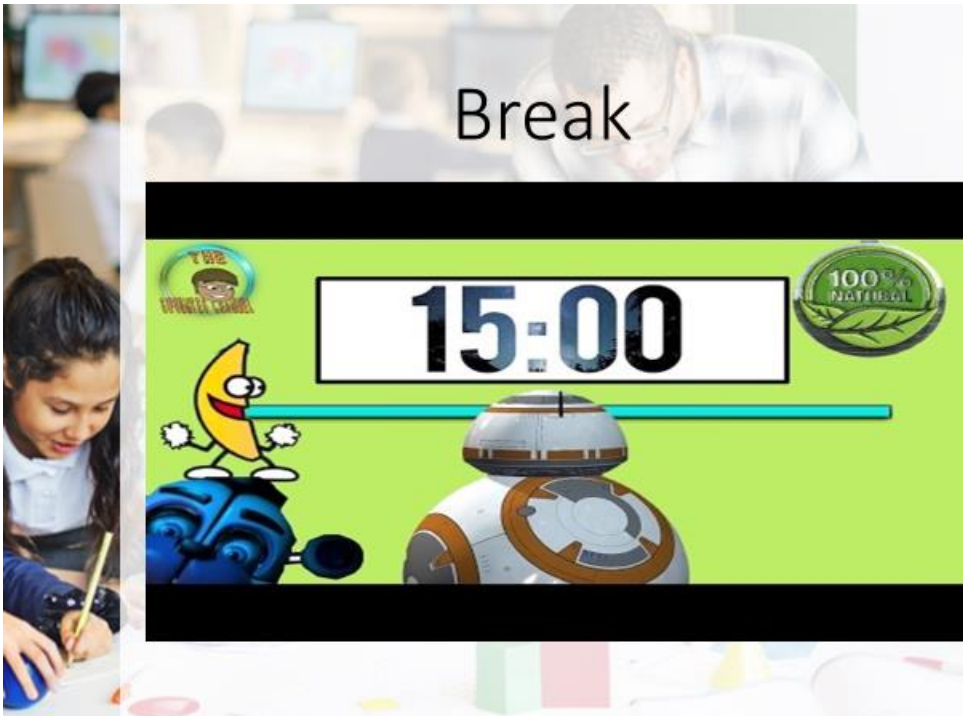
Solving/Number Sense (websites on Frame 34)

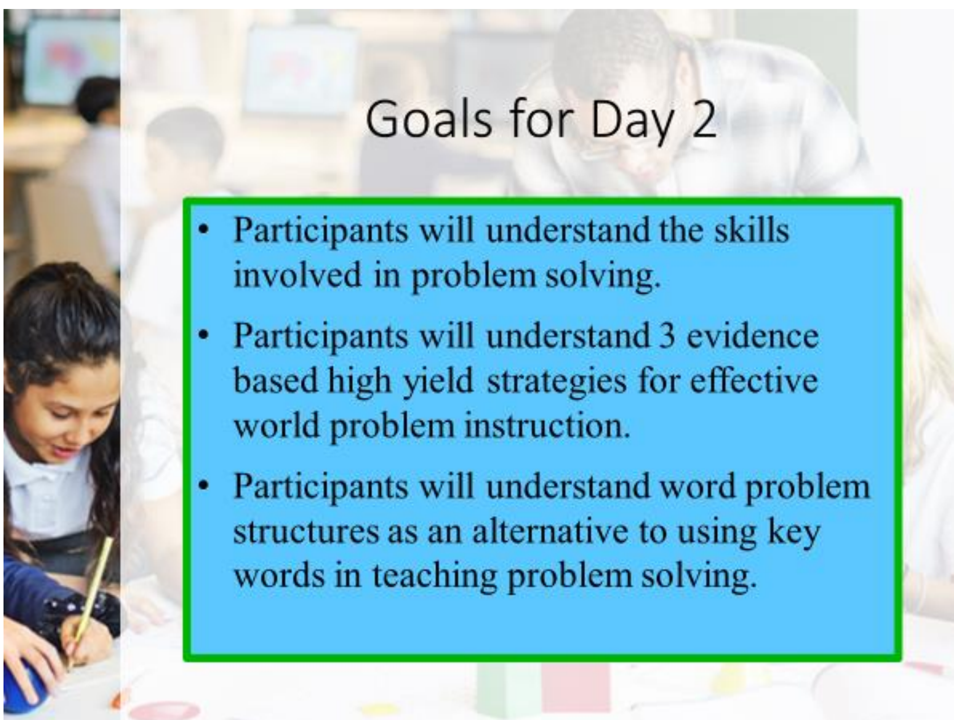
3:20-3:30 Share what resources were found and complete Day 2 Evaluation

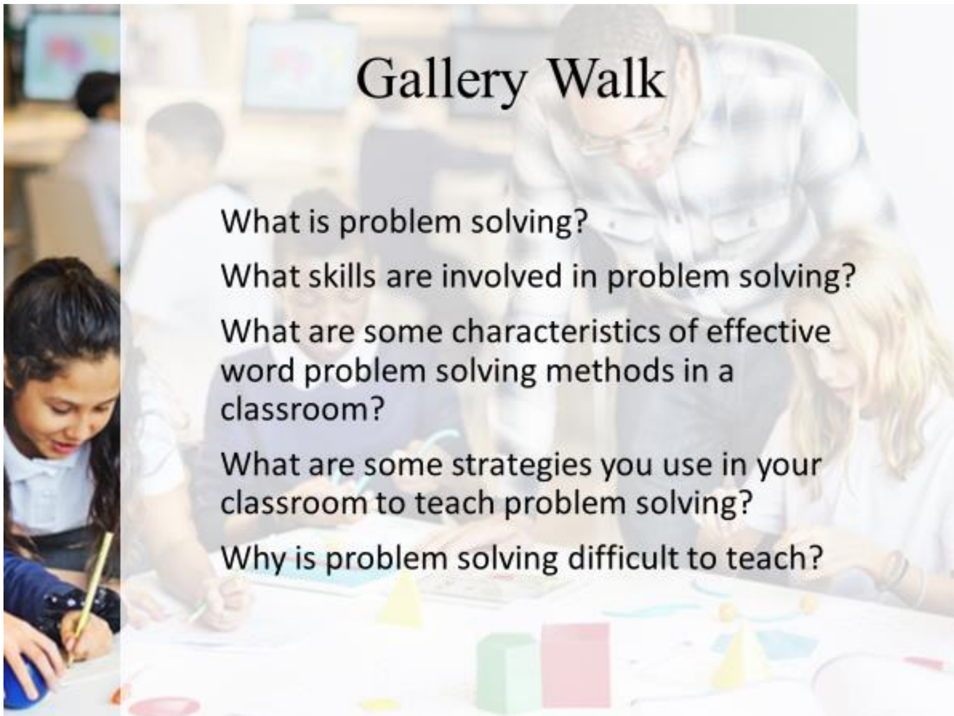


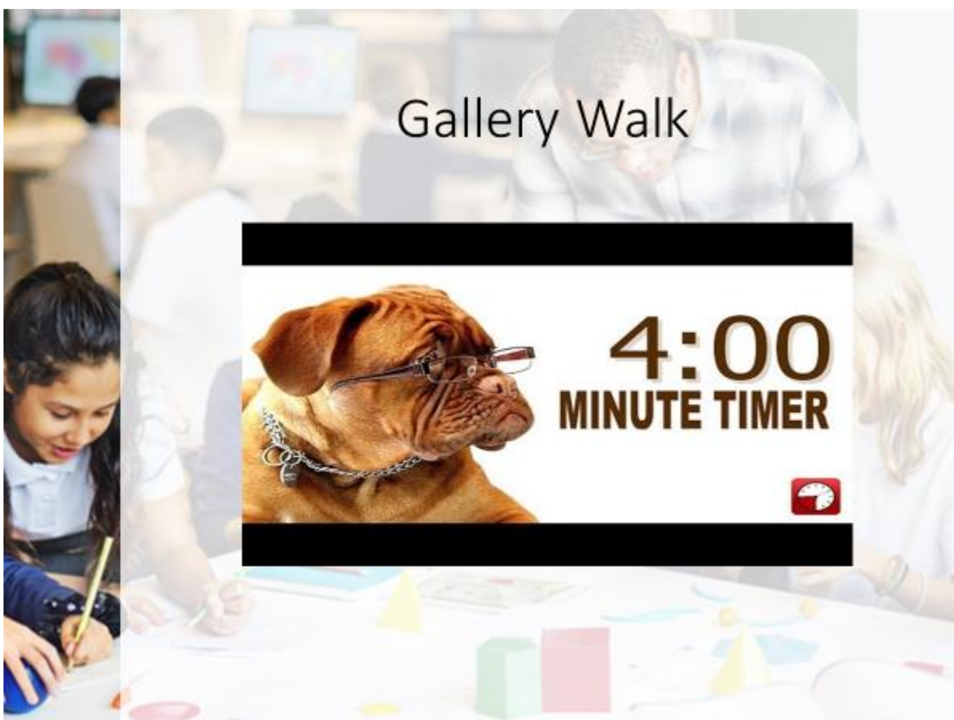

Setting the Norms
❑ Be present and engaged.
❑ Be respectful.
❑ Share the stage.
❑ Stay focused on the students.
❑ Please silence your cell phones .


Ice Breaker
Rock, Paper, Scissors Rally

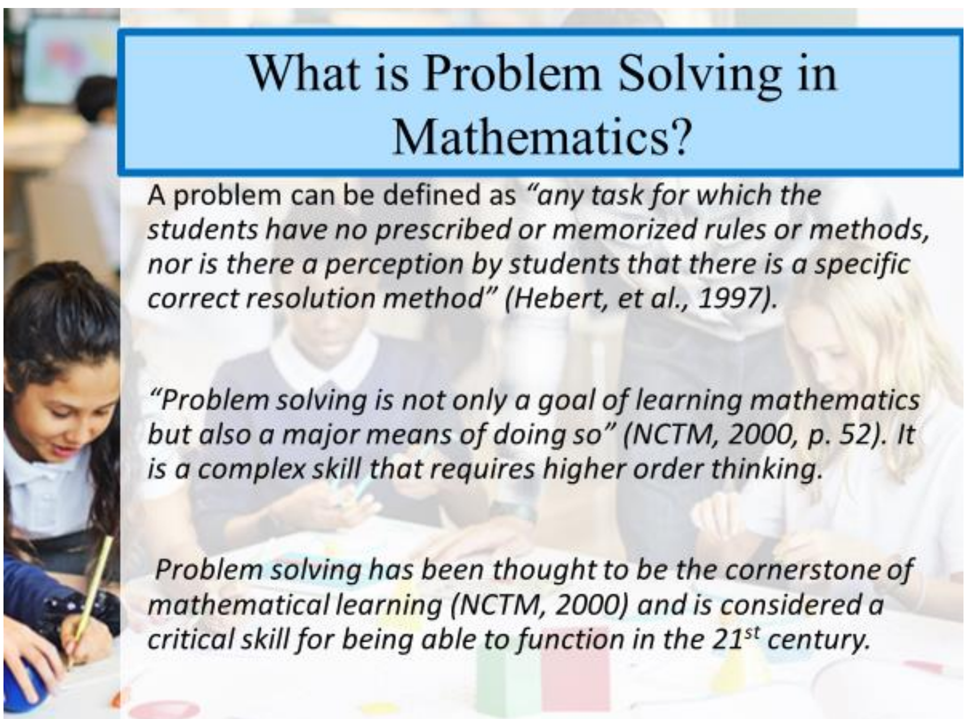

Break
15:00
100%
NATURAL

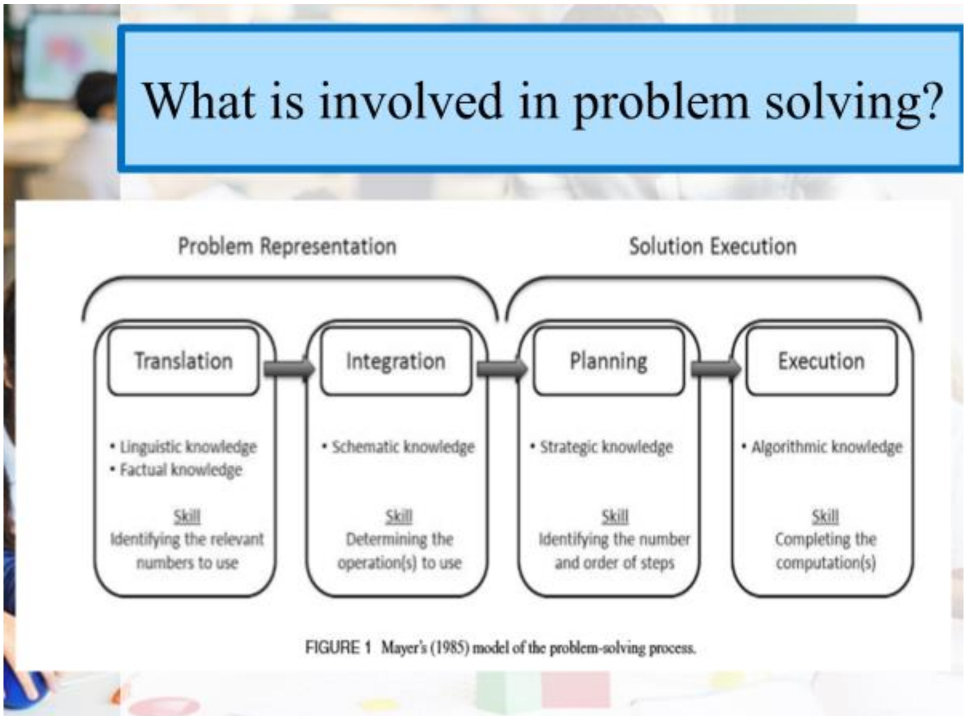

Goals for Day 2
• Participants will understand the skills involved in problem solving.
• Participants will understand 3 evidence based high yield strategies for effective world problem instruction.
• Participants will understand word problem structures as an alternative to using key words in teaching problem solving.

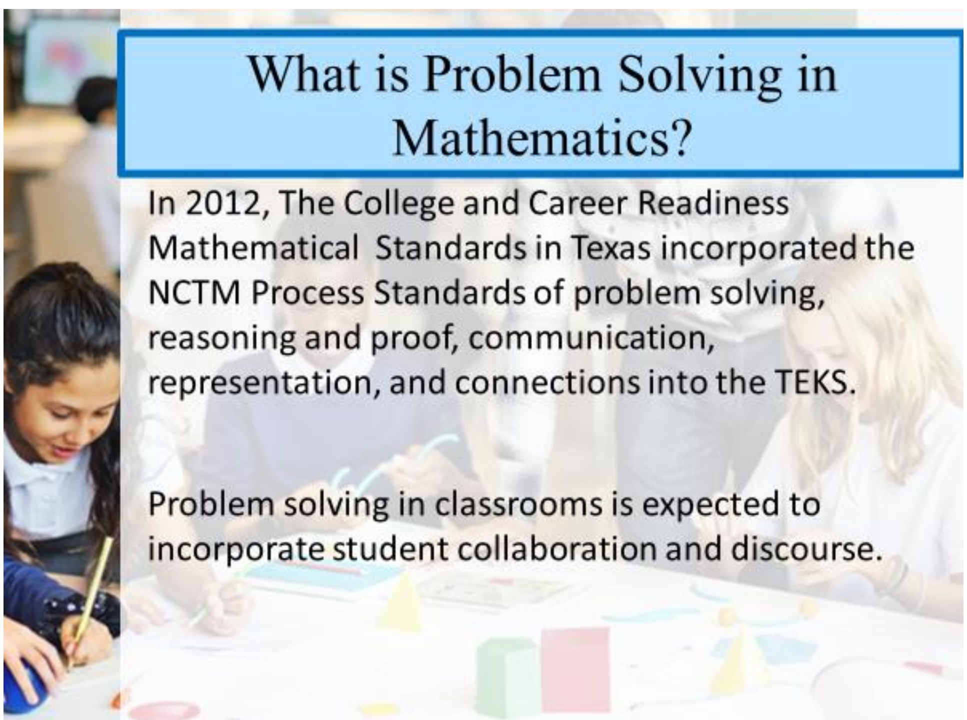

Gallery Walk
What is problem solving?
What skills are involved in problem solving?
What are some characteristics of effective word problem solving methods in a classroom?
What are some strategies you use in your classroom to teach problem solving?
Why is problem solving difficult to teach?

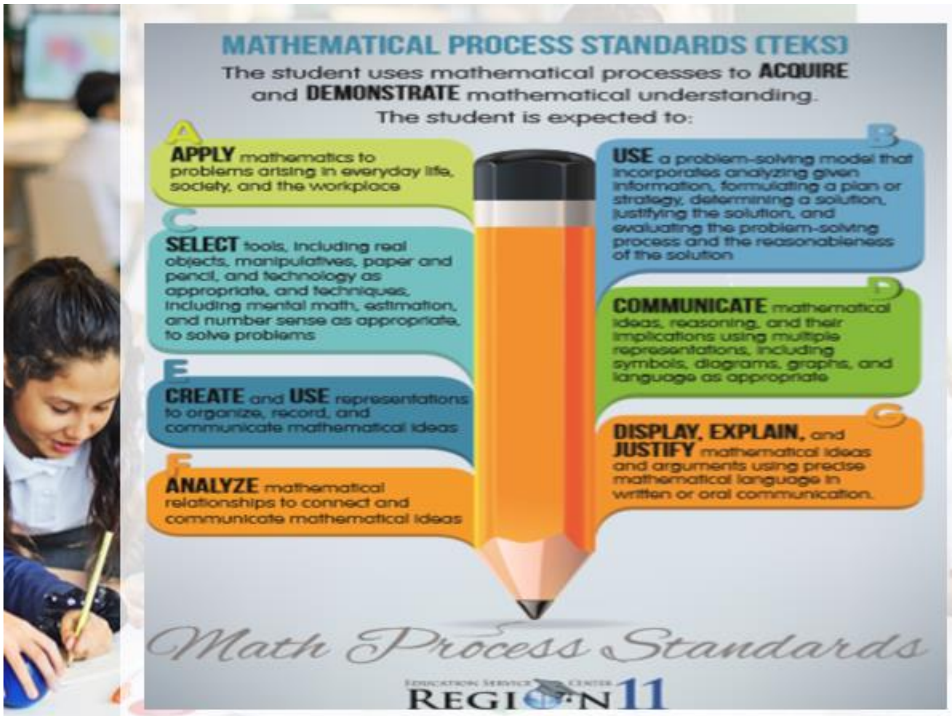

Gallery Walk
4:00
MINUTE TIMER

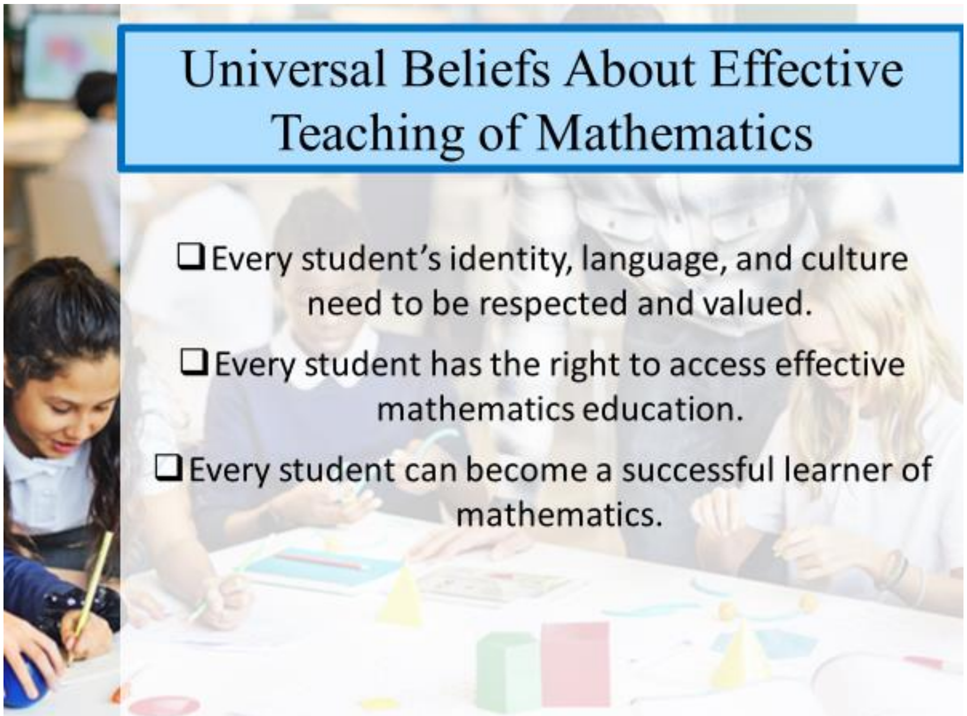

What is Problem Solving?
• https://www.youtube.com/watch?v=ftgtzFaHFGE (8:42)

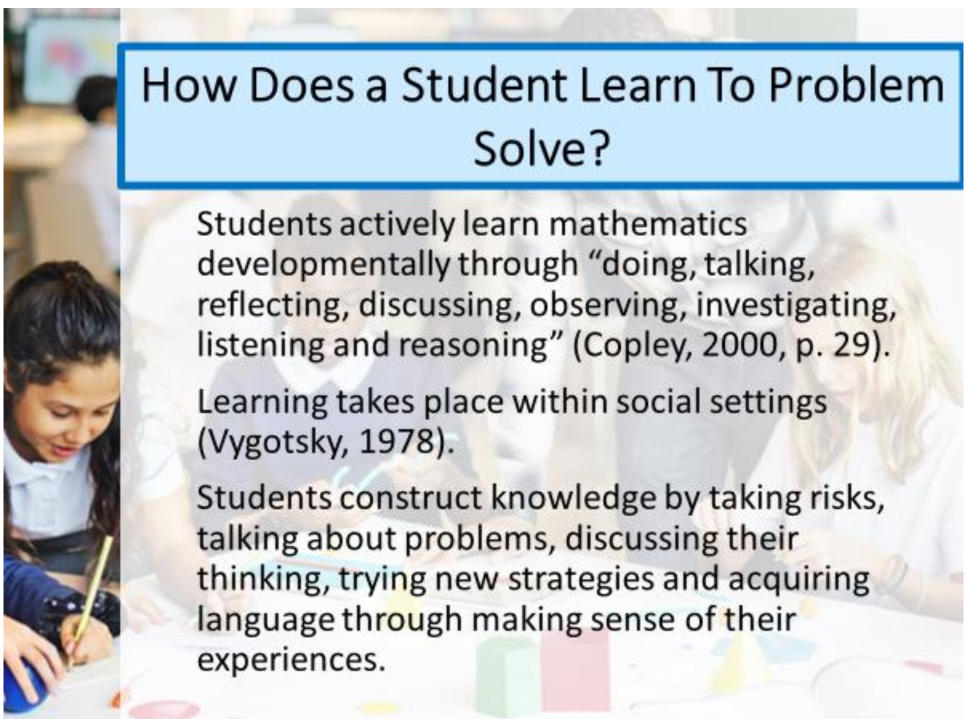

What is Problem Solving in Mathematics?
A problem can be defined as "any task for which the students have no prescribed or memorized rules or methods, nor is there a perception by students that there is a specific correct resolution method" (Hebert, et al., 1997).
"Problem solving is not only a goal of learning mathematics but also a major means of doing so" (NCTM, 2000, p. 52). It is a complex skill that requires higher order thinking.
Problem solving has been thought to be the cornerstone of mathematical learning (NCTM, 2000) and is considered a critical skill for being able to function in the 21st century.

