UNDERSTANDING THE SELF-EFFICACY OF ELEMENTARY MATH TEACHERS BY GRADE, EXPERIENCE, AND CERTIFICATION

A Record of Study

by

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ABSTRACT

Elementary teachers are generalists, usually with a reading background. As such, a number of teachers have low self-efficacy about teaching mathematics for conceptual understanding. Researchers suggest that some major categories associated with this problem are not enough adequate professional development (PD) addressing conceptual understanding in mathematics teaching (Carney et al., 2016; Taton, 2015), teachers using procedures similar to how they were taught as students (Yao et al., 2021), and teacher preparation programs failing to address low self-efficacy in mathematics teaching with their pre-service teachers (Briley, 2012; Ozben & Kilicoglu, 2021). The purpose of this study was to determine if a sustained, active content-based professional development program would increase the mathematical self-efficacy of elementary math teachers. Through this quantitative, non-experimental survey design, I formally investigated this problem by analyzing results from a pre-and post-self-efficacy survey using a modified MTEBI with 231 elementary math teachers from a north central Texas school district to determine their beliefs about teaching math conceptually. I further stratified the teachers by grade level bands, years of experience, and whether they were alternatively or traditionally trained and certified to discover any differences in self-efficacy gains. Using quantitative statistical tests of paired-samples *t*-tests, independent-samples *t*-tests, and ANOVA tests, the data were analyzed and found statistically significant differences in self-efficacy gains overall, for concepts presented during the professional learning program, and for concepts not presented in the program. There were statistically significant differences in self-efficacy gains between K-2 and 3-5 teachers with the upper-grade teachers increasing their self-efficacy scores more than the lower-grade level teachers. There were no statistically significant differences between teachers with varying years of experience, but there were differences in the PD concepts between alternatively and traditionally trained teachers with alternatively trained teachers making the biggest gains. The data showed a relevant, sustained PD program can be effective in increasing math teachers' self-efficacy in conceptual understanding of computational strategies.

DEDICATION

I would like to dedicate this work to my parents, without whom I would not fully value education and understand where it could take me in life. My father, Bill Mitchell (Class of 1962) wanted my sisters and me to be Aggies from the beginning. I finally got here, Dad! My mother, Jill Mitchell, is my inspiration to be a loving and faith-filled mother, educator, and life-long learner. Without their love, support, and encouragement, this journey would have been a lot tougher.

My family is my love, and I am so proud of all they have accomplished. My sons and daughter-in-law, Geoffrey (TAMU Class of 2015), Ashley (TAMU Class of 2014), Tyler, and Ben have shown resilience, determination, and passion in their choices of careers and life. My husband, Jack, has fully supported and loved me through this path of self-determination. I am truly blessed to have them all in my life.

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Finally, I thank my family. I thank them for listening to me go on and on about conceptual understanding and statistical terms. I know they are as proud of this accomplishment as I am of all their achievements.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This record of study was supervised by a committee comprised of Dr. Karen Rambo-Hernandez [chair] and Dr. Mary Margaret Capraro [co-chair], both from the Department of Teaching Learning & Culture. The additional committee members are Dr. Bugrahan Yalvac, also from the Department of Teaching, Learning & Culture and Dr. Jennifer Whitfield, College of Arts & Sciences, Department of Mathematics. All work for this record of study was completed by the student independently.

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NOMENCLATURE

BLS	U. S. Bureau of Labor and Statistics
CRA	Concrete, Representational, Abstract Model of Teaching
MTEBI	Mathematics Teaching Efficacy Beliefs Instrument
MTOE	Mathematics Teaching Outcome Expectancy
PCK	Pedagogical Content Knowledge
PD	Professional Development
PK	Pedagogical Knowledge
PMTE	Personal Mathematics Teaching Efficacy
ROS	Record of Study
STAAR	State of Texas Assessment of Academic Readiness
STEM	Science, Technology, Engineering, and Mathematics
TAPR	Texas Academic Performance Reports
TEA	Texas Education Agency
TIMSS	Trends in International Mathematics and Science Study

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

The Context

A student's robust mathematical knowledge in the early grades strongly predicts future academic success (Rittle-Johnson et al., 2017). Igniting the passion for learning math and nurturing the ability to be creative can have a lifelong effect on future careers. Educators along with parents can influence a student's math mindset and in doing so impact what college and career choices they will have available to them. The teacher's belief in their teaching ability strongly influences what happens in the classroom and affects student outcomes.