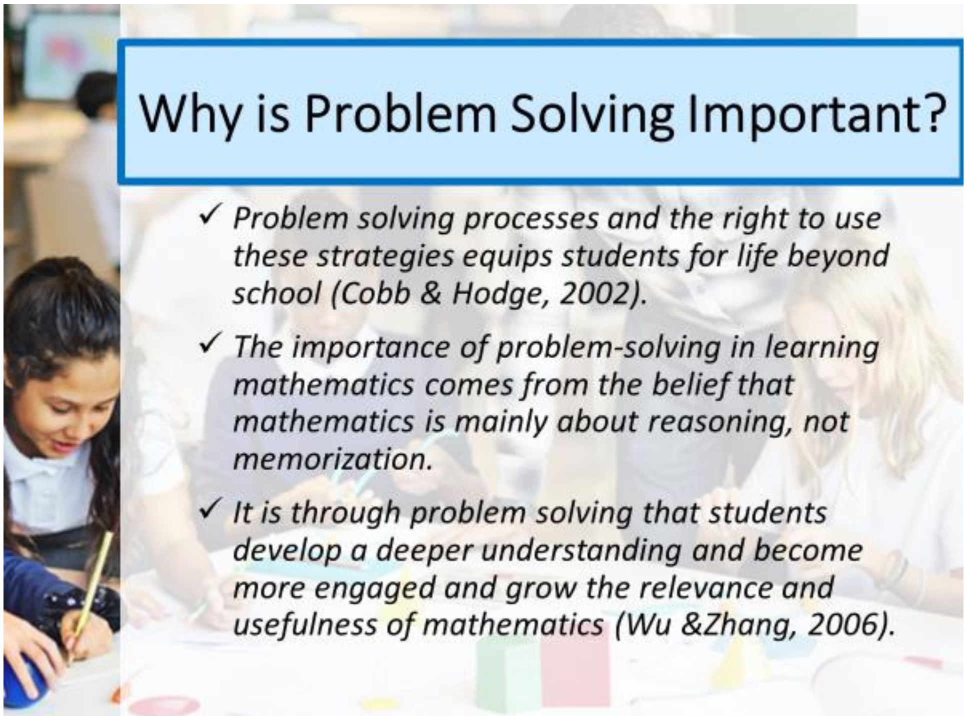

What is involved in problem solving?
Problem Representation
Solution Execution
Translation
Integration
Planning
Execution
• Linguistic knowledge
• Factual knowledge
Skill
Identifying the relevant numbers to use
• Schematic knowledge
Skill
Determining the operation(s) to use
• Strategic knowledge
Skill
Identifying the number and order of steps
• Algorithmic knowledge
Skill
Completing the computation(s)
FIGURE 1 Mayer's (1985) model of the problem-solving process.

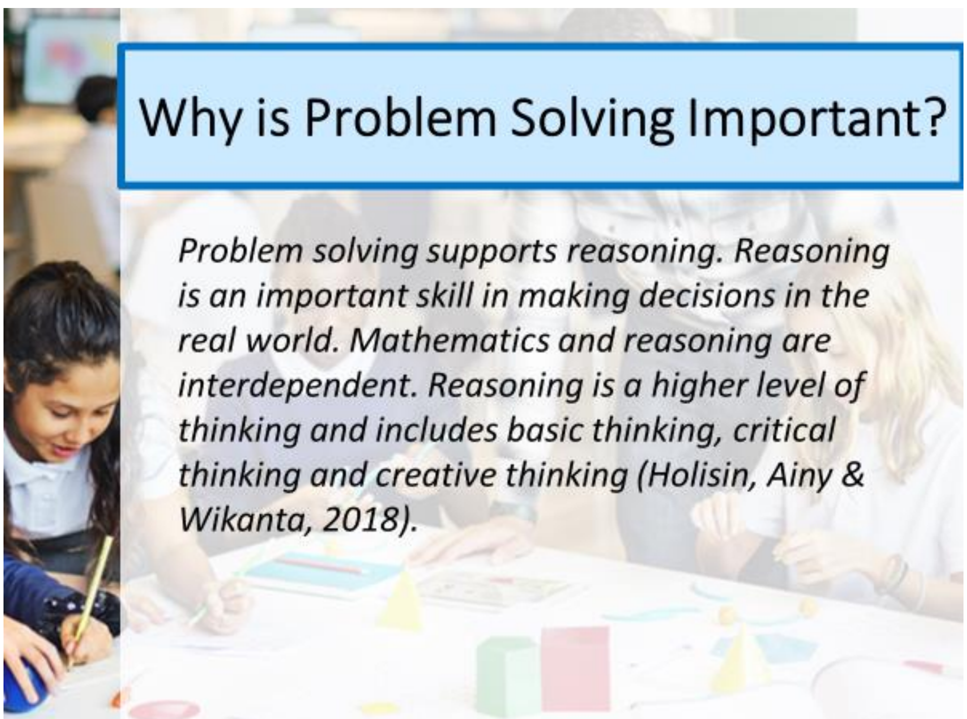

What is Problem Solving in Mathematics?
In 2012, The College and Career Readiness Mathematical Standards in Texas incorporated the NCTM Process Standards of problem solving, reasoning and proof, communication, representation, and connections into the TEKS.
Problem solving in classrooms is expected to incorporate student collaboration and discourse.

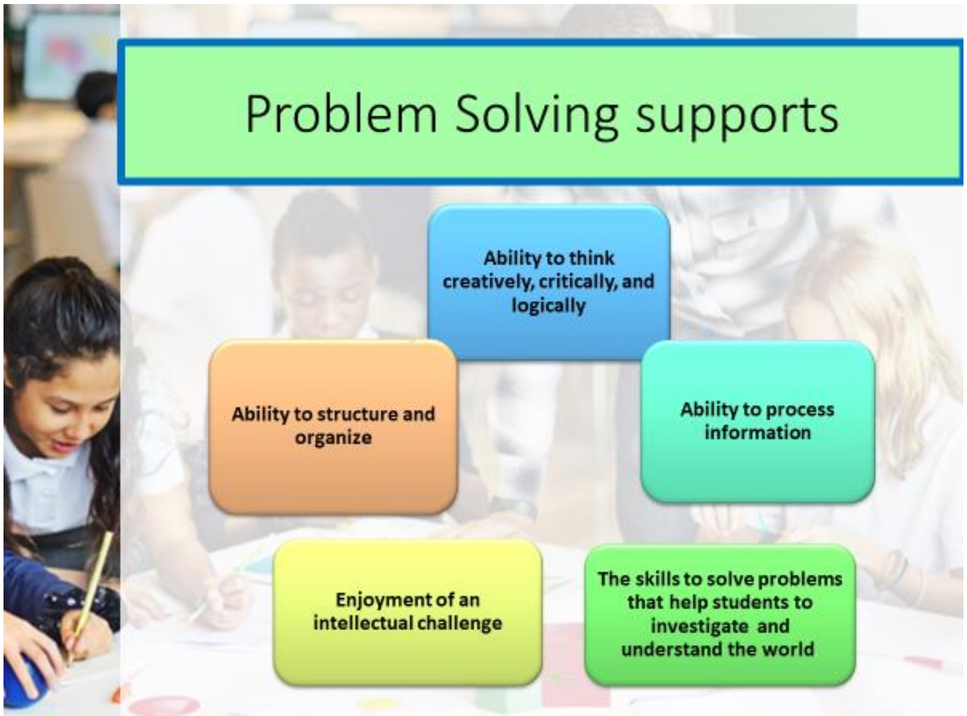

MATHEMATICAL PROCESS STANDARDS (TEKS)
The student uses mathematical processes to ACQUIRE and DEMONSTRATE mathematical understanding.
The student is expected to:
A
APPLY mathematics to problems arising in everyday life, society, and the workplace
B
USE a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution
C
SELECT tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems
D
COMMUNICATE mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate
E
CREATE and USE representations to organize, record, and communicate mathematical ideas
F
ANALYZE mathematical relationships to connect and communicate mathematical ideas
G
DISPLAY, EXPLAIN, and JUSTIFY mathematical ideas and arguments using precise mathematical language in written or oral communication.
Math Process Standards
REGION 11

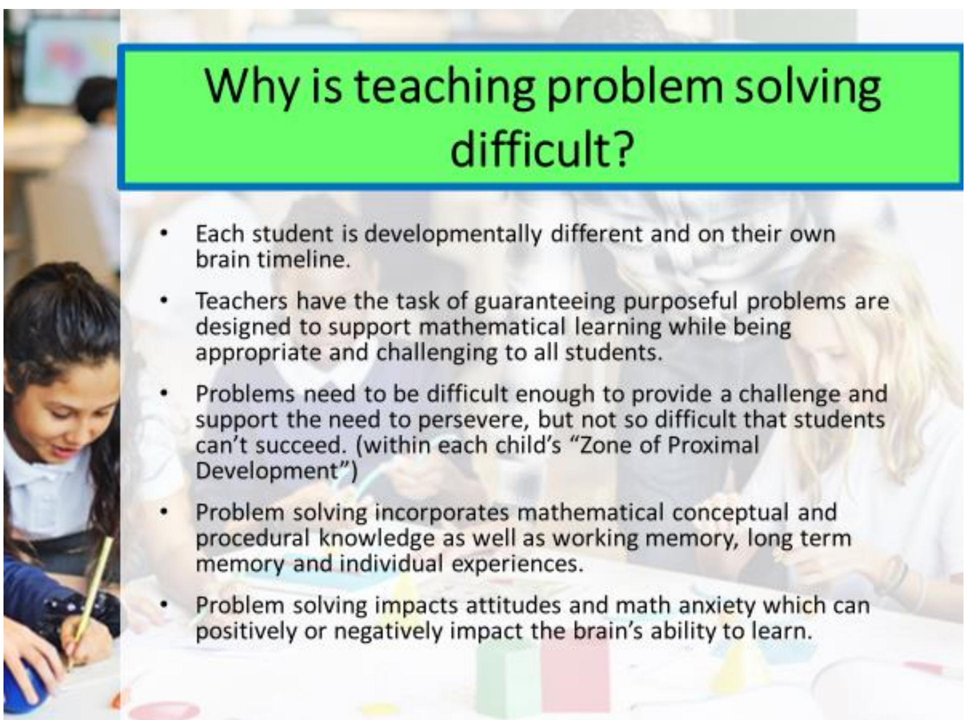

Universal Beliefs About Effective Teaching of Mathematics
❑ Every student's identity, language, and culture need to be respected and valued.
❑ Every student has the right to access effective mathematics education.
❑ Every student can become a successful learner of mathematics.

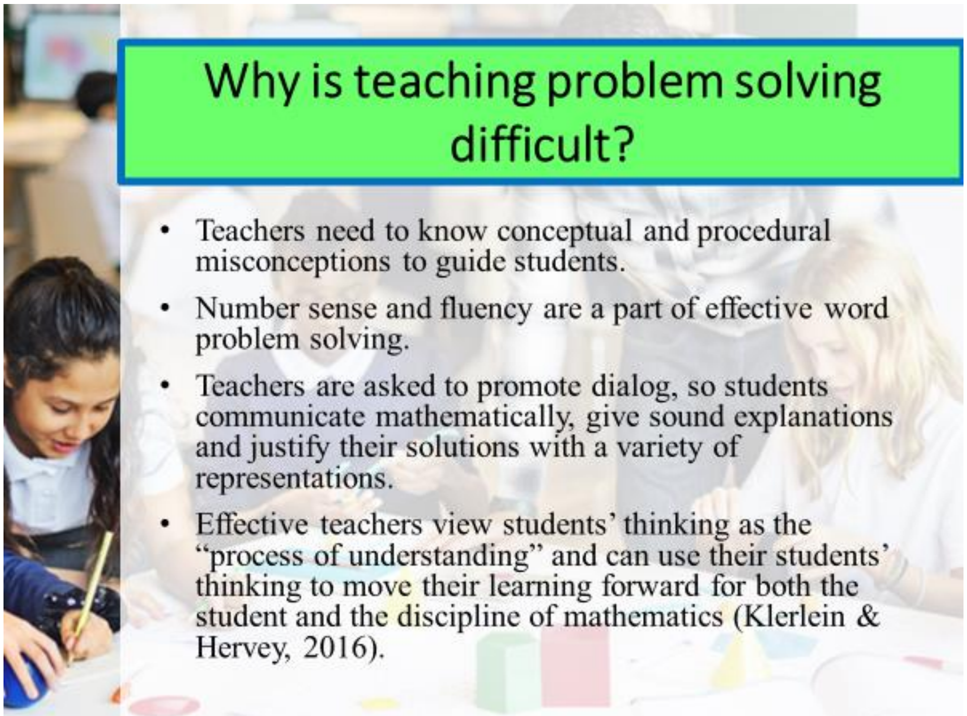

How Does a Student Learn To Problem Solve?
Students actively learn mathematics developmentally through "doing, talking, reflecting, discussing, observing, investigating, listening and reasoning" (Copley, 2000, p. 29).
Learning takes place within social settings (Vygotsky, 1978).
Students construct knowledge by taking risks, talking about problems, discussing their thinking, trying new strategies and acquiring language through making sense of their experiences.

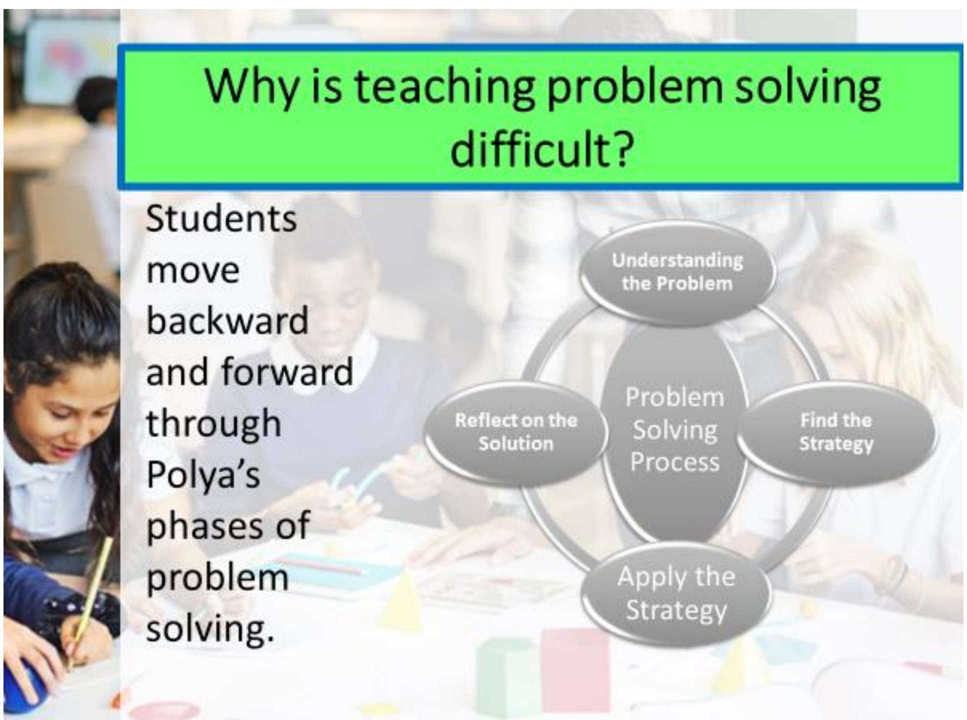

Why is Problem Solving Important?
✓ Problem solving processes and the right to use these strategies equips students for life beyond school (Cobb & Hodge, 2002).
✓ The importance of problem-solving in learning mathematics comes from the belief that mathematics is mainly about reasoning, not memorization.
✓ It is through problem solving that students develop a deeper understanding and become more engaged and grow the relevance and usefulness of mathematics (Wu &Zhang, 2006).

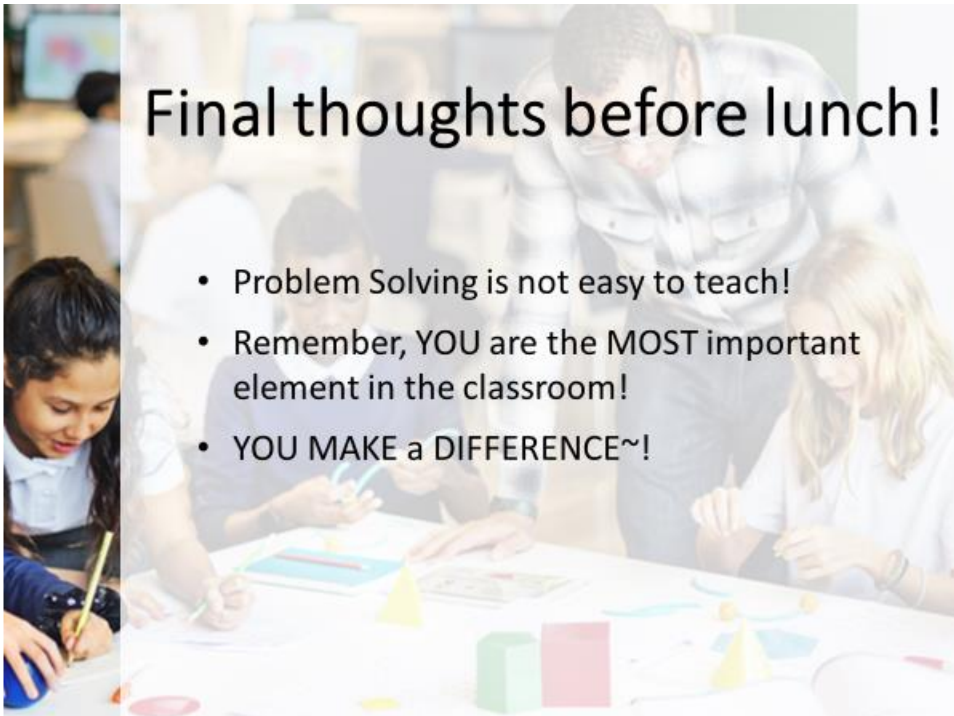

Why is Problem Solving Important?
Problem solving supports reasoning. Reasoning is an important skill in making decisions in the real world. Mathematics and reasoning are interdependent. Reasoning is a higher level of thinking and includes basic thinking, critical thinking and creative thinking (Holisin, Ainy & Wikanta, 2018).


Problem Solving supports
Ability to think creatively, critically, and logically
Ability to structure and organize
Ability to process information
Enjoyment of an intellectual challenge
The skills to solve problems that help students to investigate and understand the world

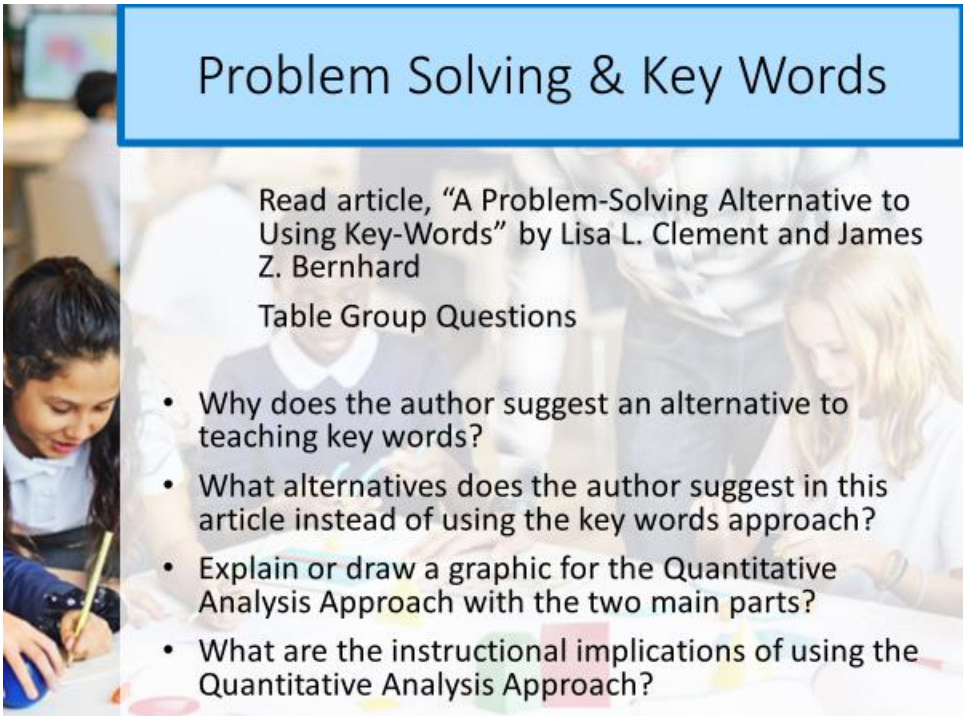

Why is teaching problem solving difficult?
Each student is developmentally different and on their own brain timeline.
Teachers have the task of guaranteeing purposeful problems are designed to support mathematical learning while being appropriate and challenging to all students.
Problems need to be difficult enough to provide a challenge and support the need to persevere, but not so difficult that students can't succeed. (within each child's "Zone of Proximal Development")
Problem solving incorporates mathematical conceptual and procedural knowledge as well as working memory, long term memory and individual experiences.
Problem solving impacts attitudes and math anxiety which can positively or negatively impact the brain's ability to learn.

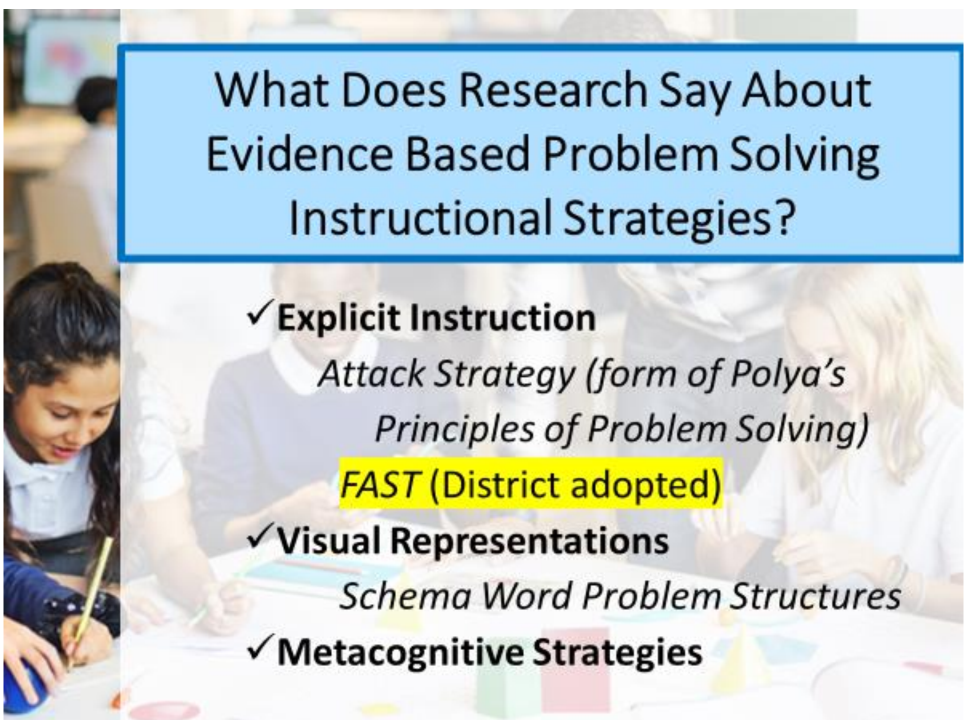

Why is teaching problem solving difficult?
• Teachers need to know conceptual and procedural misconceptions to guide students.
• Number sense and fluency are a part of effective word problem solving.
• Teachers are asked to promote dialog, so students communicate mathematically, give sound explanations and justify their solutions with a variety of representations.
• Effective teachers view students' thinking as the "process of understanding" and can use their students' thinking to move their learning forward for both the student and the discipline of mathematics (Klerlein & Hervey, 2016).

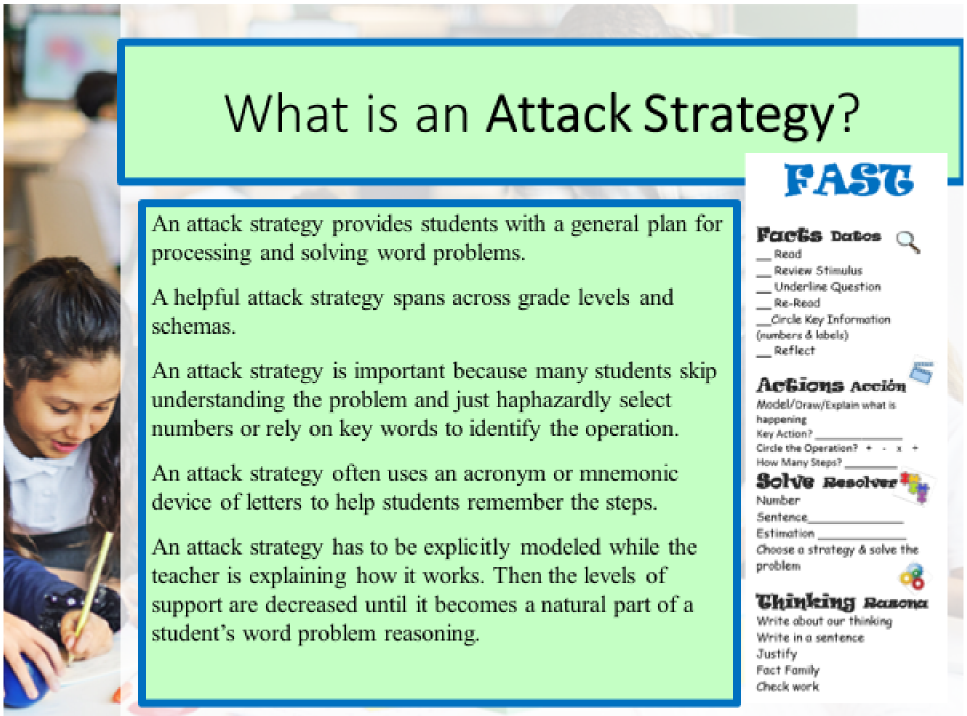

Why is teaching problem solving difficult?
Students move backward and forward through Polya's phases of problem solving.
Understanding the Problem
Find the Strategy
Apply the Strategy
Reflect on the Solution
Problem Solving Process

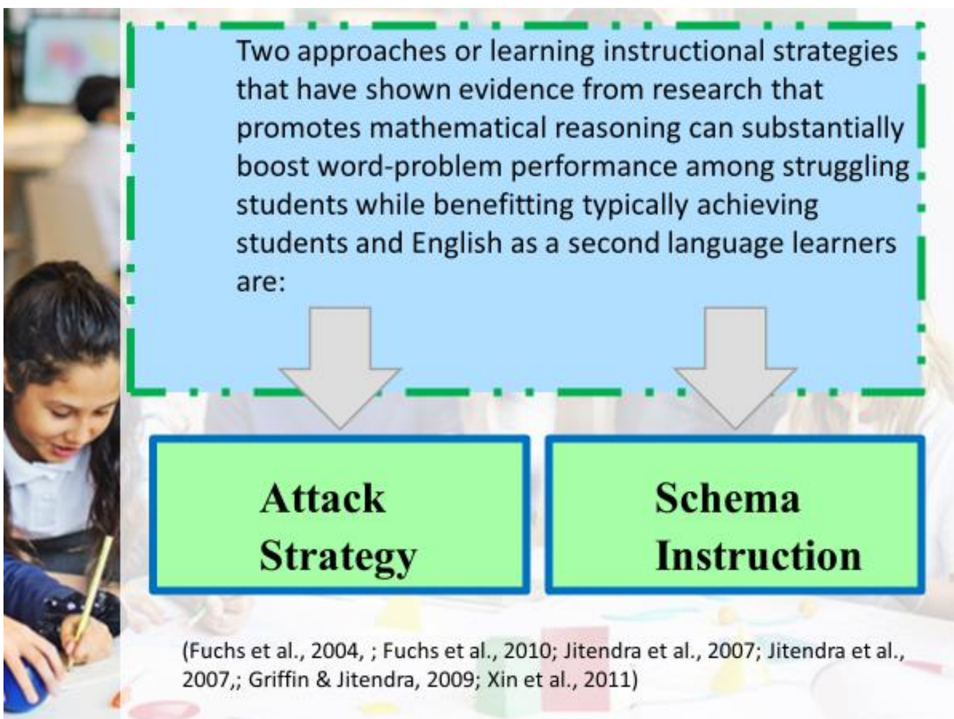

Final thoughts before lunch!
• Problem Solving is not easy to teach!
• Remember, YOU are the MOST important element in the classroom!
• YOU MAKE a DIFFERENCE~!


Lunch!
LUNCH
BREAK

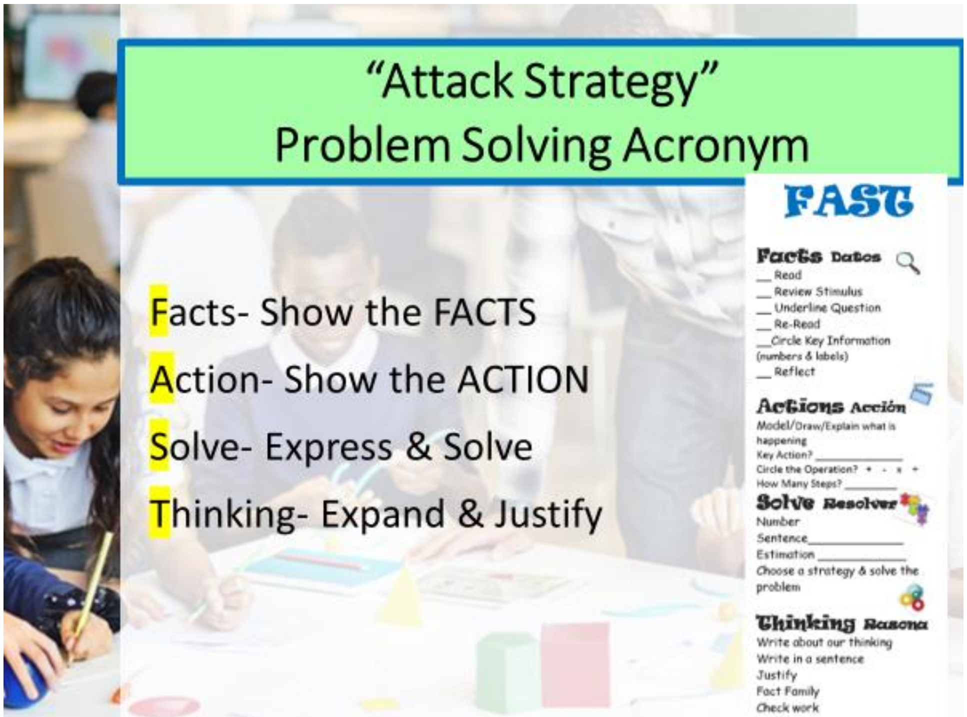

Problem Solving & Key Words
Read article, "A Problem-Solving Alternative to Using Key-Words" by Lisa L. Clement and James Z. Bernhard
Table Group Questions
• Why does the author suggest an alternative to teaching key words?
• What alternatives does the author suggest in this article instead of using the key words approach?
• Explain or draw a graphic for the Quantitative Analysis Approach with the two main parts?
• What are the instructional implications of using the Quantitative Analysis Approach?


What Does Research Say About Evidence Based Problem Solving Instructional Strategies?
✓Explicit Instruction
Attack Strategy (form of Polya's Principles of Problem Solving)
FAST (District adopted)
✓Visual Representations
Schema Word Problem Structures
✓Metacognitive Strategies

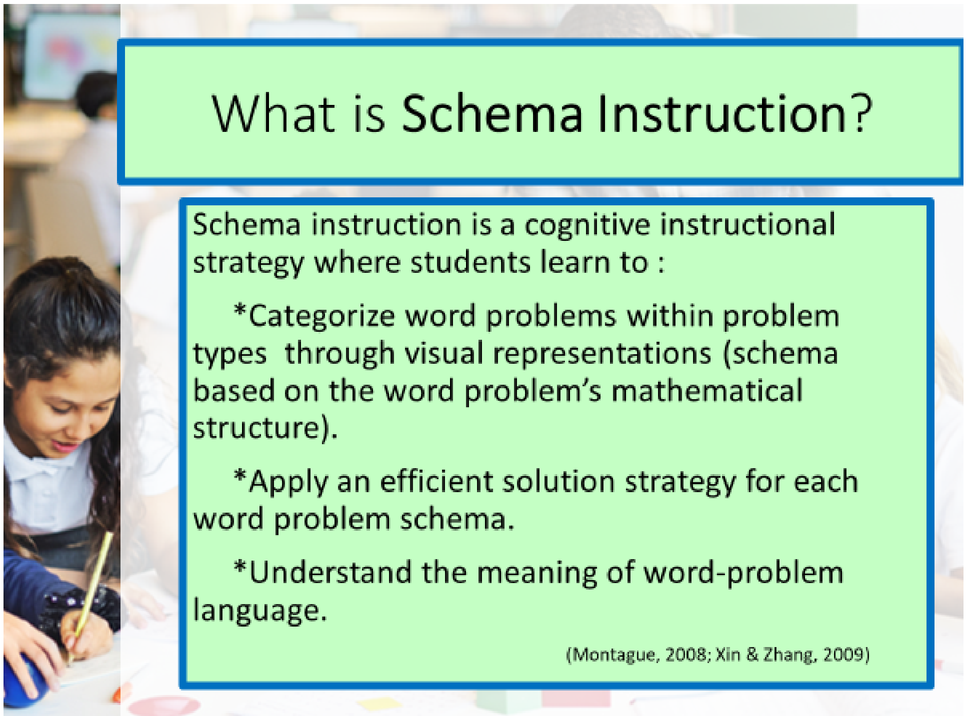

What is an Attack Strategy?
An attack strategy provides students with a general plan for processing and solving word problems.
A helpful attack strategy spans across grade levels and schemas.
An attack strategy is important because many students skip understanding the problem and just haphazardly select numbers or rely on key words to identify the operation.
An attack strategy often uses an acronym or mnemonic device of letters to help students remember the steps.
An attack strategy has to be explicitly modeled while the teacher is explaining how it works. Then the levels of support are decreased until it becomes a natural part of a student's word problem reasoning.
FAST
Facts Datos
__ Read
__ Review Stimulus
__ Underline Question
__ Re-Read
__ Circle Key Information (numbers & labels)
__ Reflect
Actions Acción
Model/Draw/Explain what is happening
Key Action? ________
Circle the Operation? + - x ÷
How Many Steps? ______
Solve Resolver
Number
Sentence________
Estimation ________
Choose a strategy & solve the problem
Thinking Razona
Write about our thinking
Write in a sentence
Justify
Fact Family
Check work

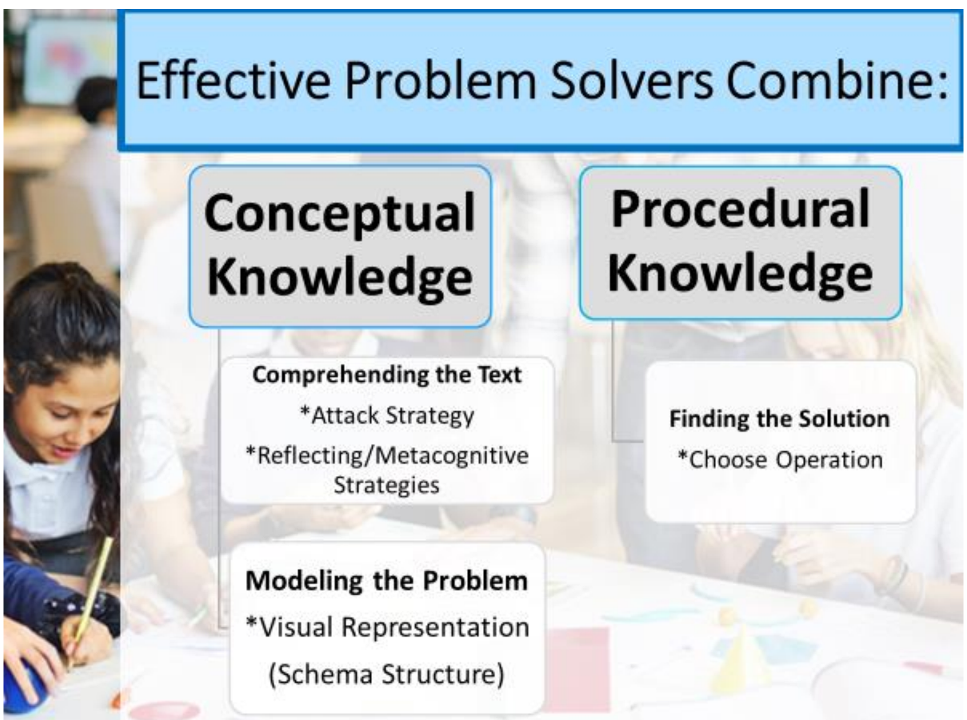

Two approaches or learning instructional strategies that have shown evidence from research that promotes mathematical reasoning can substantially boost word-problem performance among struggling students while benefitting typically achieving students and English as a second language learners are:
Attack Strategy
Schema Instruction
(Fuchs et al., 2004, ; Fuchs et al., 2010; Jitendra et al., 2007; Jitendra et al., 2007,; Griffin & Jitendra, 2009; Xin et al., 2011)

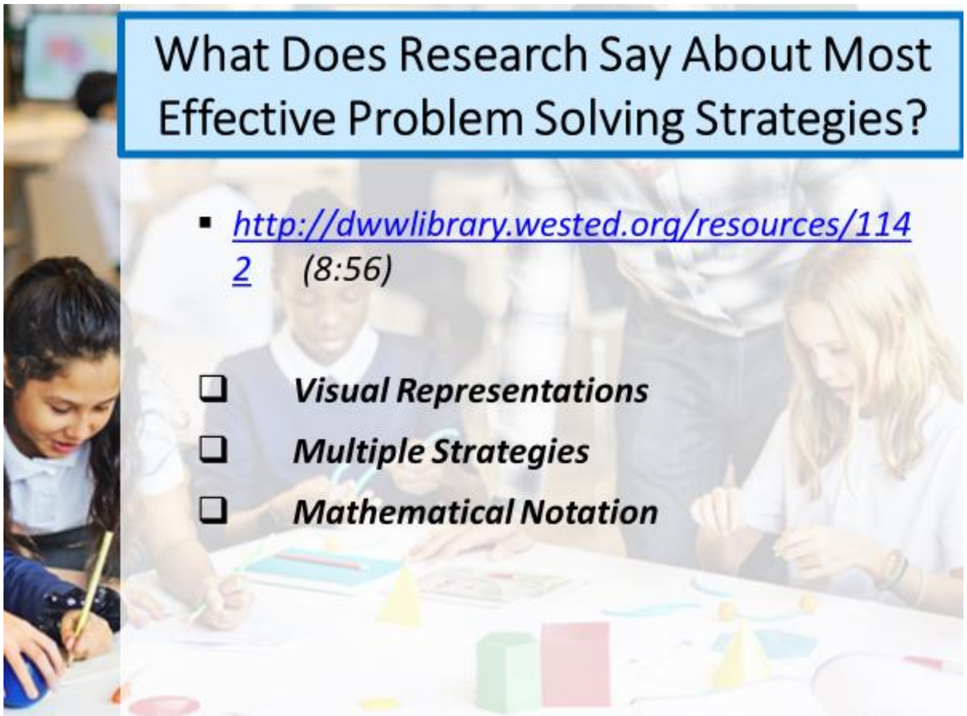

What is an Attack Strategy?
First Phase
Involves interpreting the word problem's meaning
*Read the problem
*Identify the question
*Determine the central idea (the schema or problem type)
Second Phase
Finding the Missing Quantity
* Using a graphic organizer/visual representation
*Performing the calculation
*Labeling the number answer
*Checking to make sure the answer makes sense
FAST
Facts Datos
__ Read
__ Review Stimulus
__ Underline Question
__ Re-Read
__ Circle Key Information (numbers & labels)
__ Reflect
Actions Acción
Model/Draw/Explain what is happening
Key Action? ____________
Circle the Operation? + - x ÷
How Many Steps? ________
Solve Resolver
Number
Sentence____________
Estimation ____________
Choose a strategy & solve the problem
Thinking Razona
Write about our thinking
Write in a sentence
Justify
Fact Family
Check work

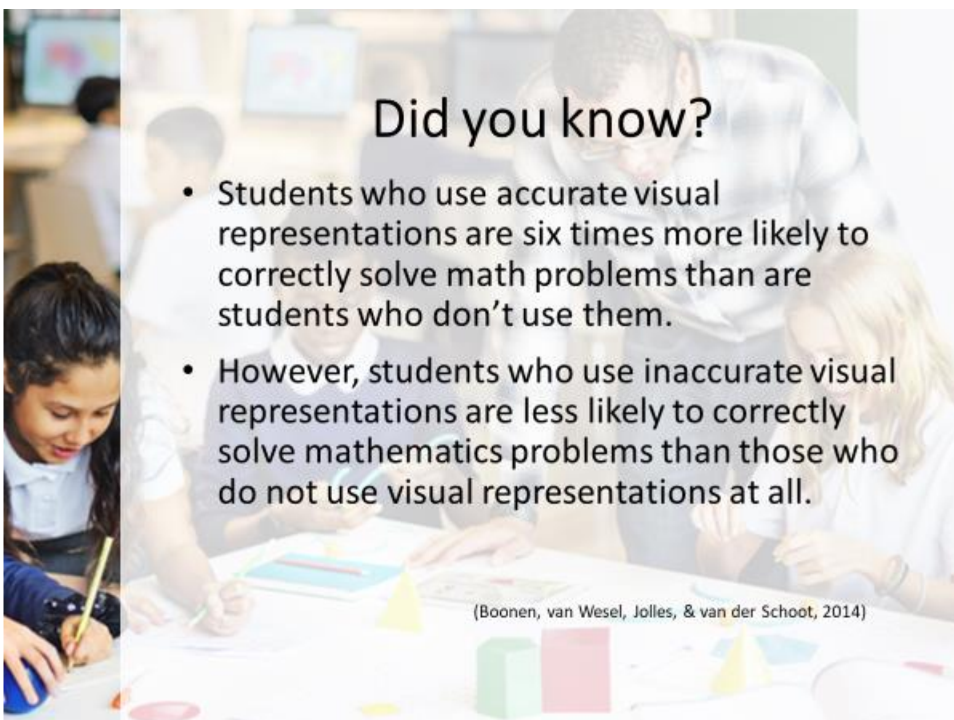

"Attack Strategy"
Problem Solving Acronym
Facts- Show the FACTS
Action- Show the ACTION
Solve- Express & Solve
Thinking- Expand & Justify
FAST
Facts Datos
__ Read
__ Review Stimulus
__ Underline Question
__ Re-Read
__Circle Key Information (numbers & labels)
__ Reflect
Actions Acción
Model/Draw/Explain what is happening
Key Action? ____________
Circle the Operation? + - x ÷
How Many Steps? ________
Solve Resolver
Number
Sentence____________
Estimation ____________
Choose a strategy & solve the problem
Thinking Razona
Write about our thinking
Write in a sentence
Justify
Fact Family
Check work


Break
15 MINUTE
RELAXING
COUNTDOWN
TIMER


What is Schema Instruction?
Schema instruction is a cognitive instructional strategy where students learn to :
*Categorize word problems within problem types through visual representations (schema based on the word problem's mathematical structure).
*Apply an efficient solution strategy for each word problem schema.
*Understand the meaning of word-problem language.
(Montague, 2008; Xin & Zhang, 2009)


Effective Problem Solvers Combine:
Conceptual Knowledge
Procedural Knowledge
Comprehending the Text
*Attack Strategy
*Reflecting/Metacognitive Strategies
Modeling the Problem
*Visual Representation
(Schema Structure)
Finding the Solution
*Choose Operation


What Does Research Say About Most Effective Problem Solving Strategies?
http://dwwlibrary.wested.org/resources/1142 (8:56)
Visual Representations
Multiple Strategies
Mathematical Notation


Did you know?
Students who use accurate visual representations are six times more likely to correctly solve math problems than are students who don't use them.
However, students who use inaccurate visual representations are less likely to correctly solve mathematics problems than those who do not use visual representations at all.
(Boonen, van Wesel, Jolles, & van der Schoot, 2014)

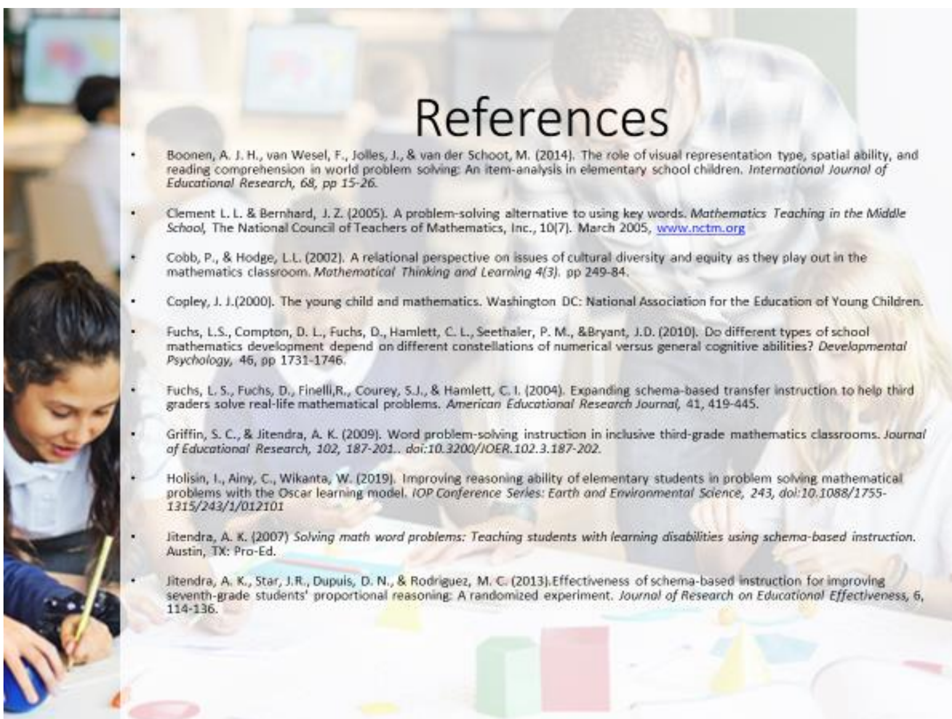
Exploration

Description of Resources	Website
Math vocabulary cards with visuals	http://www.ncesd.org/Page/983
What Works Clearinghouse Practice Guides for Math	http://ies.ed.gov/ncee/wwcPublications_Reviews.aspx?f=All%20Publication%20and%20Product%20Types,3;#pubsearch
Math Tools	http://www.mathlanding.org/collectionspd_collection/strategies-teaching-studentstruggling-mathematics http://nlvm.usu.edu/
Virtual Manipulatives	http://www.glencoe.com/sites/common_assets/mathematics/ebook_assets/vmf/VMFInterface.html
Word problems with Bar Models	http://www.playground.com/thinkingblocks.html

Day 2 Share & Evaluation

- Share out what was helpful during your exploration time.
- Please complete Day 2 Evaluation


Questions?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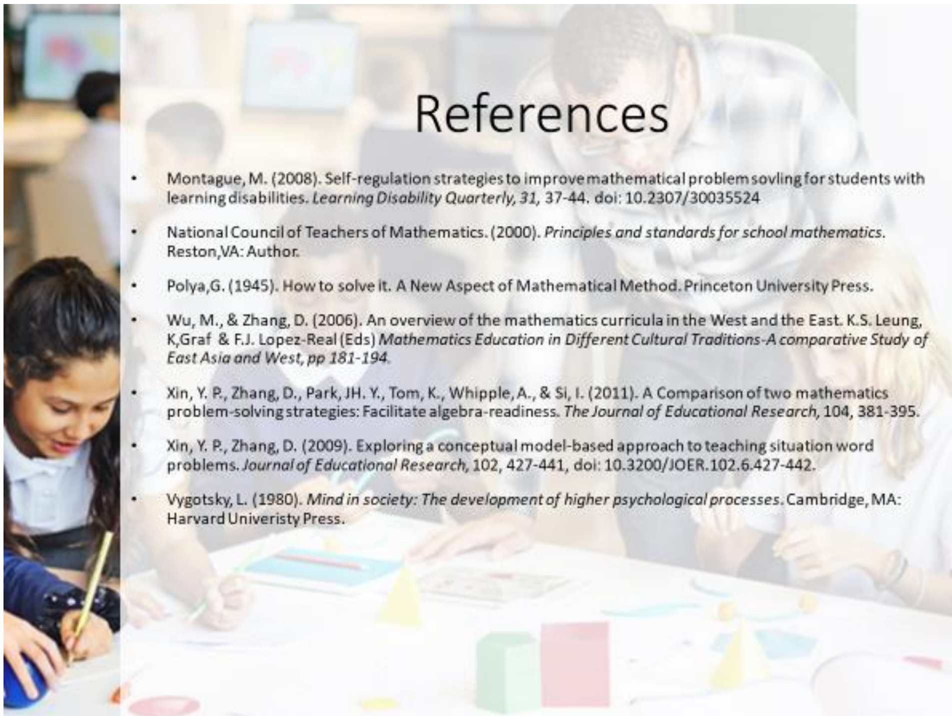
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• Xin, Y. P., Zhang, D. (2009). Exploring a conceptual model-based approach to teaching situation word problems. Journal of Educational Research, 102, 427-441, doi: 10.3200/JOER.102.6.427-442.
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Day 3 Problem Solving Graphic Representation Structures & Application

8:30-9:00 Welcome, Setting the Norms, Goals for Today

Facilitator presents “What is Schema Instruction?”-Frames 1-4

9:00-10:00 Presentation “Why should you teach problem solving using schema structure?