The belief in one's capability is known as self-efficacy. Bandura (1977) described it as "the strength of people's convictions in their own effectiveness" (p. 193). Teachers must comprehend how to teach mathematics conceptually and build the problem-solving skills students need to be successful in both math and life. Conceptual math understanding involves the knowledge of how mathematical concepts are related and how to work with numbers flexibly (National Research Council, 2001). There are factors in a teacher's experiences that shape their teaching style and understanding, which in turn affects student results. When educators are not confident in their mathematical skills and how best to teach the concepts, the impact on students' futures can be detrimental.

National Context

> "We are fast approaching another Sputnik moment; we can't afford to ignore"
> (Herman, 2018, para. 12).

The U.S. Bureau of Labor Statistics (BLS) has predicted that Science, Technology, Engineering, and Mathematics (STEM) based occupations will grow by eight percent by 2029, whereas all other occupations will only grow by 3.7 percent (Zilberman & Ice, 2021). A Pentagon report stated that as of 2020, the United States no longer graduates the most students in STEM-related fields. China and Russia are overtaking the honors both within their countries and with their students graduating from American colleges (Turner, 2021). To increase the United States' role in the STEM fields, current students must be fully prepared and possess the ability to succeed in these professions. There is a need for more students to acquire the skills and desire to participate in STEM-related education. More than two-thirds of people in STEM-related careers enjoyed math and science while in elementary school (Funk & Parker, 2018). It is our job as educators to instill a love for math and all it entails to ensure we have a strong presence in the STEM job market.

While an appreciation for math may spark an interest in STEM-related careers, regrettably our national and international test scores are not showing a marked improvement in math scores (National Assessment of Educational Progress, 2021). In 2019, the Trends in International Mathematics and Science Study (TIMSS) showed that fourth-grade students from the United States placed 15th out of 64 nations on the math portion of the international test (National Center for Education Statistics, 2019). Due to the pandemic over the last two years, statistics have shown a dramatic drop in mathematics testing scores. Covid 19 has erased years of growth in math (Texas Education Agency [TEA], 2022). Overall, the estimated math learning loss is at least nine months, if not years (TEA, 2022). International, national, and state standardized test scores show mathematics learning at a decline or at the very least, remaining stationary.

With STEM careers burgeoning, little to no improvement in national test scores, and the devastating effects of the pandemic, the need for our students to excel in mathematics increases each year. To combat this stagnation in math success, elementary math teachers must exhibit strong math pedagogical content knowledge (PCK) and be able to impart that to their students. Having a full understanding of how to teach mathematical concepts with a conceptually based foundation will increase a teacher's self-efficacy to teach conceptually and have a trickle-down effect on their students' mathematical self-efficacy. We do students a disservice if we do not actively expose them to the skills and concepts they need to thrive in future careers. A proper foundation in mathematical understanding increases the likelihood of a student pursuing a STEM career.

Situational Context

The north central Texas district I work in has a student population of 22,428 as of May 2022. According to the 2020-2021 Texas Academic Performance Report (TAPR), there are approximately 1,410 teachers in this fast-growth district (Texas Education Agency [TEA], 2021). Currently, there are 29 campuses with plans to build an additional three more elementary schools and a high school in the next four years. The demographic student breakdown consists of 38.9% Hispanic, 36.5% White, 14.9% African American, 4.5% Asian, 4.5 % Two or More Races, and 0.3% of Pacific Islander and American Indian. The district has a 42.3% economically disadvantaged student population with 12% Emerging Bilingual students and special education services provided to 11.3% of the students. Four elementary campuses host a bilingual program that extends from pre-kindergarten through fifth grade. Presently, twelve out of seventeen elementary campuses receive Title 1 funding. The district is diverse in population and languages. There are currently over 60 different languages spoken in the district which affects instruction and comprehension of math word problems.