Frames 5-10, Categories of Schema Instruction

Total Structure- Frames 8-10

10:00-10:15 Break

10:15-11:15 Difference Structure -Frames 12-17

11:15-12:15 Lunch Break

12:15-1:15 Change Structure -Frames 19-24

1:15-2:00 Let’s Practice and Sort Structures-Frames 25-29

Handouts

2:00-2:15 Break

2:15-3:00 Multiplicative Schema Structures-Frames 31-44

Equal Groups

Comparison

Ratios/Proportions

Teaching Schemas

More About Schemas

Review About Teaching Problem Solving

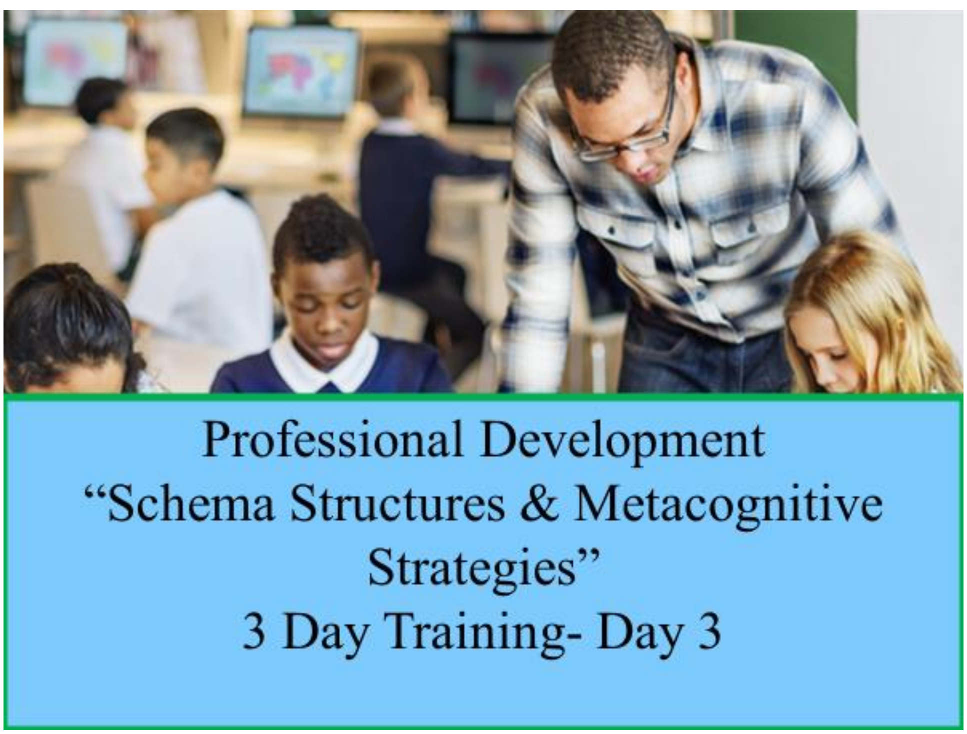
3:00-3:30 Teaching Metacognitive Strategies

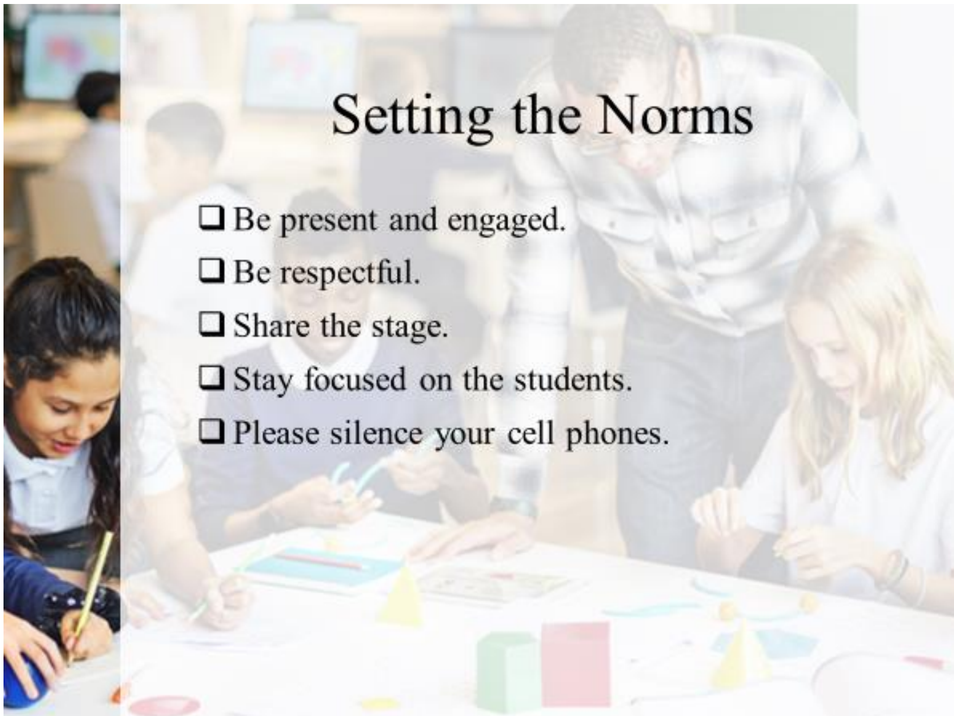
Facilitator presents "Teaching Metacognitive Strategies for Problem Solving"

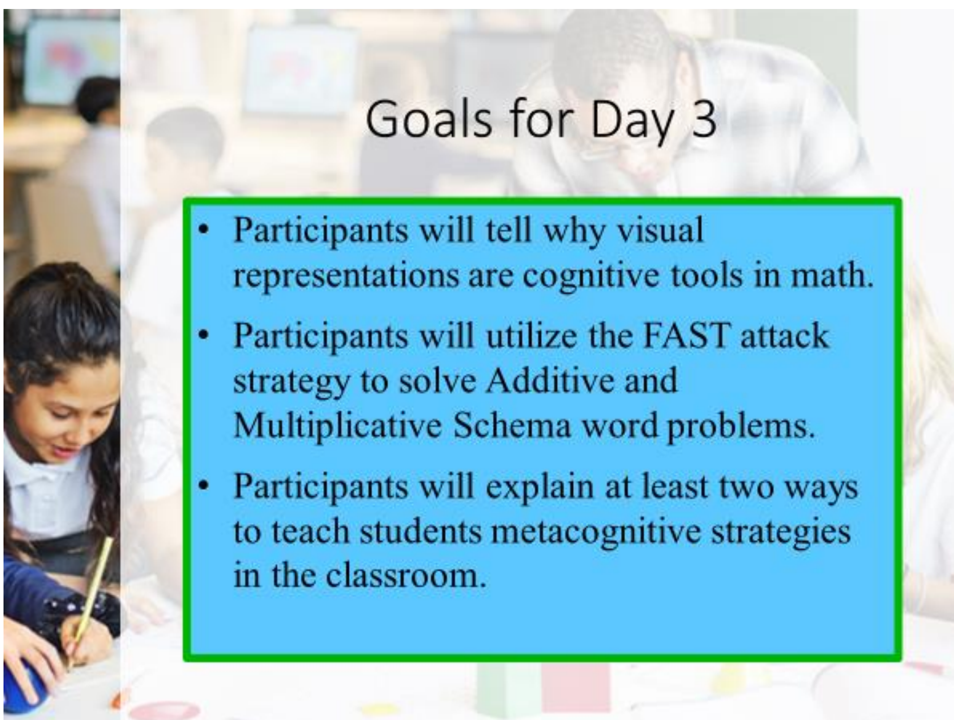
Show video "Talking Through Problems and their Solutions" from https://dwwlibrary.wested.org/resources/1133 (4:58)

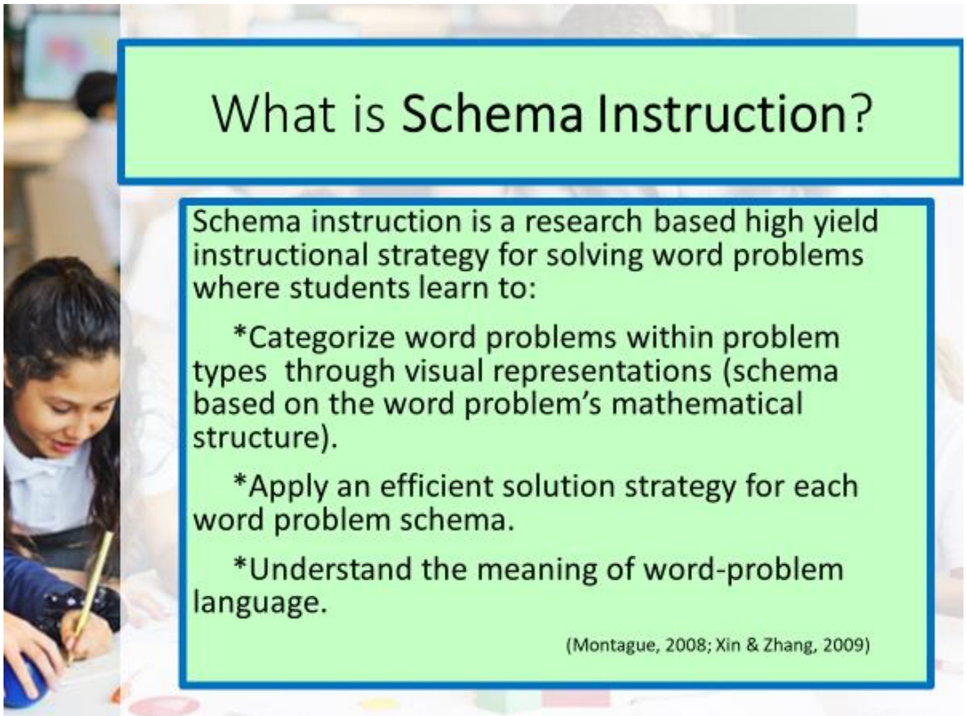
- Don't be afraid to allow students to get stuck and unstuck. Show video called "Learning and the Brain" http://learningandtheadolescentmind.org/resources_02_learning.html

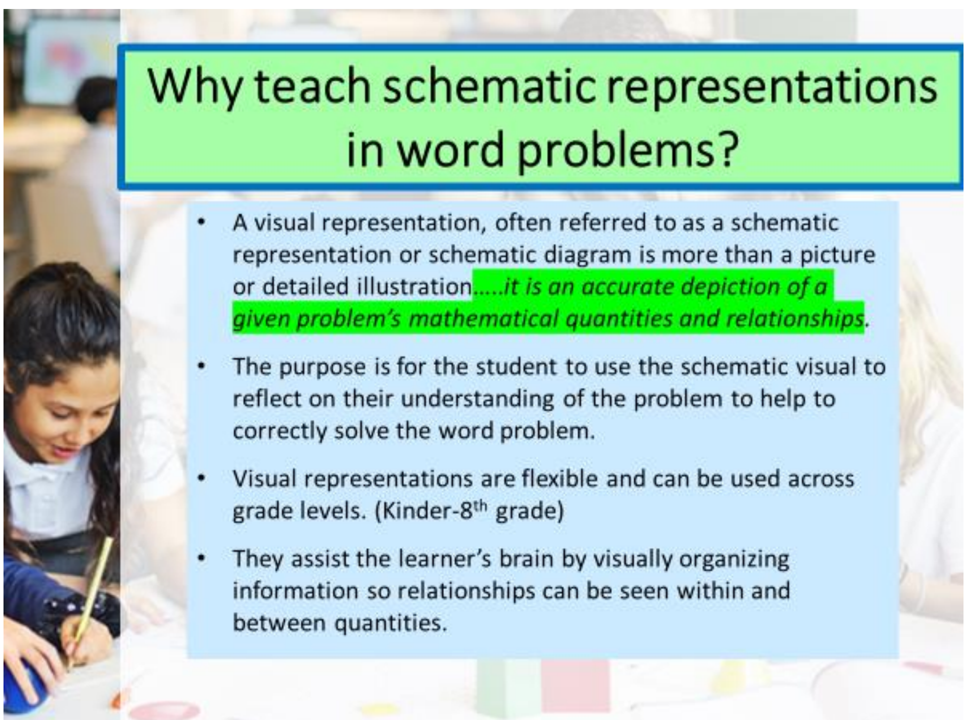
Three Day Workshop Evaluation

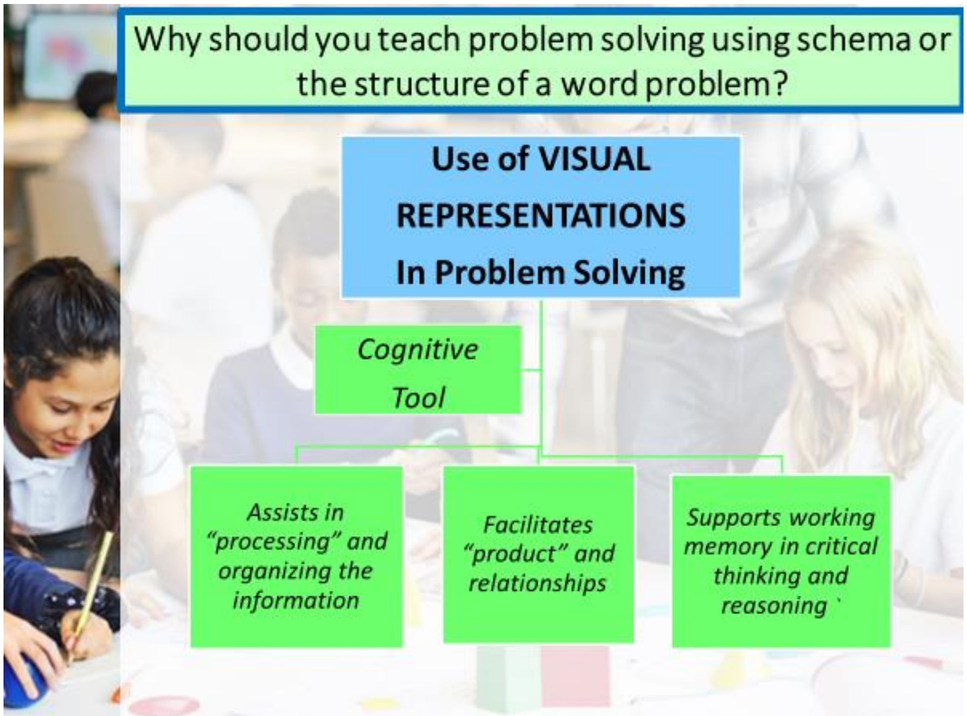


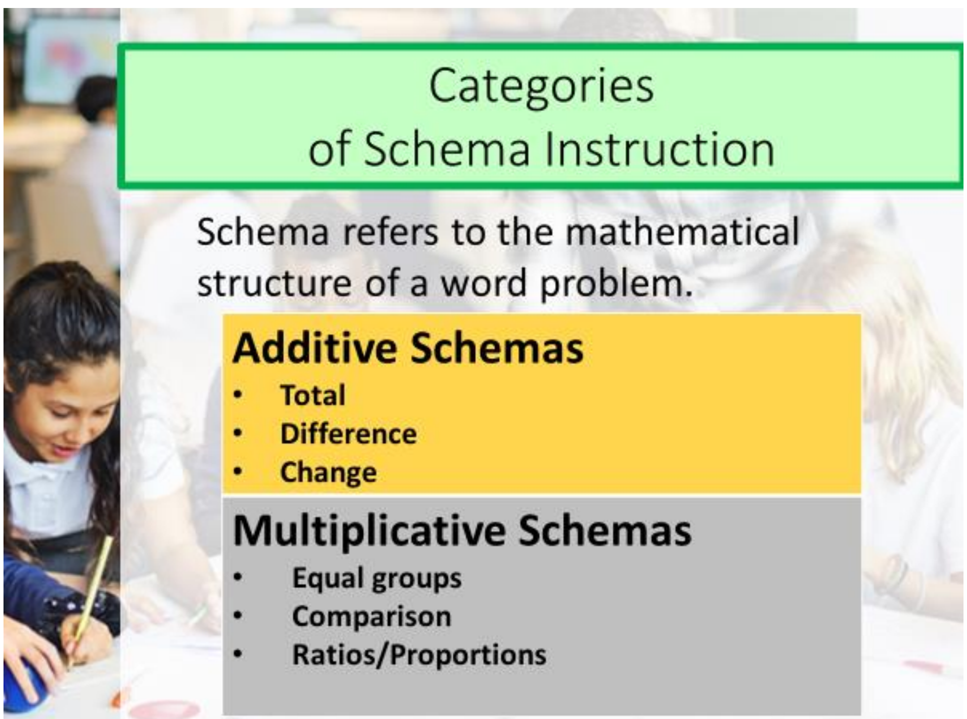

Setting the Norms
❑ Be present and engaged.
❑ Be respectful.
❑ Share the stage.
❑ Stay focused on the students.
❑ Please silence your cell phones.

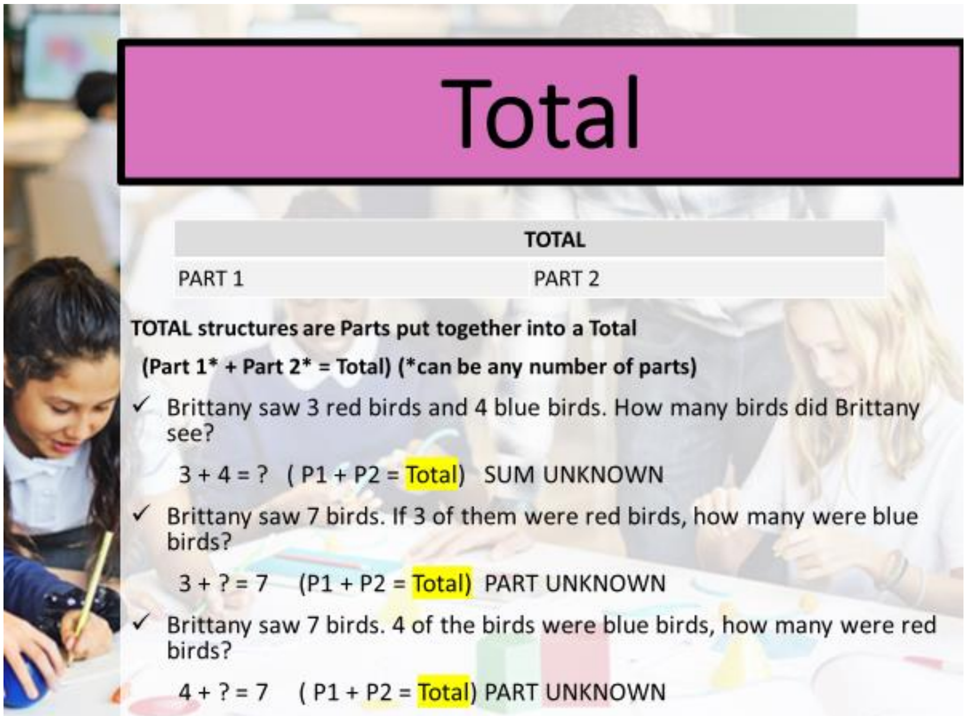

Goals for Day 3
• Participants will tell why visual representations are cognitive tools in math.
• Participants will utilize the FAST attack strategy to solve Additive and Multiplicative Schema word problems.
• Participants will explain at least two ways to teach students metacognitive strategies in the classroom.

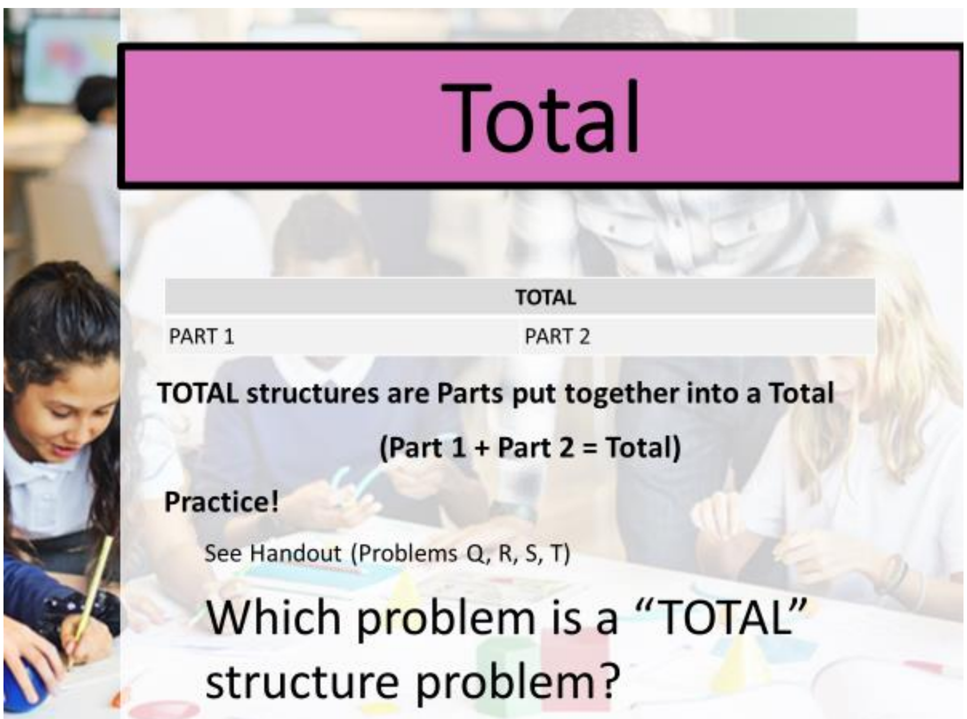

What is Schema Instruction?
Schema instruction is a research based high yield instructional strategy for solving word problems where students learn to:
*Categorize word problems within problem types through visual representations (schema based on the word problem's mathematical structure).
*Apply an efficient solution strategy for each word problem schema.
*Understand the meaning of word-problem language.
(Montague, 2008; Xin & Zhang, 2009)

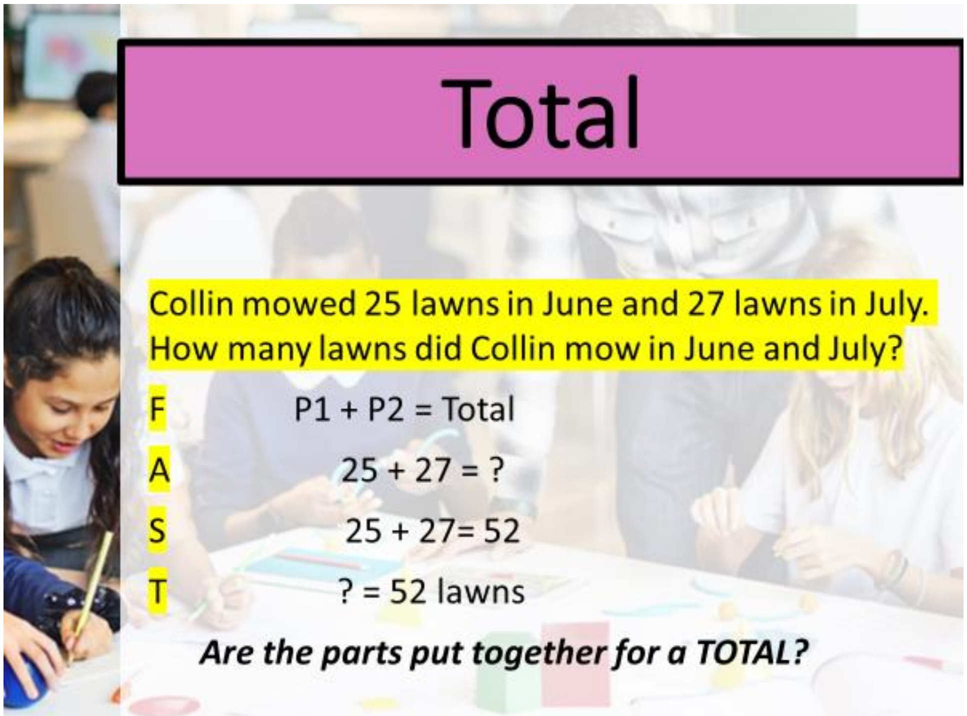

Why teach schematic representations in word problems?
• A visual representation, often referred to as a schematic representation or schematic diagram is more than a picture or detailed illustration.....it is an accurate depiction of a given problem's mathematical quantities and relationships.
• The purpose is for the student to use the schematic visual to reflect on their understanding of the problem to help to correctly solve the word problem.
• Visual representations are flexible and can be used across grade levels. (Kinder-8th grade)
• They assist the learner's brain by visually organizing information so relationships can be seen within and between quantities.

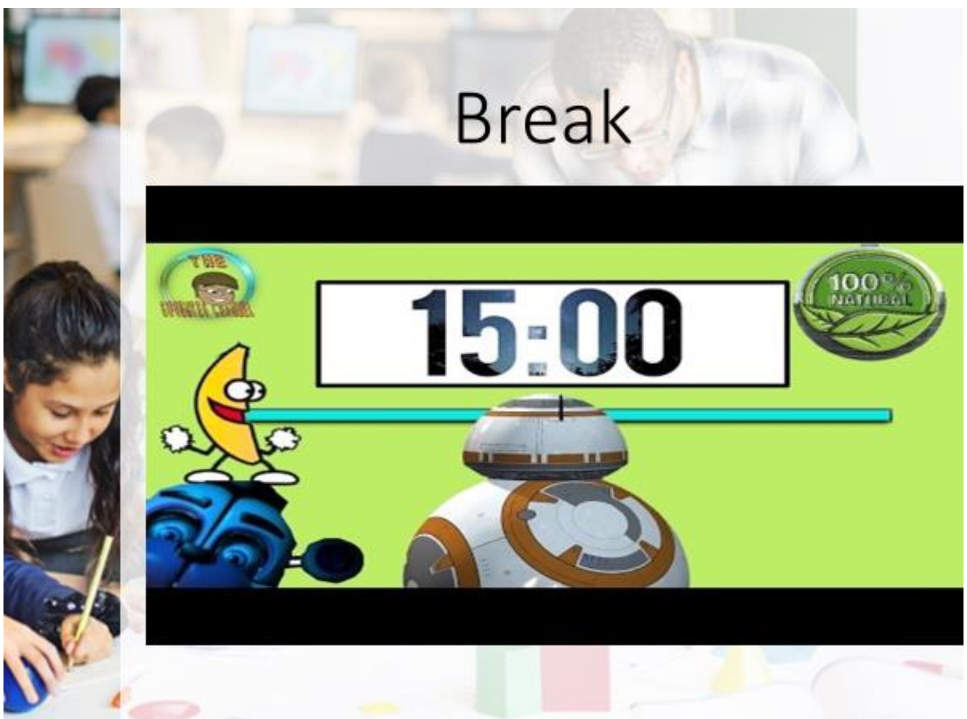

Why should you teach problem solving using schema or the structure of a word problem?
Use of VISUAL REPRESENTATIONS In Problem Solving
Cognitive Tool
Assists in "processing" and organizing the information
Facilitates "product" and relationships
Supports working memory in critical thinking and reasoning

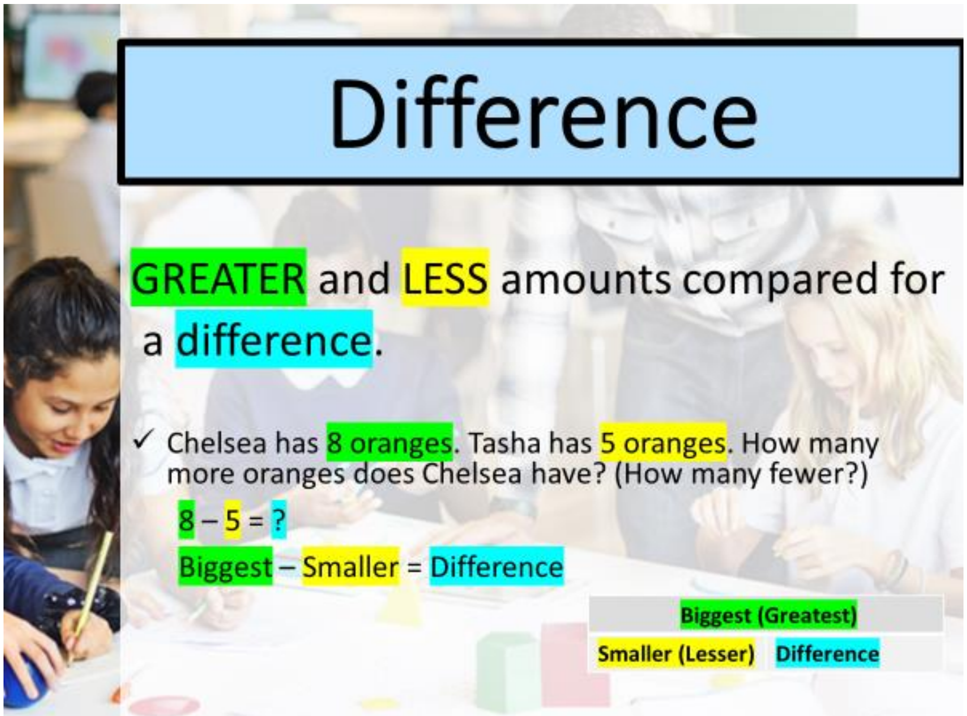

Categories of Schema Instruction
Schema refers to the mathematical structure of a word problem.
Additive Schemas
Total
Difference
Change
Multiplicative Schemas
Equal groups
Comparison
Ratios/Proportions

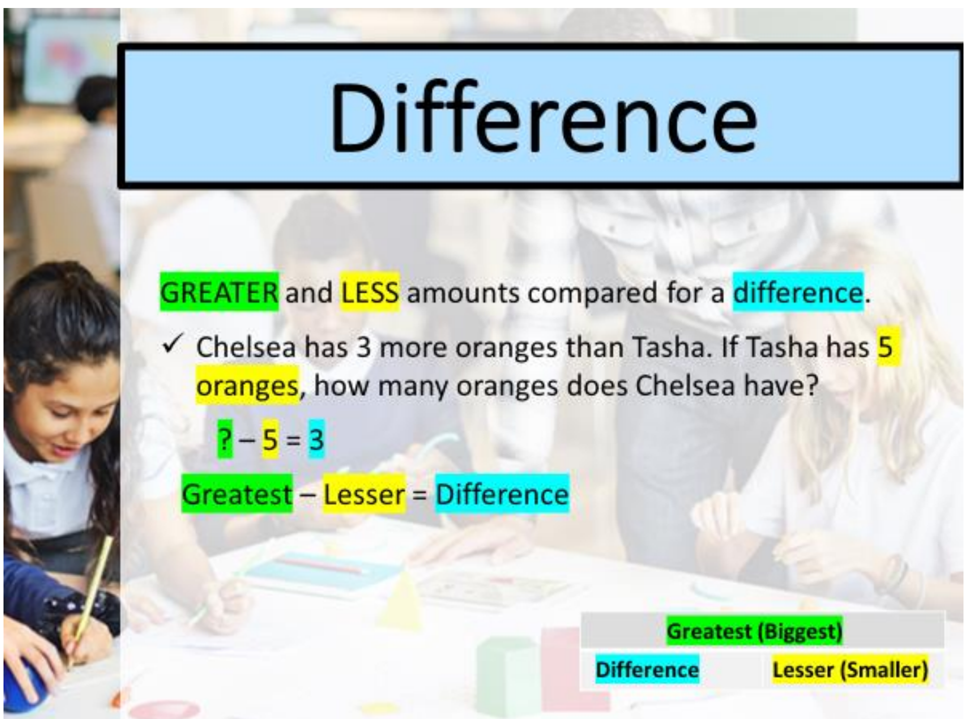

Total
TOTAL
PART 1
PART 2
TOTAL structures are Parts put together into a Total
(Part 1* + Part 2* = Total) (*can be any number of parts)
✓ Brittany saw 3 red birds and 4 blue birds. How many birds did Brittany see?
3 + 4 = ? (P1 + P2 = Total) SUM UNKNOWN
✓ Brittany saw 7 birds. If 3 of them were red birds, how many were blue birds?
3 + ? = 7 (P1 + P2 = Total) PART UNKNOWN
✓ Brittany saw 7 birds. 4 of the birds were blue birds, how many were red birds?
4 + ? = 7 (P1 + P2 = Total) PART UNKNOWN

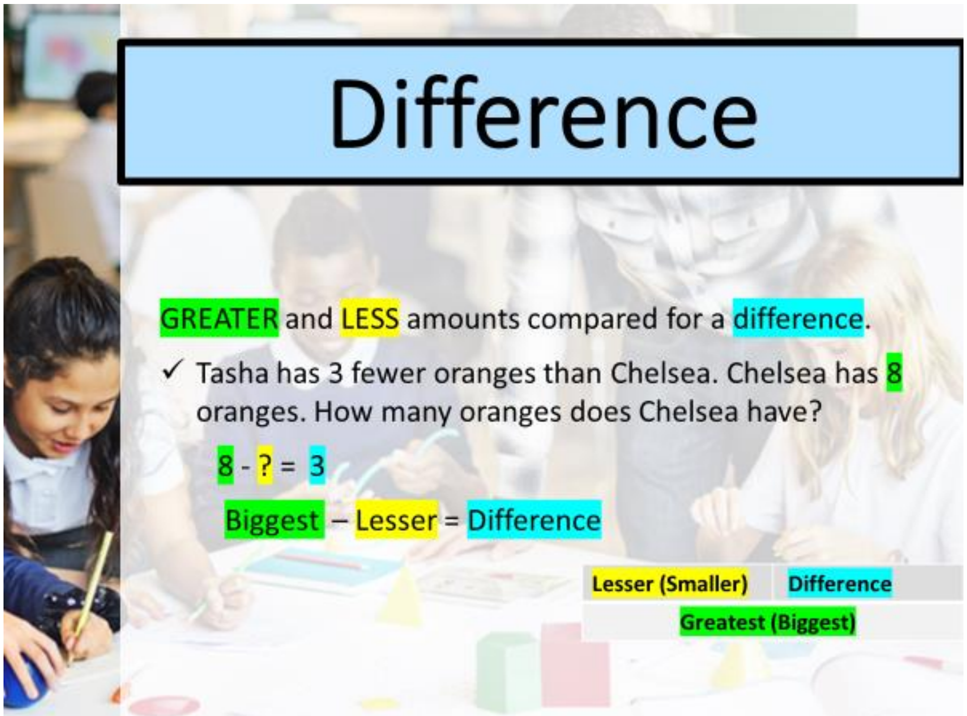

Total
TOTAL
PART 1
PART 2
TOTAL structures are Parts put together into a Total
(Part 1 + Part 2 = Total)
Practice!
See Handout (Problems Q, R, S, T)
Which problem is a "TOTAL" structure problem?

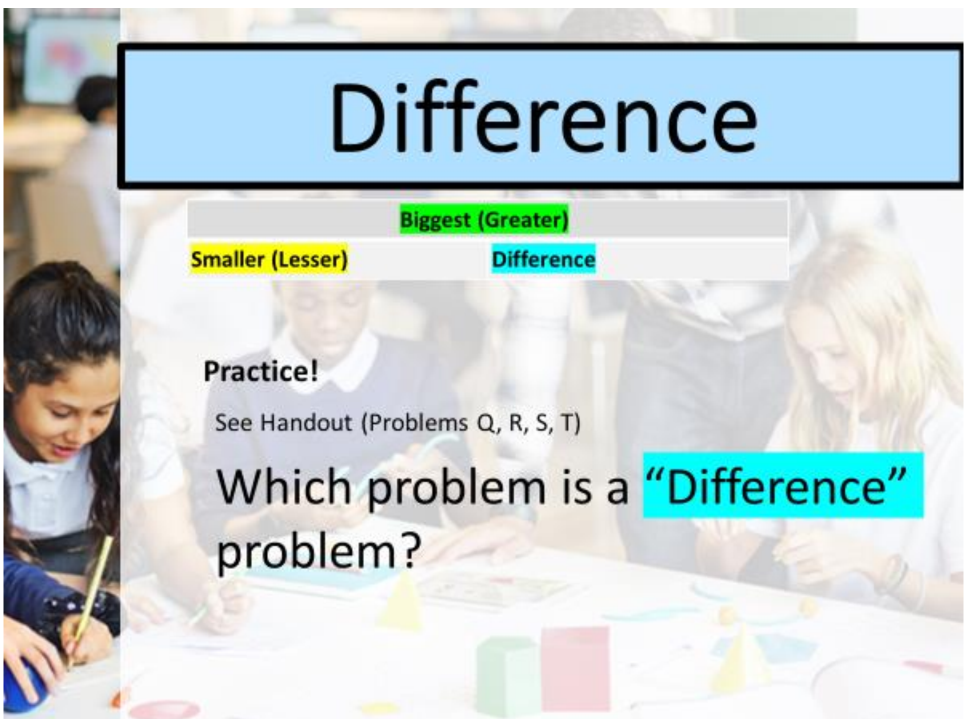

Total
Collin mowed 25 lawns in June and 27 lawns in July. How many lawns did Collin mow in June and July?
F P1 + P2 = Total
A 25 + 27 = ?
S 25 + 27= 52
T ? = 52 lawns
Are the parts put together for a TOTAL?

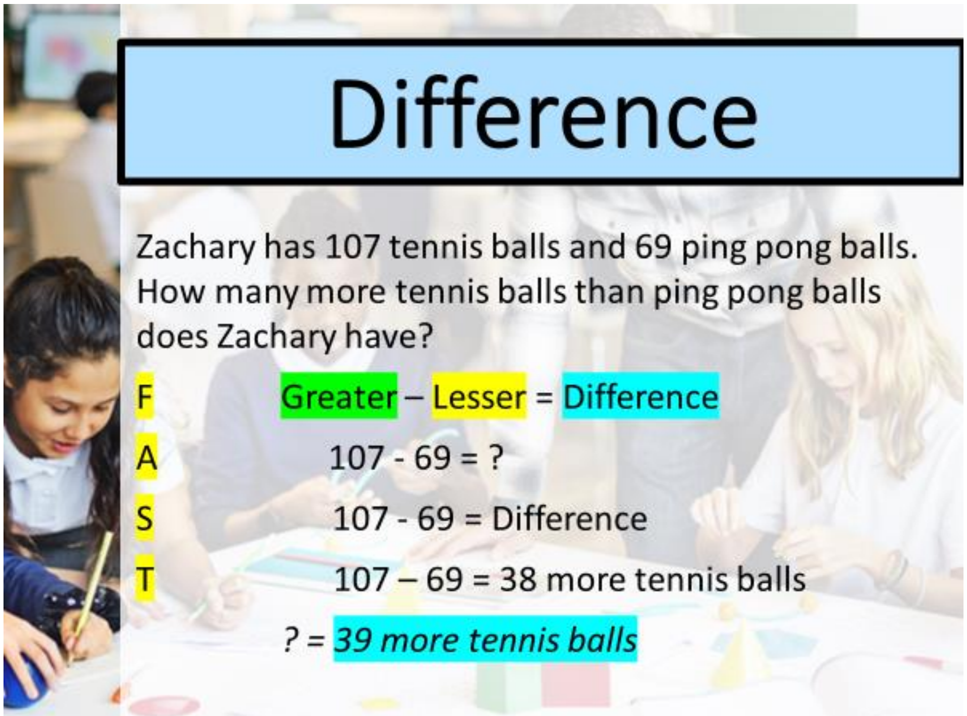

Break
15:00
100%
NATURAL

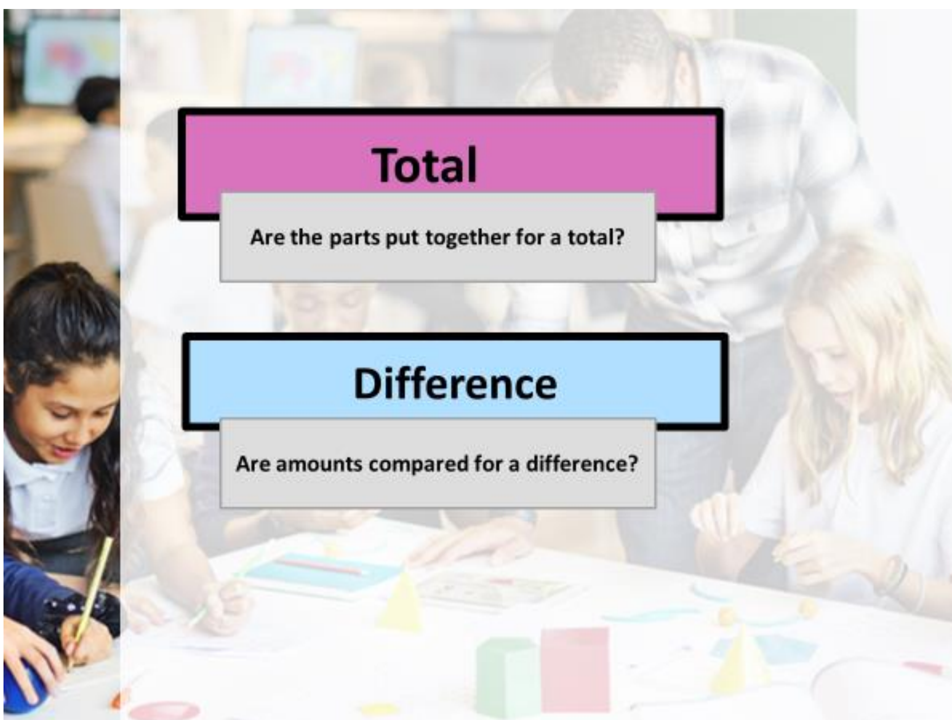

Difference
GREATER and LESS amounts compared for a difference.
✓ Chelsea has 8 oranges. Tasha has 5 oranges. How many more oranges does Chelsea have? (How many fewer?)
8 – 5 = ?
Biggest – Smaller = Difference
Biggest (Greatest)
Smaller (Lesser)
Difference


Difference
GREATER and LESS amounts compared for a difference.
✓ Chelsea has 3 more oranges than Tasha. If Tasha has 5 oranges, how many oranges does Chelsea have?
? – 5 = 3
Greatest – Lesser = Difference
Greatest (Biggest)
Difference
Lesser (Smaller)

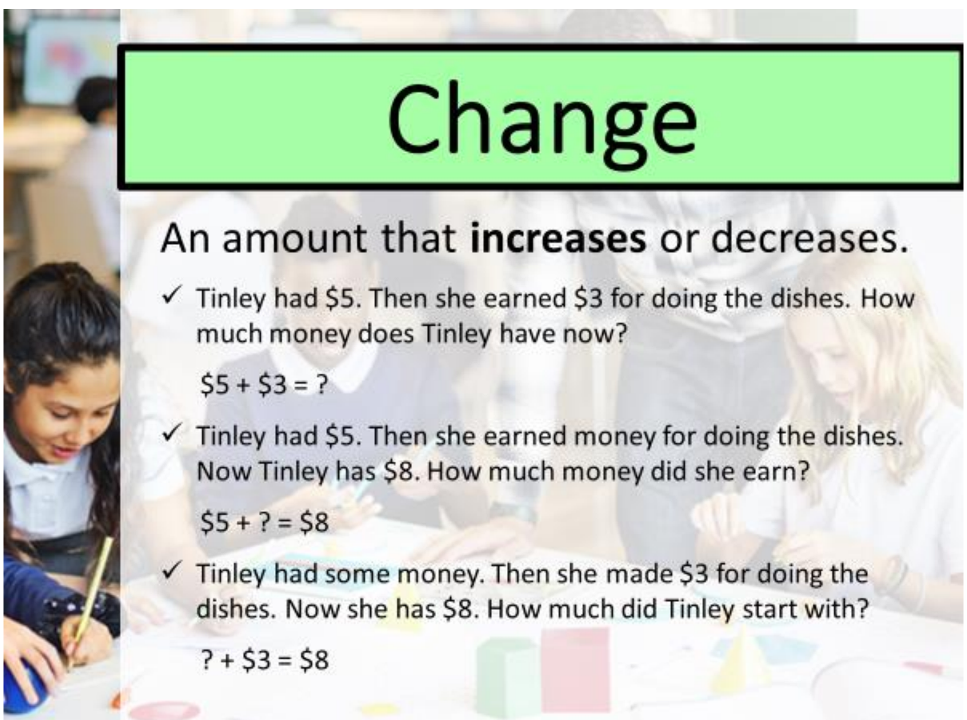

Difference
GREATER and LESS amounts compared for a difference.
✓ Tasha has 3 fewer oranges than Chelsea. Chelsea has 8 oranges. How many oranges does Chelsea have?
8 - ? = 3
Biggest – Lesser = Difference
Lesser (Smaller)
Difference
Greatest (Biggest)

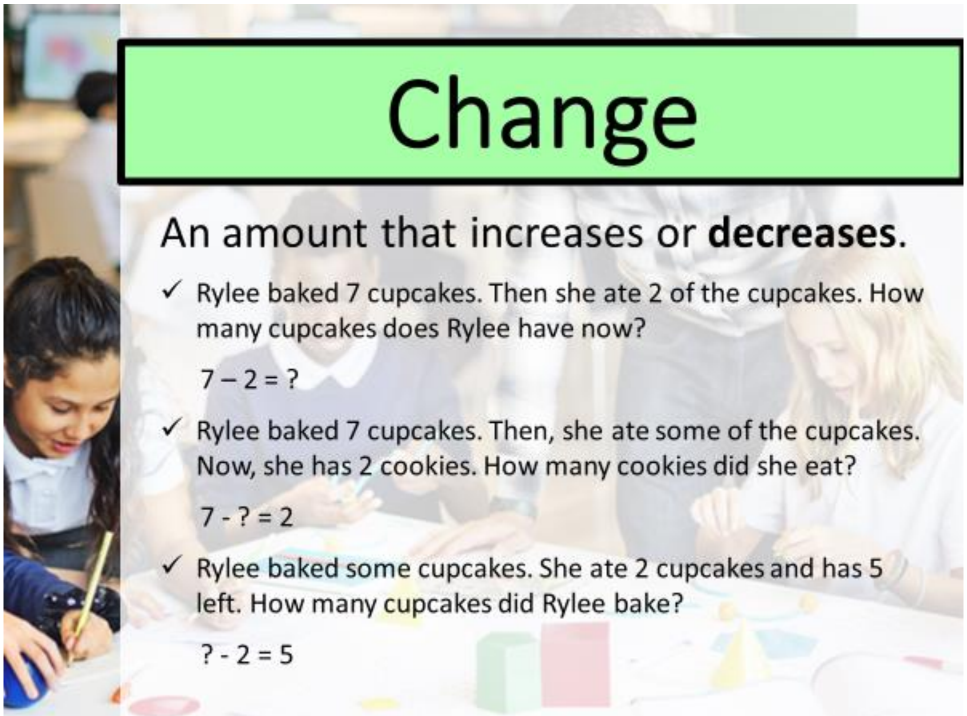

Difference
Biggest (Greater)
Smaller (Lesser)
Difference
Practice!
See Handout (Problems Q, R, S, T)
Which problem is a "Difference" problem?