Overall, the district's State of Texas Assessment of Academic Readiness (STAAR) Math scores for third and fourth grades have been below or the same as the state and region scores since 2015 (TEA, 2021). The percentage of students who received master's grade level status on the 2021 Grade 3 Math STAAR test was about half of the state and region master's scores. Students with a Special Education designation and economically disadvantaged students have experienced the biggest struggles on the 2021 Math STAAR (TEA, 2021). When analyzed further, the lowest scored standards are ones that address representations of a problem that focus on a student's conceptual understanding of a particular mathematics concept or comprehending and solving one-step and multi-step word problems.

To address the new state math standards that TEA adopted in 2012, the district slowly started to move towards teaching mathematics through an inquiry-based curriculum. The procedural-driven textbook that was in adoption at the time came with a supplemental text that was more conceptually based. Over the next few years, the curriculum turned more to the conceptually based textbook, Investigations®. The process was not a smooth transition. For years, most teachers did not fully accept the new curriculum and would shut their doors and teach in the way with which they were familiar. Procedurally driven worksheets and teacher-centered learning had been and continued to be the standard for teaching. Teachers felt students needed to follow steps to solve problems and did not need to understand why the steps were necessary. The teachers believed because they did not need to know the reasons why the steps worked, in turn, the students did not need to understand those processes, either.

The professional learning focus pivoted to showing teachers different strategies for teaching computational skills and understanding word problems. The unintentional message sent was the necessity for all students to be able to use every possible strategy to solve a problem.

Teachers began to focus on teaching all instructional strategies for computation without teaching the reasoning behind why the methods worked. The strategies then became procedural in nature. Teachers provided students with steps to follow just like an algorithm with no understanding of why the steps worked to produce an answer. Elementary teachers who may not have been strong in their mathematical understanding were confused as to the best way to teach mathematics.

The Problem

While the administration and school board members have always been supportive of the teachers in this district, the goals remain to enhance mathematics learning for all students and to increase Math STAAR scores over and above the state and region scores, especially at the elementary level. Though improving scores are goals with good intentions, the aim has backfired from the amount of intense pressure on both the teachers and the students. Elementary math teachers have become more focused on students learning test-taking skills and less focused on mathematical understanding and application of skills learned. For students to master conceptual understanding of mathematical skills, the teachers must themselves possess that knowledge and know the best way to impart that information. Elementary teachers, especially at the foundational levels, tend to be more reading-focused and are not as comfortable with a deep understanding of math. Despite learning strategies on the best way to pass a test, the academic progress of third through fifth-grade students has not shown an upward trend. This led to a root cause analysis of why students do not understand how to solve or how to represent word problems. It was determined that both students and teachers need a conceptual understanding of mathematics alongside procedural skills. The problem is clear the self-efficacy of teachers to comprehend how to teach mathematics conceptually needs to increase to affect student understanding and outcomes.

Significance of the Problem

As I have worked with elementary math teachers both in my district and in the state, I have found that through informal conversations and surveys at professional learning sessions a certain number of teachers each year have low self-efficacy with teaching conceptual understanding of mathematics. General education teachers who are not specialists in mathematics education and are responsible for imparting a deep understanding of mathematics can minimize this knowledge and not give it the importance it deserves (Wu et al., 2018). Teachers that did not grow up learning the reasoning behind why mathematical procedures work or have this information included in their teacher preparation program will be unable to pass that information on to their students because the teachers do not possess the understanding themselves (Schubert, 2019). Tricks become the norm for teaching math skills due to the teacher's lack of conceptual understanding (Hurst & Hurrell, 2020).

Teaching mathematics then turns into a short-sighted approach, only looking for a quick fix. Educators should know and understand the vertical alignment of math concepts and skills. Teachers should comprehend the long-term goals of connecting the concepts and seeing the relationships. An immediate significance of the problem of educators not possessing the full knowledge of mathematical conceptual understanding is the need for enhancing the quality of instruction (Richland et al., 2012). Positive student outcomes should be the result of learning not only how to perform mathematical processes and skills but fully understanding the connections, relationships, and the reason mathematics works.