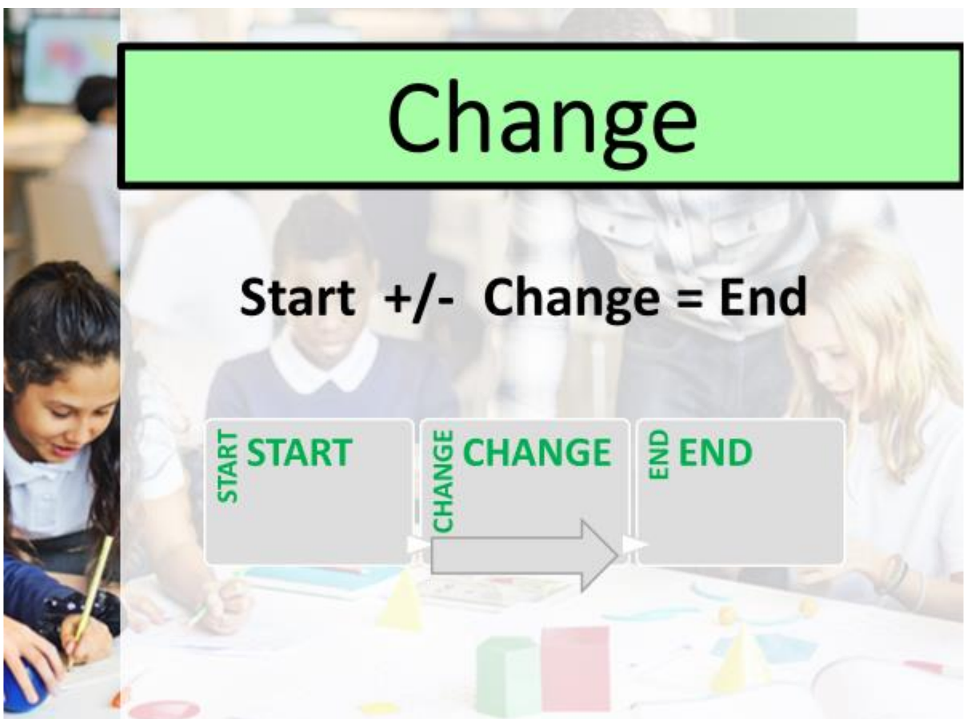

Difference
Zachary has 107 tennis balls and 69 ping pong balls. How many more tennis balls than ping pong balls does Zachary have?
F Greater – Lesser = Difference
A 107 - 69 = ?
S 107 - 69 = Difference
T 107 – 69 = 38 more tennis balls
? = 39 more tennis balls

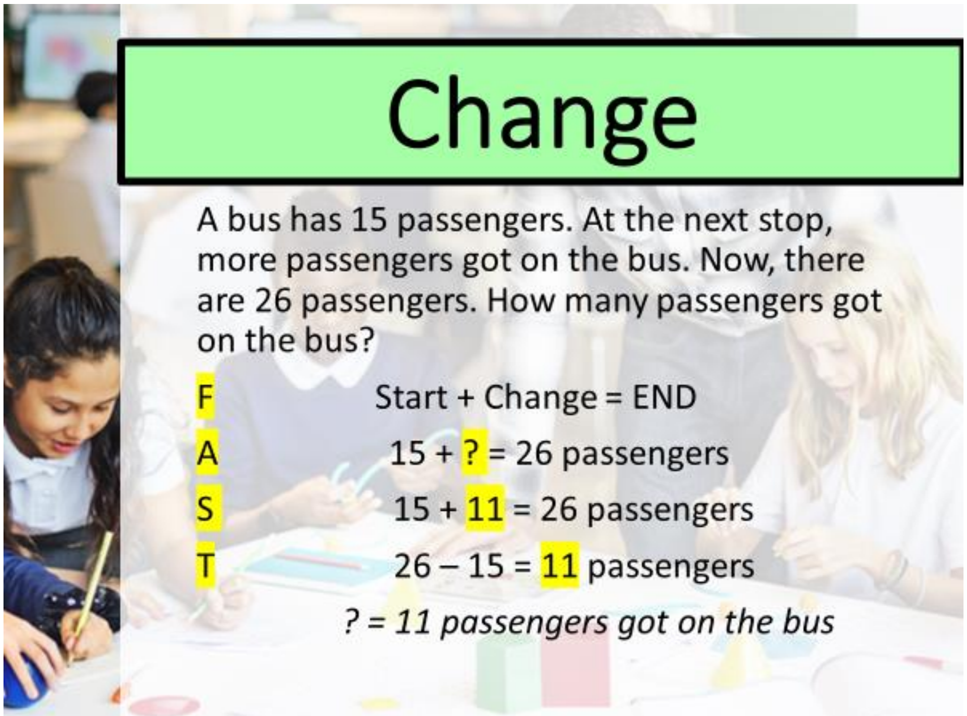

Total
Are the parts put together for a total?
Difference
Are amounts compared for a difference?

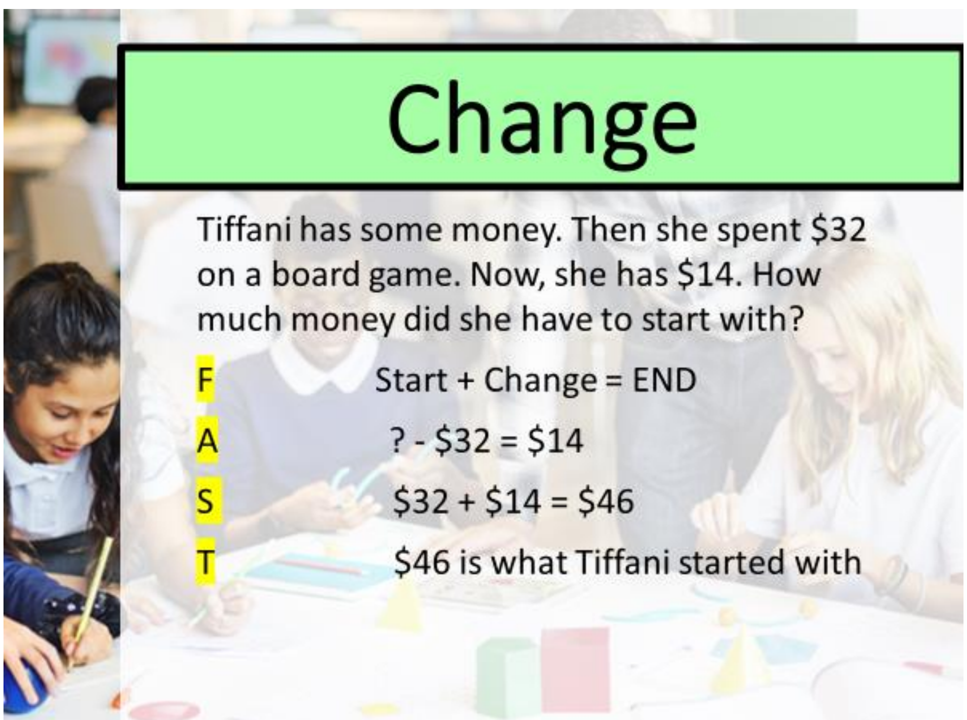

Lunch Break
LUNCH!
GoNoodle

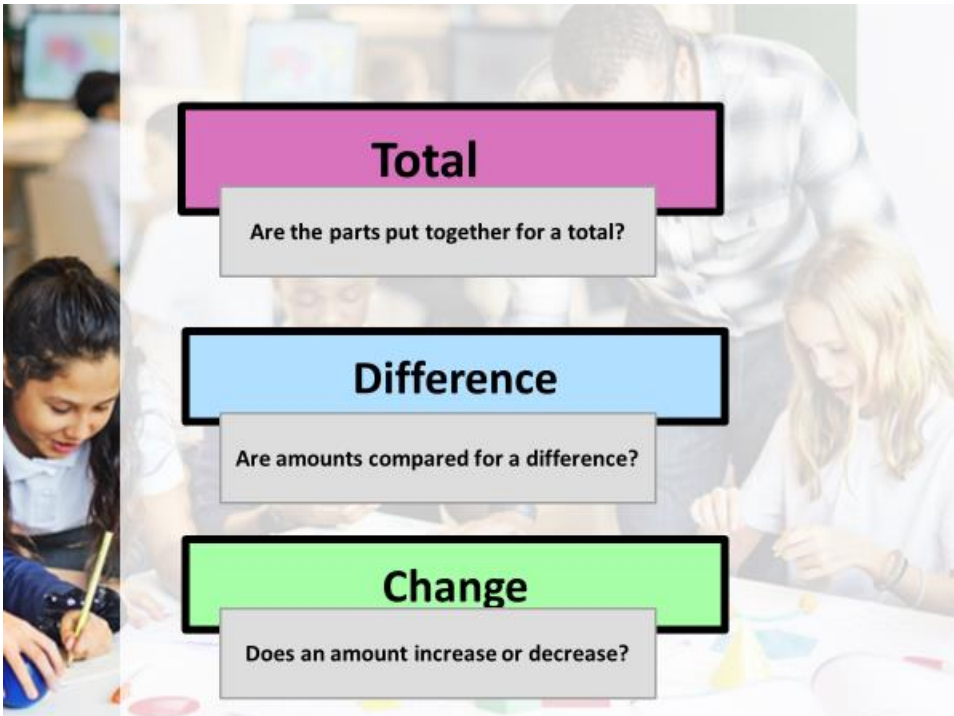

Change
An amount that **increases** or decreases.
✓ Tinley had $5. Then she earned $3 for doing the dishes. How much money does Tinley have now?
$5 + $3 = ?
✓ Tinley had $5. Then she earned money for doing the dishes. Now Tinley has $8. How much money did she earn?
$5 + ? = $8
✓ Tinley had some money. Then she made $3 for doing the dishes. Now she has $8. How much did Tinley start with?
? + $3 = $8


Change
An amount that increases or decreases.
✓ Rylee baked 7 cupcakes. Then she ate 2 of the cupcakes. How many cupcakes does Rylee have now?
7 – 2 = ?
✓ Rylee baked 7 cupcakes. Then, she ate some of the cupcakes. Now, she has 2 cookies. How many cookies did she eat?
7 - ? = 2
✓ Rylee baked some cupcakes. She ate 2 cupcakes and has 5 left. How many cupcakes did Rylee bake?
? - 2 = 5

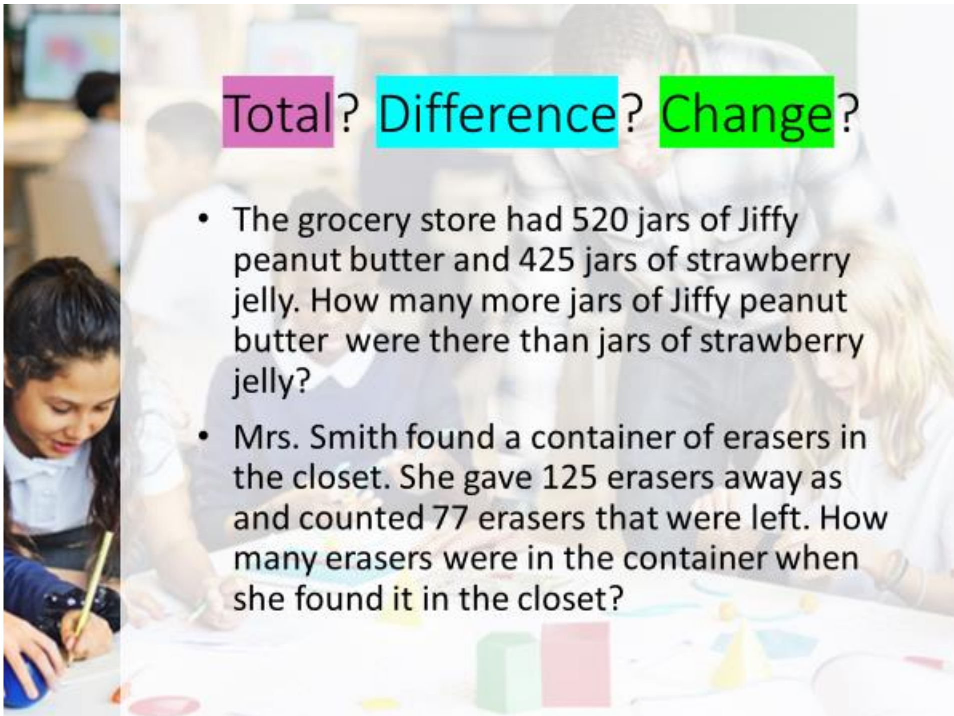

Change
Start +/- Change = End
START
START
CHANGE
CHANGE
END
END

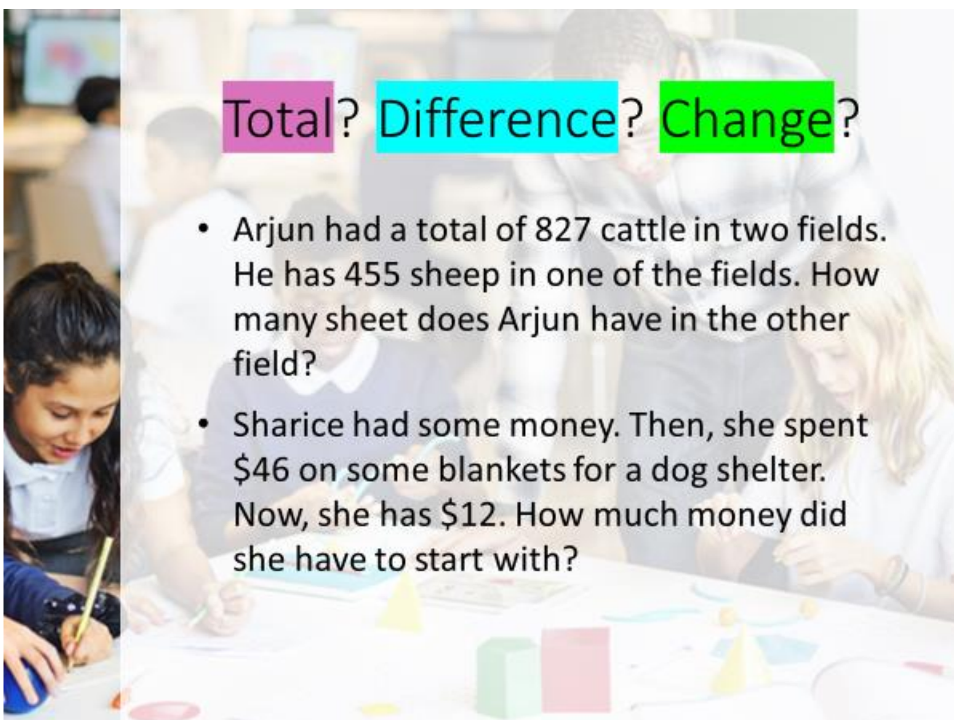

Change
A bus has 15 passengers. At the next stop, more passengers got on the bus. Now, there are 26 passengers. How many passengers got on the bus?
F Start + Change = END
A 15 + ? = 26 passengers
S 15 + 11 = 26 passengers
T 26 – 15 = 11 passengers
? = 11 passengers got on the bus

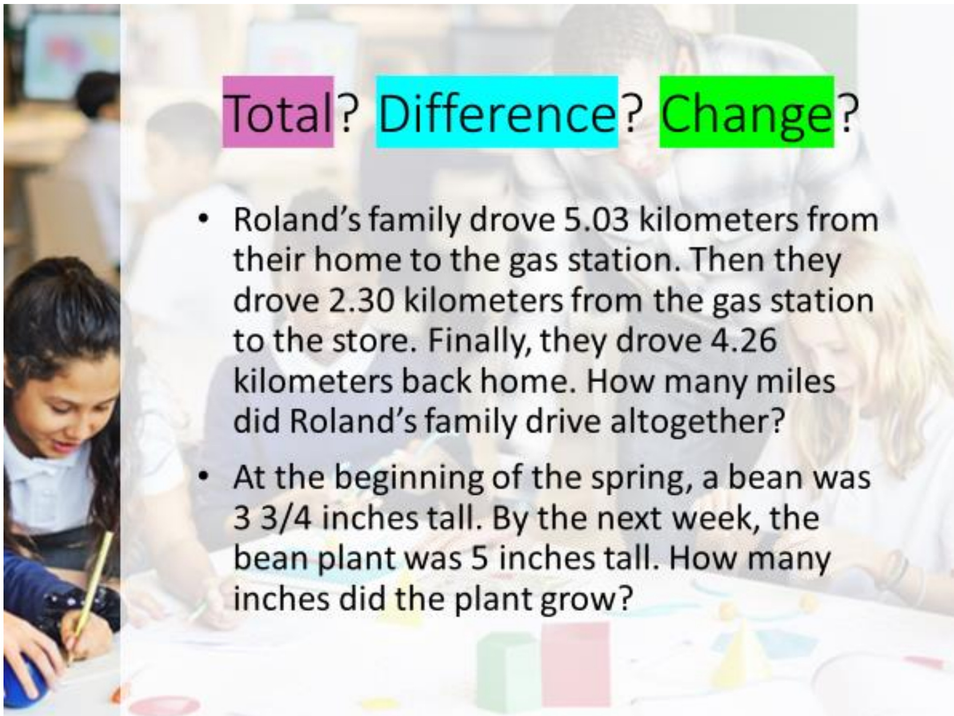

Change
Tiffani has some money. Then she spent $32 on a board game. Now, she has $14. How much money did she have to start with?
F Start + Change = END
A ? - $32 = $14
S $32 + $14 = $46
T $46 is what Tiffani started with

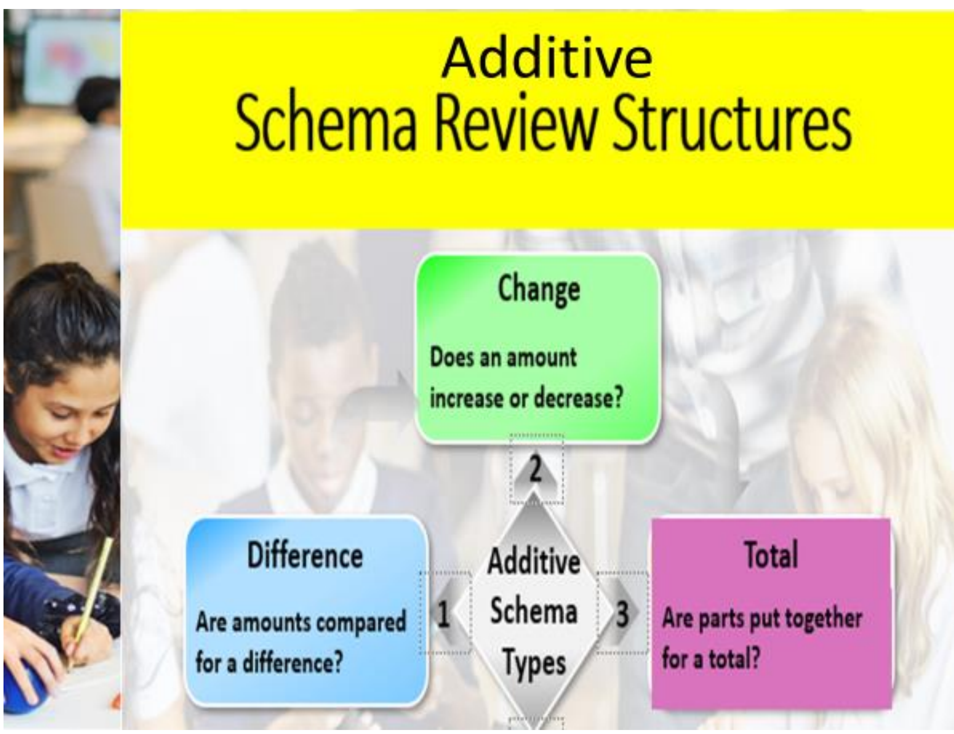

Total
Are the parts put together for a total?
Difference
Are amounts compared for a difference?
Change
Does an amount increase or decrease?


Let's Practice & Sort
Total?
Are parts put together for a total?
Difference?
Are amounts compared for a difference?
Change?
Does an amount increase or decrease?

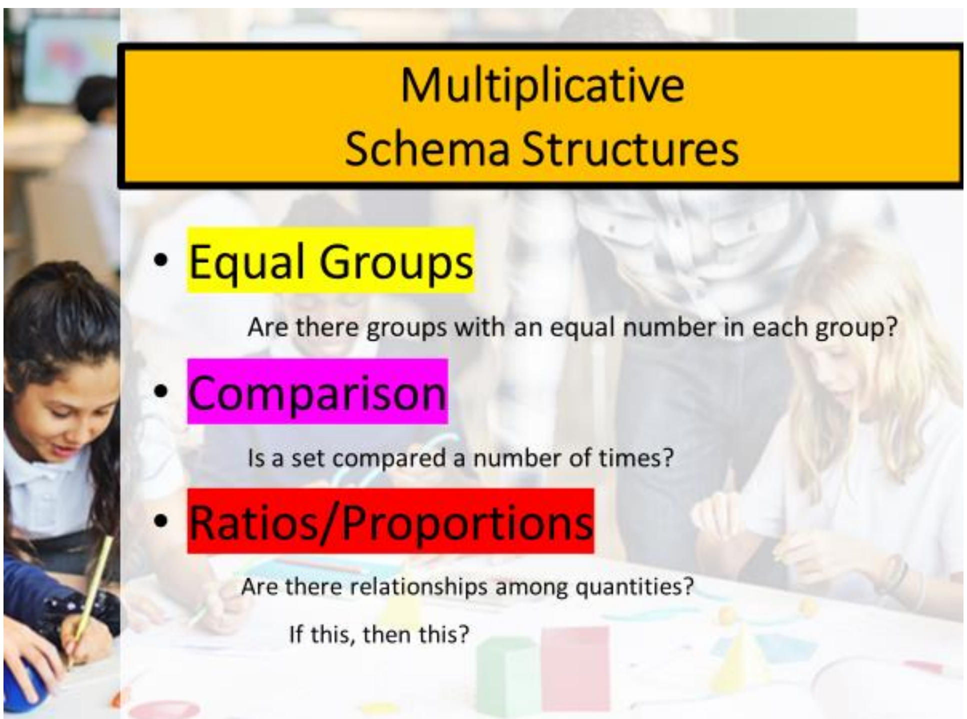

Total? Difference? Change?
• The grocery store had 520 jars of Jiffy peanut butter and 425 jars of strawberry jelly. How many more jars of Jiffy peanut butter were there than jars of strawberry jelly?
• Mrs. Smith found a container of erasers in the closet. She gave 125 erasers away as and counted 77 erasers that were left. How many erasers were in the container when she found it in the closet?

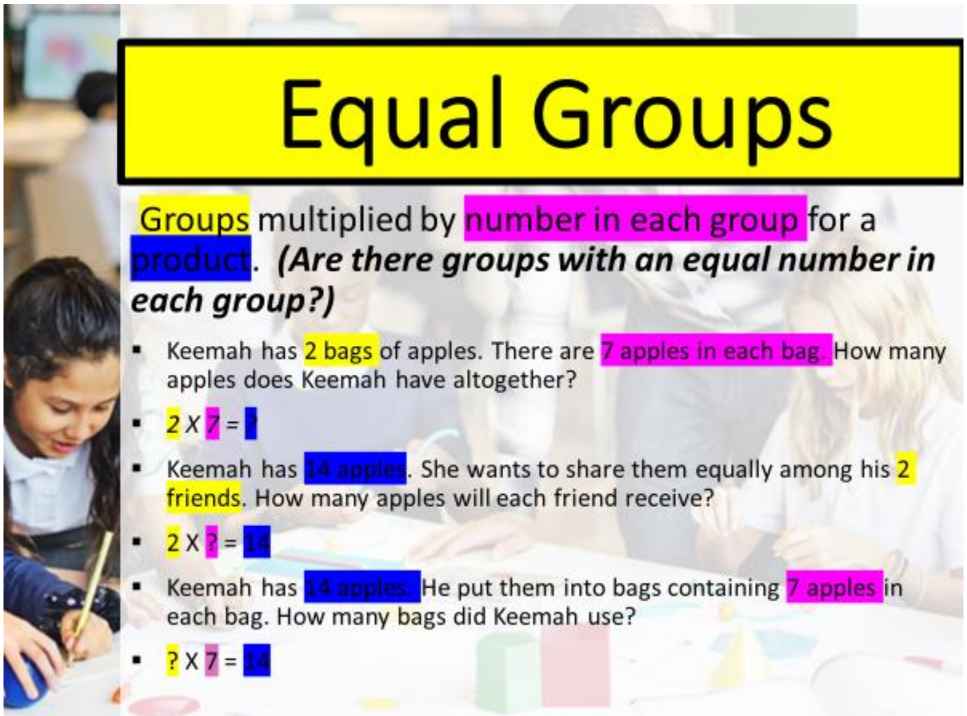

Total? Difference? Change?
• Arjun had a total of 827 cattle in two fields. He has 455 sheep in one of the fields. How many sheet does Arjun have in the other field?
• Sharice had some money. Then, she spent $46 on some blankets for a dog shelter. Now, she has $12. How much money did she have to start with?