Researchers suggest that some major categories associated with this problem are not enough adequate professional development addressing conceptual understanding in mathematics teaching (Carney et al., 2016; Taton, 2015), teachers using pedagogies similar to how they were taught as students (Yao et al., 2021), and teacher preparation programs failing to address low self-efficacy in mathematics teaching with their pre-service teachers (Briley, 2012; Ozben & Kilicoglu, 2021). Much of the existing literature focuses on pre-service teachers. There is a gap in the literature that focuses on in-service teachers and their beliefs in their abilities to teach math conceptually. Through my study, I concentrated on educators currently teaching in elementary mathematics classrooms, both first-year teachers and experienced teachers. The research purpose was to understand if a sustained professional development program to develop conceptual mathematics understanding had an impact on a teacher's self-efficacy in teaching conceptual understanding.

Research Questions

The purpose of this study was to examine the effects of a sustained professional development program on the beliefs of elementary math teachers' self-efficacy regarding effectively teaching mathematics conceptually. For this study, I focused on kindergarten through fifth-grade math teachers in a north central school district. To assess the value of the professional development program, I sought to answer four main research questions:

1. What is the impact of elementary teachers' participation in professional development focused on teaching math conceptually on teacher self-efficacy?
2. What are the differences in the gain scores of teacher self-efficacy when teaching math conceptually between kindergarten through second-grade teachers and third through fifth-grade teachers?
3. What are the differences in the gain scores of teacher self-efficacy when teaching math conceptually between beginning teachers and experienced teachers?

4. What are the differences in the gain scores of teacher self-efficacy when teaching math conceptually between teachers who received alternative training and certification and teachers who received traditional training and certification?

Personal Context

I am extremely interested in the growth and development of elementary mathematics teachers. As an elementary math curriculum coordinator, my responsibility is to ensure students are successful in understanding mathematics based on the math standards established by Texas. My passion is to bring about that success through an inquiry-based, conceptual understanding of what mathematics entails. To do that, elementary math teachers need to be willing to grow in their own knowledge and practice of teaching math.

I held a training for new teachers five years ago and had them place a dot on a survey to chart their feelings about math when they were growing up. The answer choices included:

1. I do not understand math and feel anxiety when asked to solve a word problem.
2. I tolerate math and feel basic math is necessary but not much beyond that.
3. I can do some math but have no strong feelings either way about it.
4. I am confident in my math skills but do not obsess over them.
5. I LOVE math and think of it in my sleep!

Figure 1

Childhood Math Feelings of Teachers' Survey

Most teachers chose 1, 2, or 3. They were not confident in their math skills growing up and many continued with that same belief as educators. Unsurprisingly, the majority who chose a lower number were kindergarten through second-grade teachers who taught self-contained classes and were more confident in their reading skills than their mathematical understanding. This self-doubt and low self-efficacy in teachers' own math abilities can lead to unintentionally spreading those feelings of inadequacy to students.

Researcher's Background

From the time I was a child, I knew teaching was my calling. I pursued my bachelor's degree in elementary education with a double minor in both reading and mathematics. I could not decide between the two contents I loved equally. I taught in elementary schools, primarily in the early grades of kindergarten, first, and second grade before taking twelve years off to raise my three sons. I went back to teaching when my oldest was in middle school and transitioned into a K-5 math interventionist role when I realized this was a job I would really enjoy. I worked primarily with students who struggled with a conceptual understanding of math and lacked the belief that they were math people. We worked on self-confidence and motivation as much as we investigated math concepts.

I remained in this role for seven years until I advanced into a math instructional coach position. For two years, I collaborated with teachers on improving mathematics instruction. Ultimately, I became the district's elementary math curriculum coordinator. My current role is to determine the math scope and sequence for each grade from prekindergarten to fifth grade. I hold the responsibility for aligning the learning both vertically and horizontally and producing a guaranteed and viable curriculum.

In this role, I have participated in many professional learning sessions and am on a quest to continue learning and growing in my craft and knowledge of math. I have learned a lot about why math works the way it does in these last three jobs. My knowledge and philosophy around mathematics instruction has grown and changed from when I first began teaching. I thought I knew math, especially at the elementary level when I taught primary grades. I have come to realize that I did not fully understand what math meant and why it worked the way it did. I just followed the steps the teachers taught me and felt successful. It was not until much later that I realized math is beautiful and complex. There are patterns and meanings behind all the concepts. I had much to learn to be an effective math teacher.

The Path to Research

While in math classes throughout my childhood, I excelled in getting the right answer because I was particularly good at following directions. I hated word problems, though, because I never knew how to solve them unless there was an example in the textbook. I was a math producer, not a math problem solver. I did not understand the conceptual reasoning behind math. I had only memorized procedures, not why they worked and when to apply them. It was not until I attended a math professional development session while in the role of mathematics interventionist that I learned how to correctly use manipulatives. I received a lesson in what subtraction really means and I had misconceptions influencing how I was instructing my students. I knew how to teach the algorithm or procedure but did not understand subtraction not only means when a part is taken away but also, the difference between two amounts. This small learning had me embark on a journey to discover and explore the conceptual understanding of mathematics.

In my current role as a curriculum coordinator and previous role as an instructional coach, I have had the opportunity to collaborate with teachers in professional learning and to observe them teaching in the mathematics classroom. All the responsibilities new teachers to the profession possess overwhelm them. Classroom management, numerous meetings, assessments, data to analyze, and finding strengths and areas for growth for each of their students consume lots of time. Diving deep into the math curriculum may take a back seat. In the classroom, I observed teachers who are not confident in their ability to answer students' math questions when it goes beyond the planned lesson. During professional development, teachers new to the profession and experienced teachers who have changed grade levels or content areas have described this lack of self-confidence as a direct result of their own childhood negative experiences in the math classroom.

If the goal is to encourage a student's critical thinking and love for math and not repeat the deleterious feelings towards math, the teacher's role proves to be extremely important as the facilitator of math learning. A competent, confident, knowledgeable teacher is necessary to break the cycle of thinking that math is not important enough to pursue in higher educational levels or as a career. As I spend more time examining teachers' practices, I realize the necessity of an elevated level of teacher self-efficacy in mathematical conceptual understanding and teaching.

This realization has driven the search for relevant literature and research questions on how to enhance teacher self-efficacy in teaching math conceptually.

Significant Stakeholders

The primary stakeholders are the elementary math teachers at my north central Texas school district that participated in the professional development sessions on mathematical conceptual understanding. Their input on knowledge gained will impact the professional development plan going forward. Using feedback from completed surveys of the math teachers lead to the artifacts of professional development in understanding and teaching mathematics conceptually. These artifacts benefited the math teachers' knowledge and understanding of how to teach mathematics effectively. In addition, another group of stakeholders are all other elementary teachers in this school district as the creation and implementation of an effective professional development plan will change their experience when attending future professional learning sessions.

Other stakeholders included the campus administrators, district content coordinators, the professional learning and continuous improvement staff, and most importantly, students. Campus administrators saw a difference in the learning going on in the classrooms. There should be more hands-on experiences with understanding taught behind every procedure. More engagement in the classroom happened through deep discussions and inquiry-based lessons. District content coordinators benefited from the development of a professional learning program that is based on audience participation. The understanding of how effective professional development can impact what is happening in the classrooms is influential in designing forthcoming professional development sessions. The continuous improvement and professional learning staff and content coordinators benefited through feedback from contributing elementary math teachers that directed how the continuous improvement cycle helped in all aspects of planning professional learning.

Finally, students are the ultimate stakeholders. The reason for education is to improve our students' minds and futures. By improving teacher self-efficacy and expanding conceptual mathematical knowledge, students should benefit and gain significant mathematical understanding. Student outcomes will be more likely to improve in daily learning, in life choices, and in future careers.

Important Terms

Conceptual mathematical understanding – "comprehension of mathematical concepts, operations, and relations" (National Research Council, 2001, p. 5).

Number sense – "refers to a person's general understanding of numbers and operations along with the ability and inclination to use this understanding in flexible ways to make mathematical judgements and to develop useful strategies for handling numbers and operations" (Mcintosh et al., 1992, p. 3).

Pedagogical content knowledge (PCK) - "goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching" (Shulman, 2013, p. 6). "Includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons" (Shulman, 2013, p. 7).