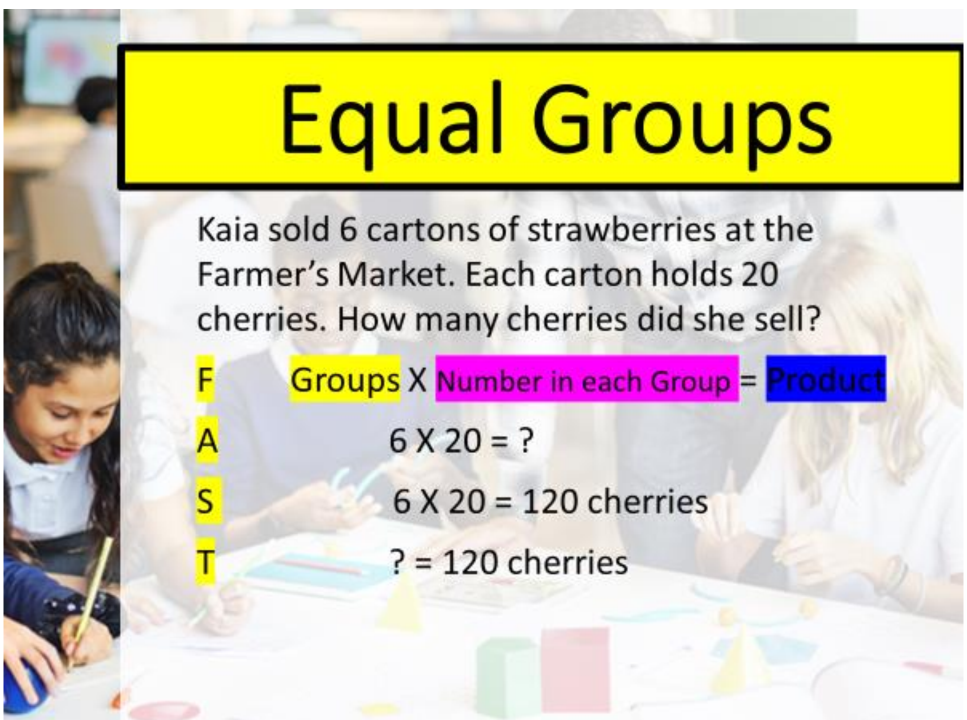

Total? Difference? Change?
• Roland's family drove 5.03 kilometers from their home to the gas station. Then they drove 2.30 kilometers from the gas station to the store. Finally, they drove 4.26 kilometers back home. How many miles did Roland's family drive altogether?
• At the beginning of the spring, a bean was 3 3/4 inches tall. By the next week, the bean plant was 5 inches tall. How many inches did the plant grow?

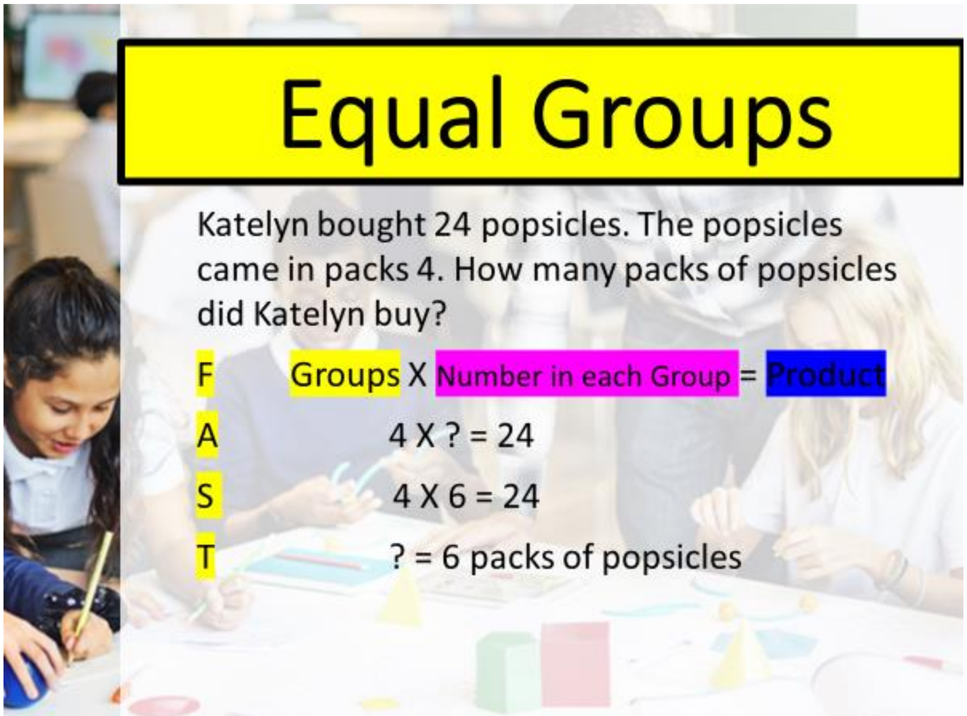

Additive
Schema Review Structures
Change
Does an amount increase or decrease?
2
Difference
Are amounts compared for a difference?
1
Additive Schema Types
3
Total
Are parts put together for a total?

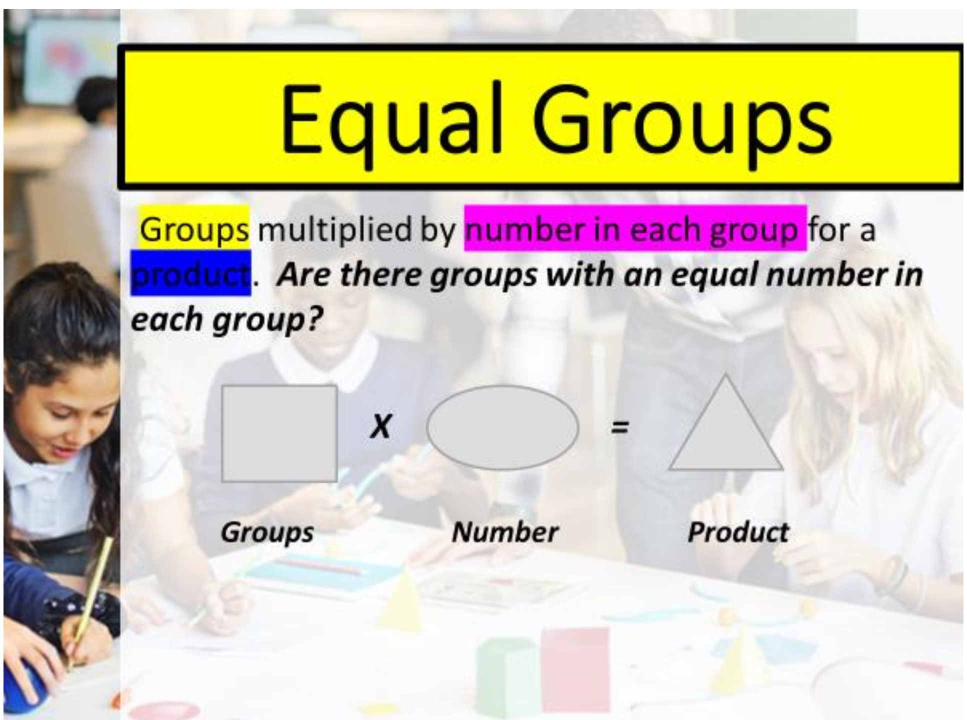

Break
15:00

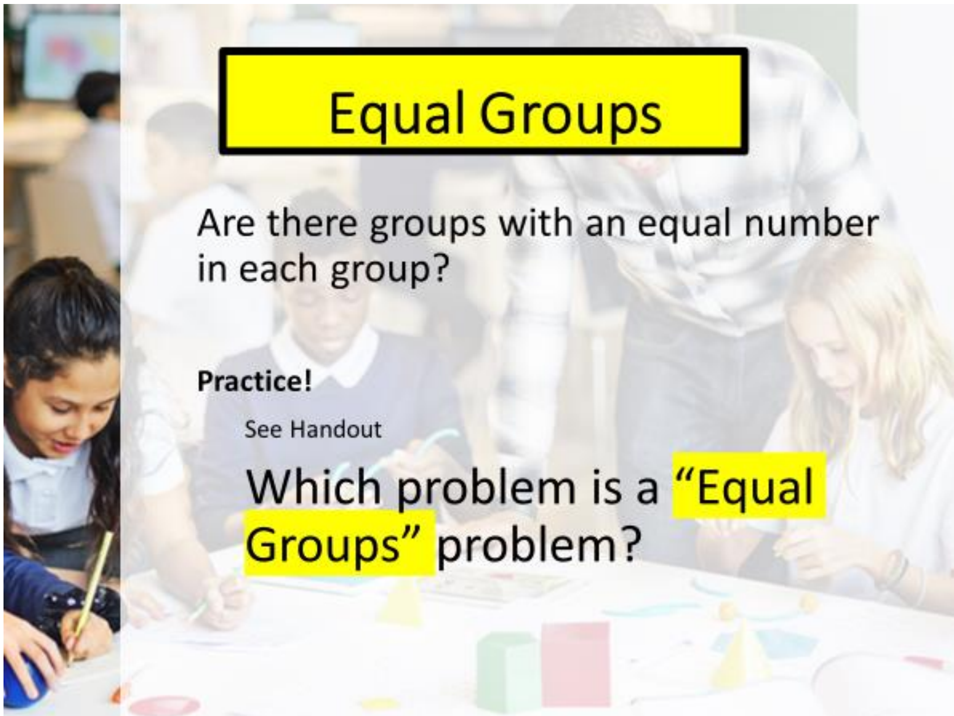

Multiplicative
Schema Structures
• Equal Groups
Are there groups with an equal number in each group?
• Comparison
Is a set compared a number of times?
• Ratios/Proportions
Are there relationships among quantities?
If this, then this?

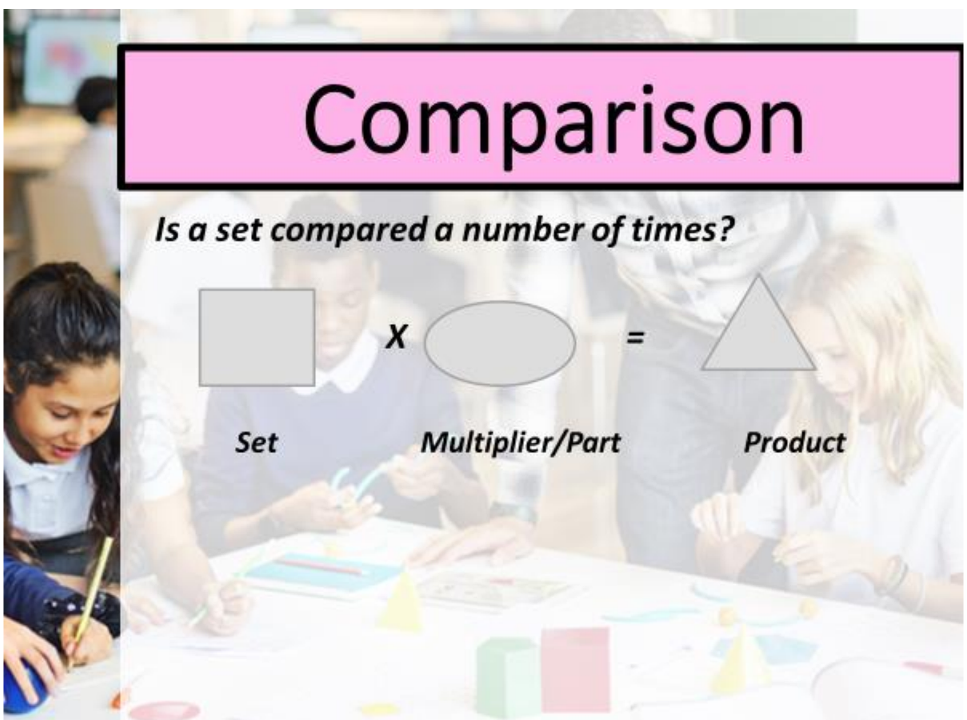

Equal Groups
Groups multiplied by number in each group for a product. (Are there groups with an equal number in each group?)
Keemah has 2 bags of apples. There are 7 apples in each bag. How many apples does Keemah have altogether?
2 X 7 = ?
Keemah has 14 apples. She wants to share them equally among his 2 friends. How many apples will each friend receive?
2 X ? = 14
Keemah has 14 apples. He put them into bags containing 7 apples in each bag. How many bags did Keemah use?
? X 7 = 14

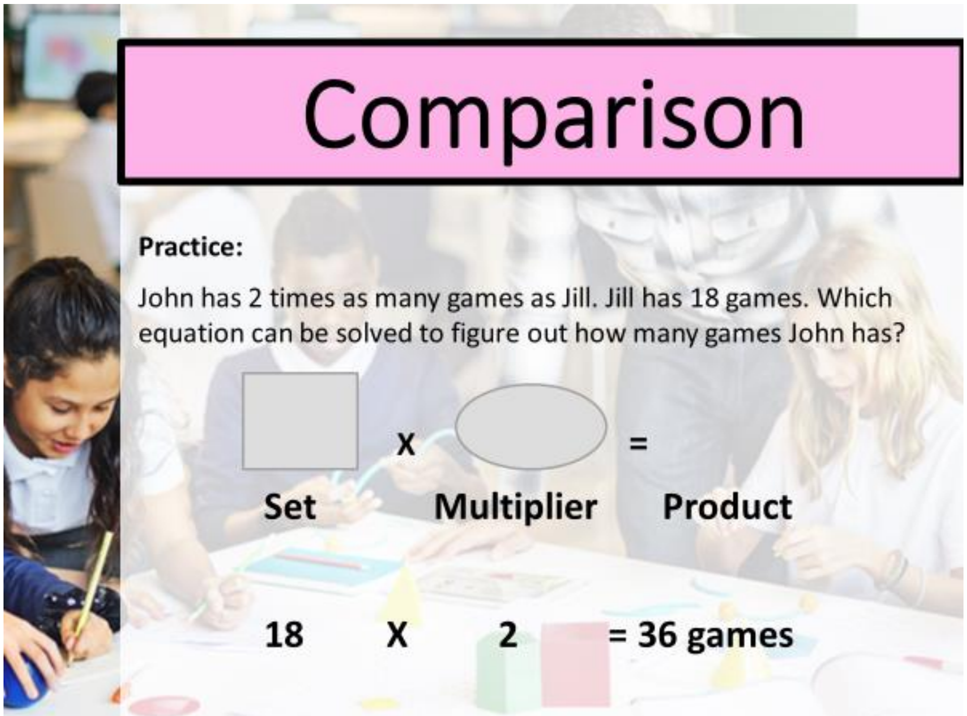

Equal Groups
Kaia sold 6 cartons of strawberries at the Farmer's Market. Each carton holds 20 cherries. How many cherries did she sell?
F Groups X Number in each Group = Product
A 6 X 20 = ?
S 6 X 20 = 120 cherries
T ? = 120 cherries

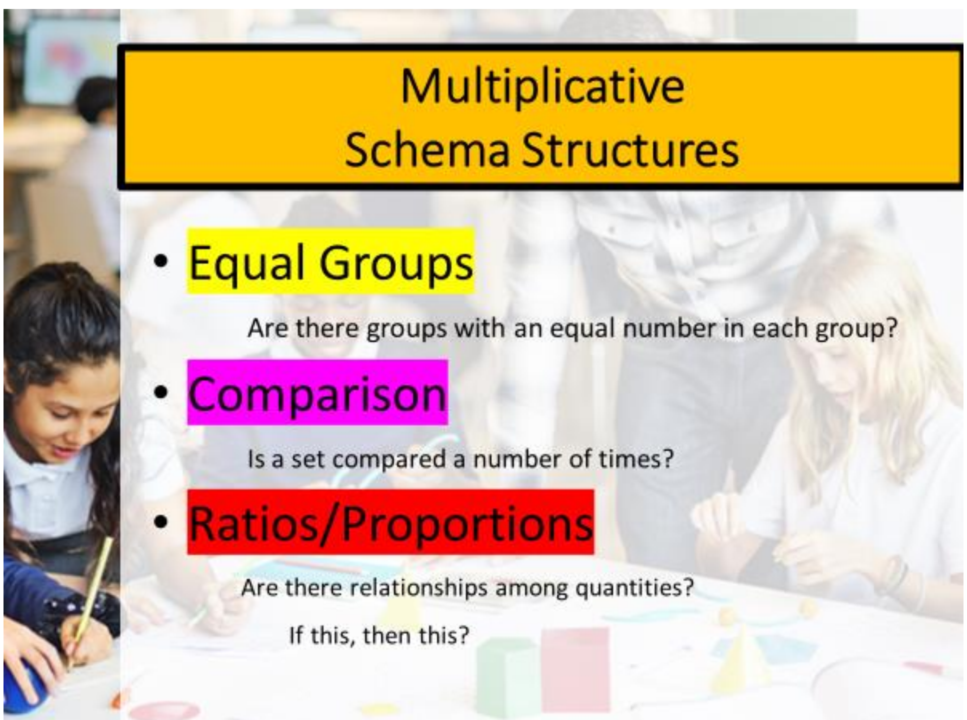

Equal Groups
Katelyn bought 24 popsicles. The popsicles came in packs 4. How many packs of popsicles did Katelyn buy?
F Groups X Number in each Group = Product
A 4 X ? = 24
S 4 X 6 = 24
T ? = 6 packs of popsicles

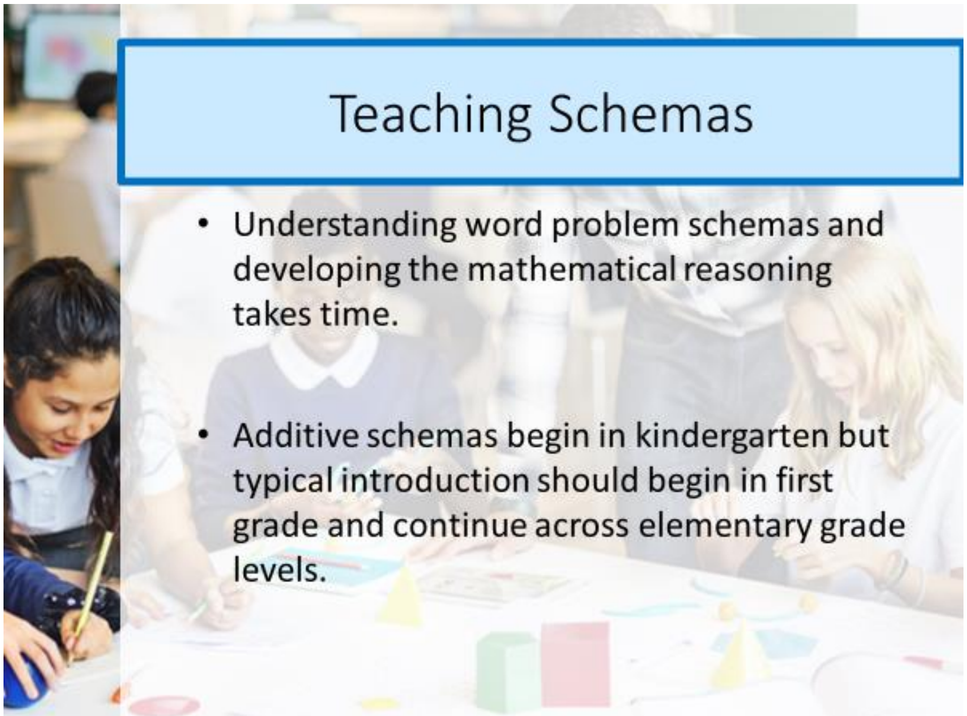

Equal Groups
Groups multiplied by number in each group for a product. Are there groups with an equal number in each group?
X
=
Groups
Number
Product

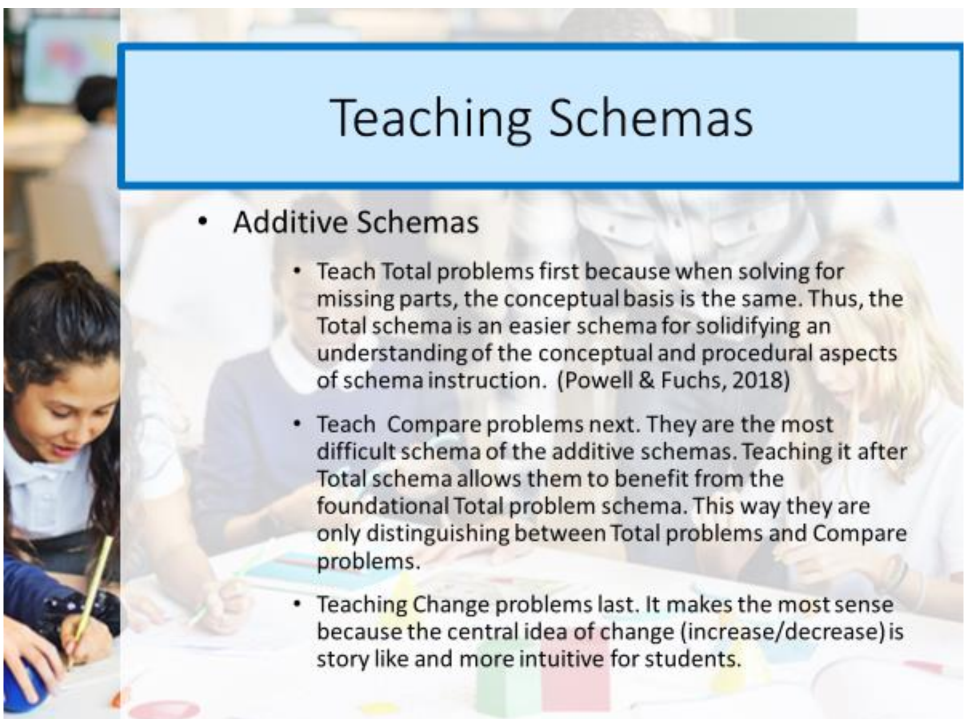

Equal Groups
Are there groups with an equal number in each group?
Practice!
See Handout
Which problem is a "Equal Groups" problem?


Comparison
Is a set compared a number of times?
X
=
Set
Multiplier/Part
Product


Comparison
Practice:
John has 2 times as many games as Jill. Jill has 18 games. Which equation can be solved to figure out how many games John has?
X
=
Set
Multiplier
Product
18
X
2
= 36 games


Multiplicative
Schema Structures
• Equal Groups
Are there groups with an equal number in each group?
• Comparison
Is a set compared a number of times?
• Ratios/Proportions
Are there relationships among quantities?
If this, then this?


Teaching Schemas
• Understanding word problem schemas and developing the mathematical reasoning takes time.
• Additive schemas begin in kindergarten but typical introduction should begin in first grade and continue across elementary grade levels.


Teaching Schemas
• Additive Schemas
• Teach Total problems first because when solving for missing parts, the conceptual basis is the same. Thus, the Total schema is an easier schema for solidifying an understanding of the conceptual and procedural aspects of schema instruction. (Powell & Fuchs, 2018)
• Teach Compare problems next. They are the most difficult schema of the additive schemas. Teaching it after Total schema allows them to benefit from the foundational Total problem schema. This way they are only distinguishing between Total problems and Compare problems.
• Teaching Change problems last. It makes the most sense because the central idea of change (increase/decrease) is story like and more intuitive for students.


More About Schemas
• Additive schemas are usually introduced and addressed within the same school year.
• Equal groups and Comparison schemas are typically featured during the elementary years.
» 2^{nd} and 3^{rd} grade initially taught equal-group schema
» 3^{rd} and 4^{th} grade comparison schema explicitly taught
• Proportions and Ratio schema usually taught in intermediate grades or middle school.
• Additive & Multiplicative Schemas can be used with whole numbers and rational numbers.


More About Schemas
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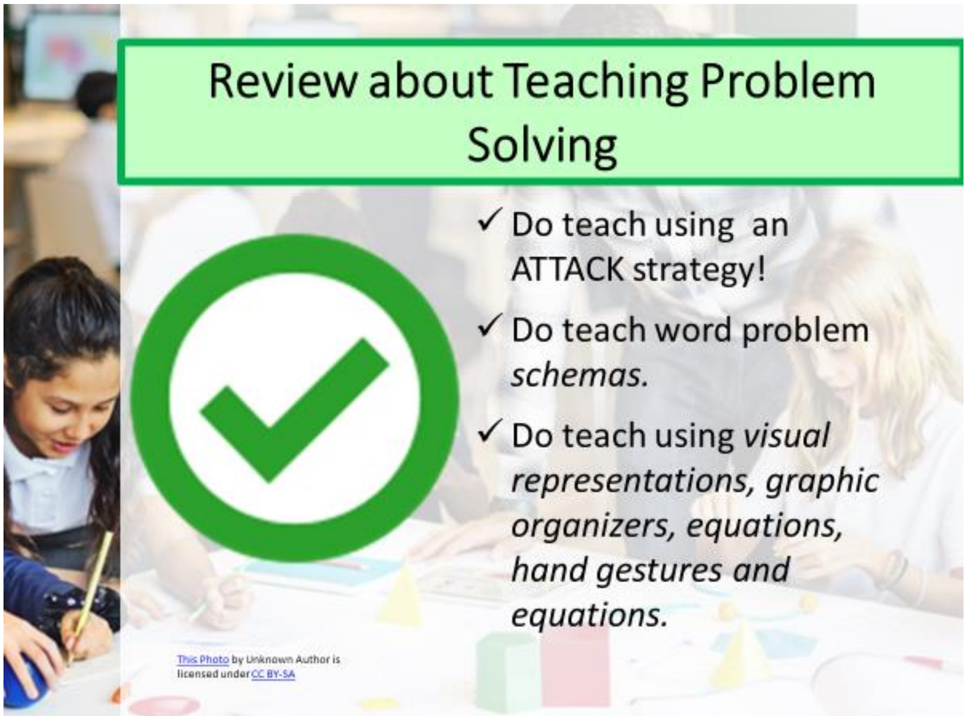
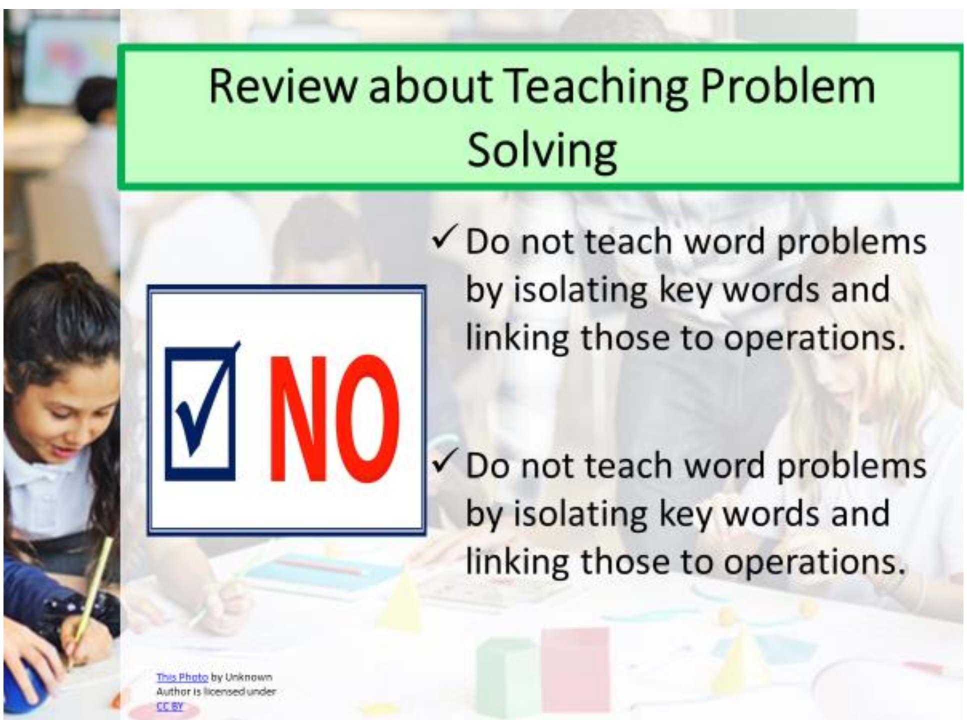
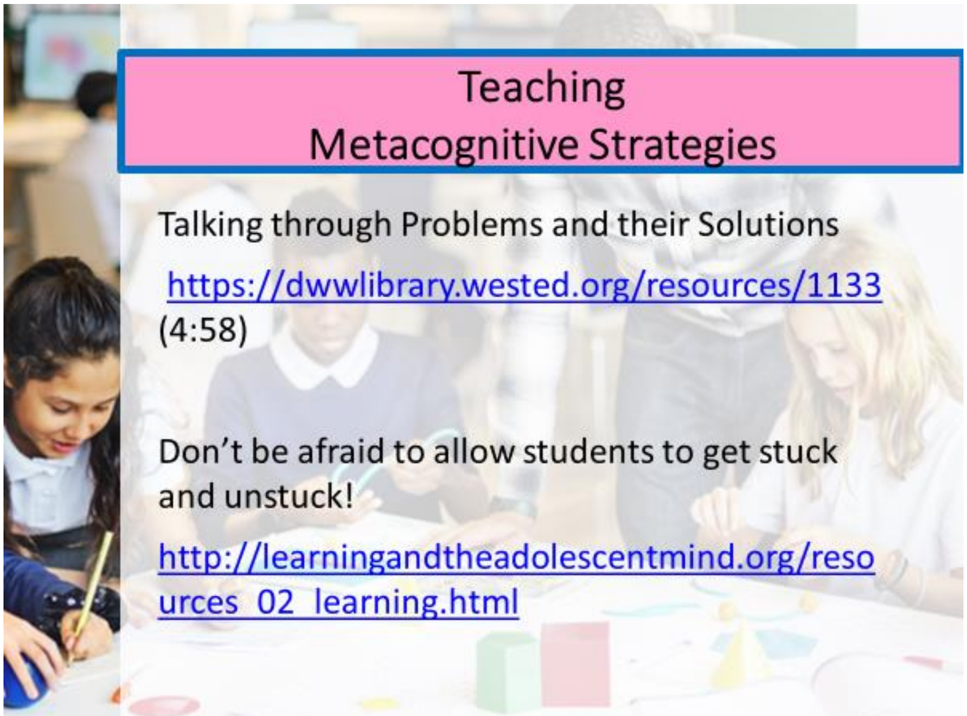
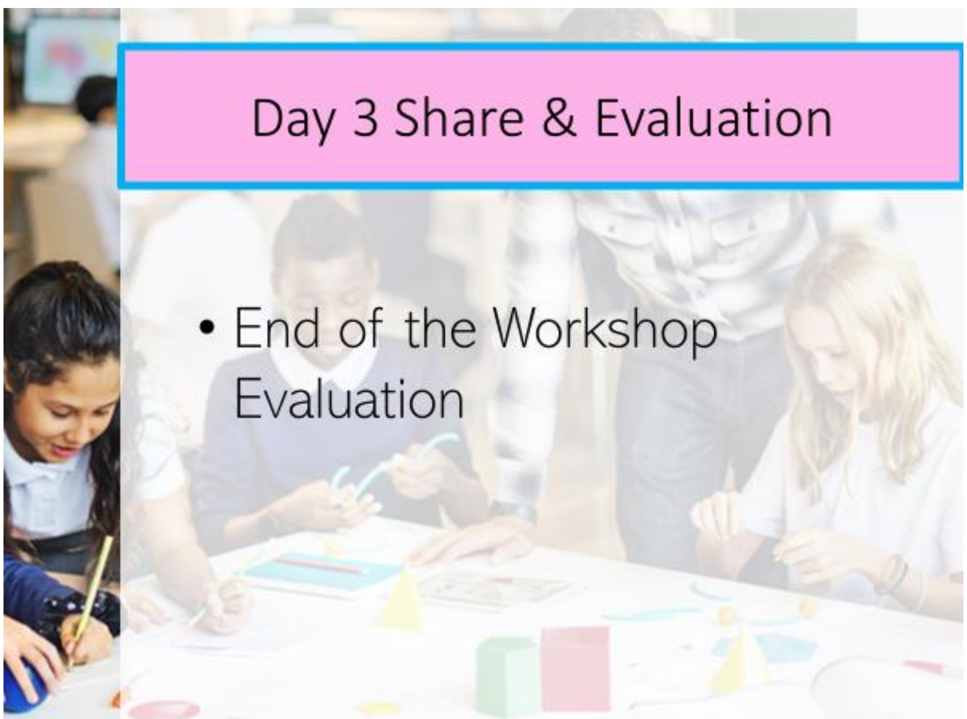
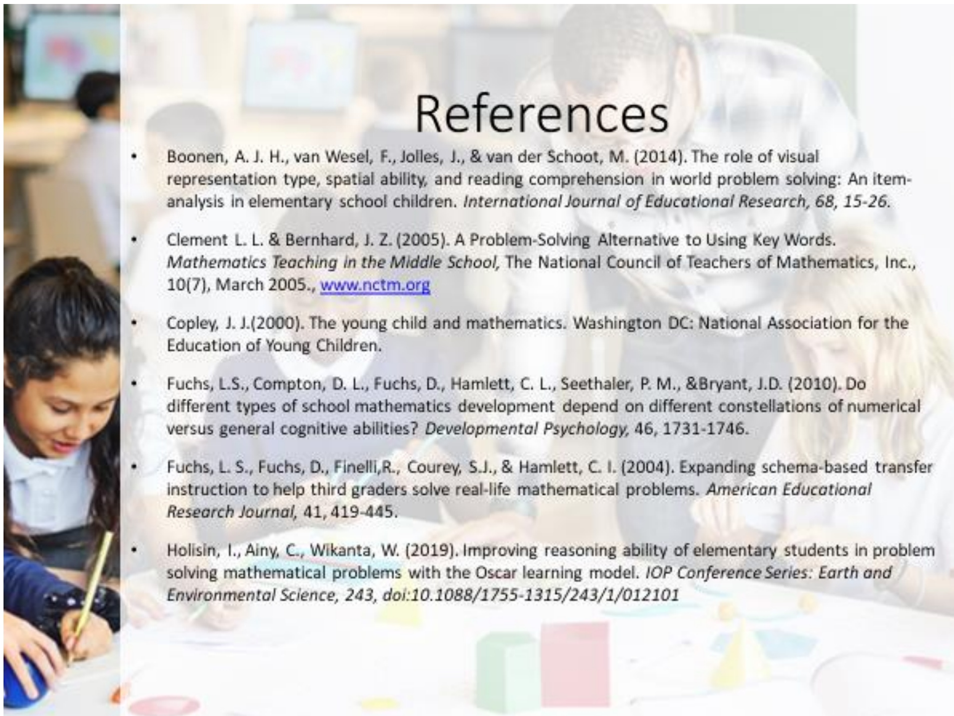

Review about Teaching Problem Solving
✓ Do teach using an ATTACK strategy!
✓ Do teach word problem schemas.
✓ Do teach using visual representations, graphic organizers, equations, hand gestures and equations.
This Photo by Unknown Author is licensed under CC BY-SA


Review about Teaching Problem Solving
☑ NO
✓ Do not teach word problems by isolating key words and linking those to operations.
✓ Do not teach word problems by isolating key words and linking those to operations.
This Photo by Unknown Author is licensed under CC BY


Teaching
Metacognitive Strategies
Talking through Problems and their Solutions
https://dwwlibrary.wested.org/resources/1133
(4:58)
Don’t be afraid to allow students to get stuck
and unstuck!
http://learningandtheadolescentmind.org/reso
urces_02_learning.html


Day 3 Share & Evaluation
• End of the Workshop
Evaluation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Clement L. L. & Bernhard, J. Z. (2005). A Problem-Solving Alternative to Using Key Words. *Mathematics Teaching in the Middle School,* The National Council of Teachers of Mathematics, Inc., 10(7), March 2005., www.nctm.org
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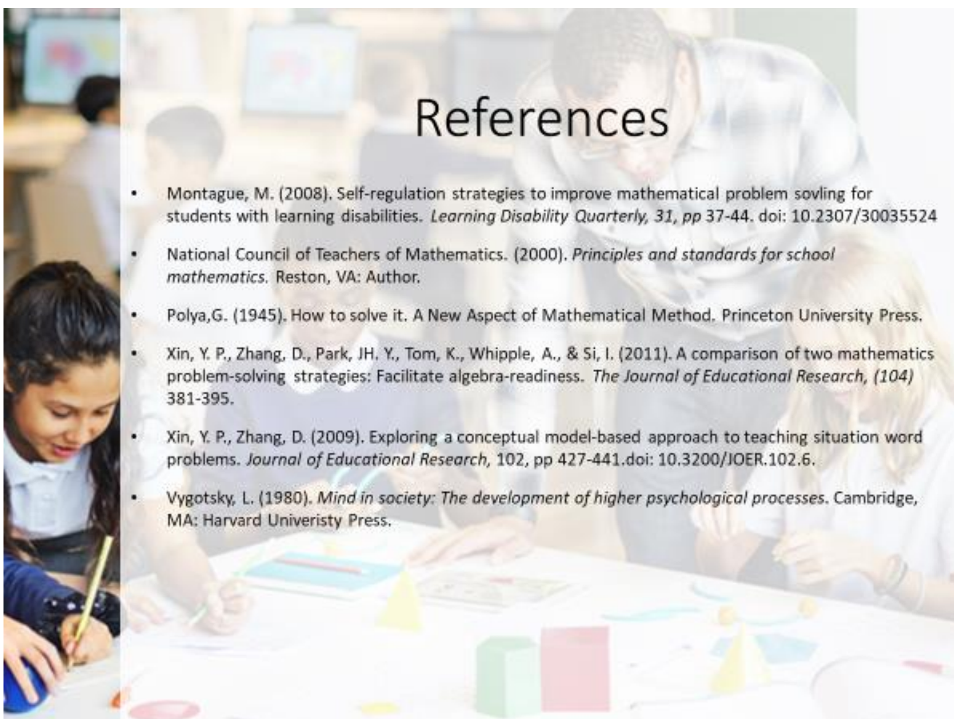
Fuchs, L. S., Fuchs, D., Finelli,R., Courey, S.J., & Hamlett, C. I. (2004). Expanding schema-based transfer instruction to help third graders solve real-life mathematical problems. *American Educational Research Journal,* 41, 419-445.
Holisin, I., Ainy, C., Wikanta, W. (2019). Improving reasoning ability of elementary students in problem solving mathematical problems with the Oscar learning model. *IOP Conference Series: Earth and Environmental Science, 243, doi:10.1088/1755-1315/243/1/012101*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National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author.
Polya,G. (1945). How to solve it. A New Aspect of Mathematical Method. Princeton University Press.
Xin, Y. P., Zhang, D., Park, JH. Y., Tom, K., Whipple, A., & Si, I. (2011). A comparison of two mathematics problem-solving strategies: Facilitate algebra-readiness. *The Journal of Educational Research, (104)* 381-395.
Xin, Y. P., Zhang, D. (2009). Exploring a conceptual model-based approach to teaching situation word problems. *Journal of Educational Research,* 102, pp 427-441.doi: 10.3200/JOER.102.6.
Vygotsky, L. (1980). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard Univeristy Press.

Appendix B: Email Invitation to Possible Participants

Dear (X) third grade math Teacher,

My name is Diana Everman. I am a doctoral student at Walden University in the Higher Education and Adult Learning Program. You are invited to participate in a research study entitled: *third grade math teachers' perceptions of their preparedness to teach the standards for the STAAR math test.* The purpose of this qualitative case study is to explore (X) ISD math teachers' perceptions of their preparedness to meet the demands of the third grade CCRS for the STAAR test.

This examination may promote a project resulting in an improved professional learning community opportunity resulting in better understanding and teaching strategies of the third grade College and Career Readiness math standards to raise third grade math student achievement. It may also result in the district beliefs of: We believe in a Professional Learning Community (PLC) culture that allows time to collaborate and share best practices to improve continually.

This study seeks to invite all third grade math teachers in (X) ISD to participate in one-on-one interviews regarding their perceptions of teaching the College and Career Readiness Math standards in third grade. Throughout the process of this study, you will be asked questions about your perceptions of your preparedness to teach the CRRS and your instructional strategies and teaching practices.

If you wish to participate in this study, please return the attached Informed Consent Form by email. I will then return an email to you with further instructions.

Thank you for your time and consideration. Your participation is greatly appreciated.

Sincerely,

Diana Everman

Appendix C: Researcher Confidentiality Agreement

Name of Signer: Diana Everman

During the course of my activity in collecting data for this research: third Grade Math Teachers' Perceptions of Their Preparedness to Teach the Standards for the STAAR Math Test. I will have access to information, which is confidential and should not be disclosed. I acknowledge that the information must remain confidential, and that improper disclosure of confidential information can be damaging to the participant.
By signing this Confidentiality Agreement, I acknowledge and agree that:

1. I will not disclose or discuss any confidential information with others, including friends or family.
2. I will not in any way divulge copy, release, sell, loan, alter or destroy any confidential information except as properly authorized.
3. I will not discuss confidential information where others can overhear the conversation. I understand that it is not acceptable to discuss confidential information even if the participant's name is not used.
4. I will not make any unauthorized transmissions, inquiries, modification or purging of confidential information.
5. I agree that my obligations under this agreement will continue after termination of the job that I perform.
6. I understand that violation of this agreement will have legal implications.
7. I will only access or use systems or devices I'm officially authorized to access, and I will not demonstrate the operation or function of systems or devices to unauthorized individuals.

Signing this document, I acknowledge that I have read the agreement and I agree to comply with all the terms and conditions stated above.

Signature:

____

Date:____

Appendix D: Interview Protocol Form

Participant Interview Protocol
Date: ______________________________________
Interviewee (Assigned a number) _______________
Interviewer: ________________________________

Other Topics Discussed
____
____
____

Post Interview Comments or Leads:
____
____
____

Interview Protocol

You will be asked to sign a consent form devised to meet the human subject requirements. Essentially, this document states that: (1) all information will be held confidential, (2) your participation is voluntary, and you may stop at any time if you feel uncomfortable, and (3) I do not intend to inflict any harm. Thank you for agreeing to participate.

I have planned this interview to last no longer than 45-60 minutes.

Introduction

You have been selected to speak with me today because you have been identified as a third grade math teacher in (X) ISD. The purpose of this interview is to elicit a conversation about the experiences and perceptions of third grade math teachers' preparedness to teach the standards for the STAAR math test. The questions I have prepared for this interview are semi-structured and are designed to facilitate a conversation about third grade teachers' experiences and perceptions of their preparedness in teaching the third grade math standards for the STAAR test.

Interviewer Background

How long have you been…
_________________in your present position?
_________________at this district? _________________school?
_________________teaching?

Additional background information on interviewee:

What is you highest degree? ___________________________________

What is your field of study? ____________________________________

1. Briefly describe your role at the research site.

Probe: How are you involved in teaching, learning, and assessment of the third grade College and Career Readiness Standards?

2 Which Career and College Readiness Math Standards do you feel prepared to teach?

Which Career and College Readiness Math Standards do you feel you could use more instructional **understanding** to teach?

Probe: Can you expand upon that response?

Probe: Which instructional Career and College Readiness Math Standards do you feel you need additional or different strategies to teach?

3. What do you perceive as the goals of third grade Math Career and College Readiness Math Standards?

Probe: To what extent do you think these goals are being met?

4. What kinds of professional learning experiences have you had in understanding the CCRS for third grade math?

5.What kind of professional learning experiences would you like to see regarding teaching third grade math CCRS standards?

6. Describe your “ideal” professional learning experience in third grade mathematics Career and College Readiness standards?

7.Tell me about the effects the standards have had on your teaching and student learning.

8.How extensive are the changes you've made in your classroom?

Probe: Explain your response.

Probe: How extensive are the changes you still need to make?

9.What strategies have you found effective in terms of instructional practices in teaching the CRRS?

Not effective? / less effective?

10.Describe some effective math lessons you have had in terms of instruction?

Probe? Describe some that did not go so well. What was missing?

11.. Is there anything else you would like to add or say concerning the implementation of the math STAAR standards?

12. Do you have any questions for me?

Appendix E: Field Notes from One on One Semi-Structured Interviews

Interviewer ID (number)____

Name of locality where interview took place _________________________________

Name of Researcher ____

Interview Date ____

Length of Interview ____

TIME	DESCRIPTIVE NOTES	REFLECTIVE NOTES

Appendix F: Letter Request to Conduct Study in (X) ISD

Date: X/XX/17

Dear (X) Superintendent, School Board and (X) ISD,

I am currently a doctoral student at Walden University in the Higher Education and Adult Learning Program. I am in the research stage of the course and would like to conduct a study in the school district at the elementary campuses. I am interested in studying the perceptions of third grade math teachers in (X) ISD about their preparedness to teach the Career and College Readiness Math standards for the third grade Math STAAR test.

During the study I will request the voluntary participation of teachers for one-on-one interviews. There will not be any data gathered from the students at the school. Each possible volunteer will sign a Consent Form. Please see the attachment (Appendix B). Within the Consent to Participate in Research form is listed the purpose of the study, procedures for the semi-structured interviews, risks and benefits of being in the study, the voluntary nature of the study, guarantee of confidentiality and a contact is listed for any questions or concerns.

The results of the study can guide the teacher's reflective practice and provide data to result in a professional learning community opportunity as the project of this qualitative research study. The results could also guide administrators in making math staff professional learning opportunity decisions.

Please do not hesitate to contact me if you have any questions or would like to further discuss this project. I can be reached at.

Sincerely,

Diana Everman, M.Ed.

Appendix G: Professional Development Evaluation

Professional Development Evaluation

Day 1 ***Day 2*** ***Day 3***

Date ______________________________

Place an X in the box that corresponds to your answer. 😊

	YES	NEUTRAL	NO
Was the PD today relevant to your job?			If no, why not?
Do you feel you achieved today's objectives?			If no, why not?
Did you learn new instructional strategies to use with your students?			If no, why not?
Was the material presented in a manner that made sense?			If no, why not?
Were the group activities helpful?			If no, why not?
Which activity was ***most beneficial*** to you? Why?			
Which activity was ***least beneficial***? Why?			
Which activity would you like to know more about or have more time to learn? Additional Comments			

Appendix H: Problem Solving Pretest

Solve the problems below using the most appropriate strategy/strategies.

1. While playing a game, John defeated 8 monsters and earned 2,040 points. If she traded in all her points for 5 more lives, how much would each of her lives be worth in points?

2. Suzy lived 60 blocks from her Grandma's house. She decided to ride her bike to her Grandmas. She got 2/3 of the way there and realized she had forgotten her phone, so she rode back home. Then she went back to her Grandmas and finally back home. How many blocks did Suzy bike in all?

3. Julio decided to run a 12K marathon. He had already run a 2K and 5K marathon. How many meters will he have run in all when he finishes?

4. Yen had a box of 24 X-box games. The games were either an adventure game, a sports game or a word game. If 1/6 of his games were adventure games and 2/3 were sports games, how many of his games were word games?

5. Mrs. Smith went to the store to buy some art supplies for a project for her class. She bought a box of watercolors for $24.58 and she bought two packages of watercolor paper for $7.99 each. She had a coupon for $5.00 off her total purchase. How much did she pay for the supplies she purchased?