Procedural mathematical skills – Proficiency in using specific steps to solve a particular type of problem while not being able to generally apply the same steps to other kinds of problems (Rittle-Johnson et al., 2001).

Professional Development (PD) – PD is comprised of diverse ways to learn new topics, concepts, strategies, or pedagogies, including short bursts of learning to longer, sustained over time trainings (Harbour et al., 2022).

Self-efficacy –How people perceive their abilities to accomplish something (Bandura, 1977).

Teacher preparation programs – "a system of interconnected and interdependent learning experiences, including academic and clinical experiences, intended to facilitate the acquisition of an academic knowledge base for teaching, the ability to apply that knowledge base to practice, and the development of capacity to learn in and from practice" (Hollins & Warner, 2021, p. 2).

Closing Thoughts on Chapter I

Admitting a lack of understanding of what one is expected to teach is hard to do. Low self-efficacy in the field of mathematics education is a difficult topic to discuss with others. Teachers who have taught only one year to educators who have been working in the field for multiple years want to be perceived as competent at their job. Knowing the vertical alignment of mathematical concepts and the importance of that crucial, foundational understanding of math is essential to effective instruction of mathematical constructs.

This research study began with an examination of teacher self-efficacy in teaching mathematics conceptually in kindergarten through fifth-grade math classrooms. I implemented a sustained, hands-on, professional development program based on a mathematical conceptual understanding with the teachers. Quantitative data from a survey administered before and after professional learning tracked the effectiveness of the program and the influence on teacher self-efficacy. In Chapter 2, I explored the literature on teacher self-efficacy, along with reasons for low self-belief in the ability to teach mathematics deeply, which includes ineffective professional learning, the quality of teacher preparation programs, and a lack of conceptual mathematics understanding. I discussed the methods and data collection in Chapter 3, the analysis of the data in Chapter 4, and I conveyed my conclusions in Chapter 5.

CHAPTER II

REVIEW OF SUPPORTING SCHOLARSHIP*

Introduction

Teaching mathematics effectively requires educators to understand complex, interconnected topics. For students to grasp these multifaceted ideas, teachers need to engage learners in activities that help develop a deep, conceptual understanding. Teaching mathematics conceptually is often a difficult pursuit for elementary teachers who are typically generalists. The problem arises when educators do not have the self-confidence to teach mathematics conceptually. Teachers who do not fully comprehend the reasoning behind mathematics are less likely to impart that knowledge to their students. If educators teach students the same way they were taught, with little to no understanding, the myth perpetuates that only certain people are “good at math” and deserving of the knowledge of why math works the way it does. To counteract the falsehood that math is reserved for certain people and the rest must just learn procedures without understanding the meaning behind the steps, elementary math teachers need to have the self-belief they are capable of not only understanding the math but can teach it in a way that makes sense to their students. My Record of Study (ROS) concentrated on the development of professional development workshops for elementary math teachers that focused on increasing teacher self-efficacy in teaching math conceptually which should lead to student success in mathematics skills and concepts.

The aim of this review was to examine relevant prior researchers who studied self-efficacy of teachers followed by explanations for various levels of teacher self-belief. The review begins with the definition and historical background of self-efficacy. Following that is the theoretical and conceptual framework that defined the study. Next I presented the relevant prior literature on teacher self-efficacy, which includes how mathematics was learned influences self-efficacy, struggles with mathematics in the early years of learning, and how student outcomes and success are all affected by the teacher's self-belief in the ability to understand and teach mathematics conceptually. I then explored how teacher self-beliefs in their teaching ability affect student self-efficacy. Following that is a glimpse into the potential factors that influence a teacher's confidence in their ability to teach mathematics, including conceptual understanding of mathematics, effectiveness of teacher preparation programs, and the impact of professional learning. Lastly, I discussed concluding thoughts on how sustained professional learning can bolster elementary teachers' mathematics content knowledge and pedagogy.

Historical Background of Self-Efficacy

Researchers have discussed the concept of efficacy for many years. Bandura (1977) was one of the first researchers to clearly describe efficacy and its effects. In Bandura's (1977) seminal article, he defined efficacy expectations as the belief that a person can successfully implement the behavior necessary to generate the desired outcome. Self-efficacy, therefore, would be the belief in one's own ability to enact the essential behavior to reach the preferred result. Similarly, Usher et al. (2019) stated "Self-efficacy, or the belief in one's capability to perform a given task, is another psychosocial factor shown to predict success" (p. 877). Building on Bandura's (1977) self-efficacy theory, Tschannen-Moran et al. (1998) declared that self-efficacy had more to do with self-perceived competence instead of actual competence. The belief that one has the capability to behave in a way that will produce an anticipated outcome is the consensus of the definition of self-efficacy.

Accordingly, self-efficacy in mathematics is the belief that one is capable of understanding and performing a math task or problem to achieve the outcome wanted. Bandura (1977) stated self-efficacy is specific to individual tasks, unlike self-esteem or self-worth. Possessing self-efficacy in mathematics is the understanding that one has the confidence in their ability to be successful on a specific problem, task, or situation (Hackett & Betz, 1989). In fact, research has linked high self-efficacy to influencing teacher and student attitudes towards mathematics leading to student achievement and future career choices in mathematical fields (Hackett & Betz, 1989; Tschannen-Moran et al., 1998). Having high efficacy expectations affects the amount of effort one will put forth and increase their stamina and grit when faced with challenges (Bandura, 1977). Teacher mathematical self-confidence is the belief that one is fully capable of understanding and teaching mathematical concepts to the highest ability.

Theoretical and Conceptual Framework

Bandura (1977) developed the self-efficacy theory which states a person builds belief in themselves through four sources: "performance accomplishments, vicarious experience, verbal persuasion, and physiological states" (Bandura, 1977, p. 195). He believed how well one performed successfully on previous tasks, watching an efficacious person achieve a successful outcome, other's belief and persuasion that the person is capable of accomplishing things, and being familiar with emotional reactions to disagreeable situations, all have a significant impact on a person's efficacy. The self-efficacy theory is grounded in social cognitive theory. This theory maintains a person's beliefs, actions, and environmental conditions determine their achievements (Bandura, 1977; Schunk & Pajares, 2002). The self-efficacy theory frames this study of what impact a sustained professional learning program can have on a teacher's self-belief of mathematical conceptual understanding and their ability to teach mathematics effectively.

The conceptual framework presented in Figure 1 lays out the foundation of the literature review. A myriad of factors forms teacher self-efficacy. An educator's sense of conceptual understanding of mathematics, the effectiveness of the attended teacher preparation program, and any professional learning a teacher received all influence a teacher's sense of self-belief in their ability to teach mathematics with a deep level of understanding. A sustained, rich in understanding, and value-laden professional development program can potentially increase a teacher's mathematical self-efficacy and hopefully increase student success in mathematics.

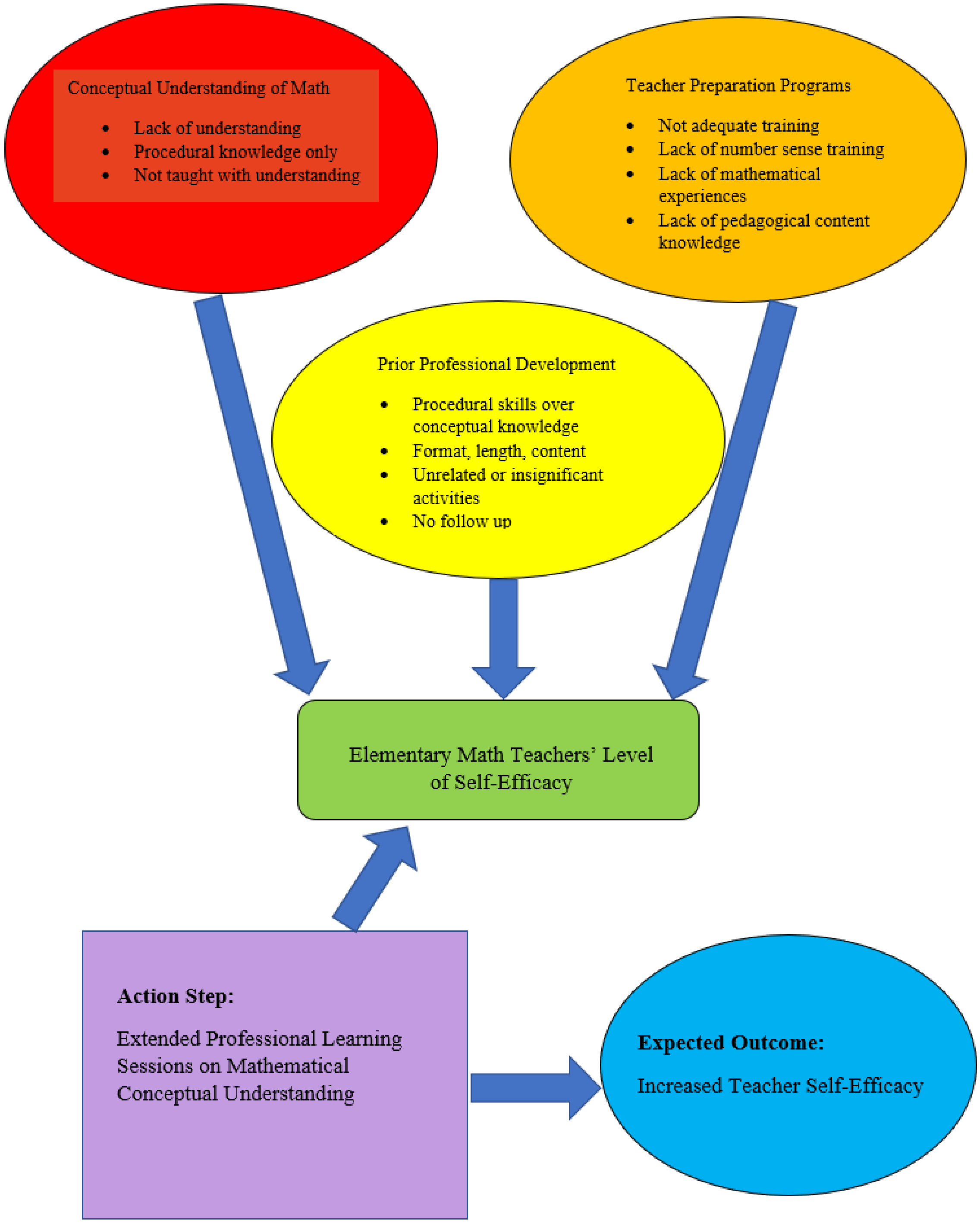

Figure 2

Conceptual Framework

Most Significant Research and Practice Studies

Teacher Self-Efficacy

An educator's belief in their ability to teach math conceptually depends on their formative childhood education in mathematics and the learning they received with their professional responsibilities. Researchers have discovered struggling with mathematical concepts as students themselves resulted in teachers possessing low opinions of their ability to teach mathematics (Rushton et al., 2016). Furthermore, researchers have found, "To be effective, teachers must know and understand deeply the mathematics they are teaching and be able to draw on that knowledge with flexibility in their teaching tasks" (National Council of Teachers of Mathematics, 2000, p. 17). Effective teaching of mathematics is complex and can create a strain on teachers (Rushton et al., 2016). Researchers have determined that self-efficacy is the consequence of how teachers first processed any mathematical experiences they had (Henson, 2001). If educators do not acquire the mathematical conceptual understanding in their own learning, passing on the knowledge needed by students becomes increasingly more difficult.

A teacher's self-efficacy can directly influence student outcomes. An educator's beliefs in their own ability to teach mathematics in a conceptual way leads to teacher-provided opportunities to students through sense making activities and lessons with challenging mathematical tasks (Riggs et al., 2018). Teachers who rate themselves as holding high self-beliefs in their mathematical pedagogical knowledge (PK) used skills and instructional strategies learned in professional development sessions more than educators with low self-efficacy (Zee & Koomen, 2016). In contrast, Brown (2005) observed that the efficacy of some early childhood educators did not bring about highly effective instructional strategies used in the classroom but did find teachers with higher self-efficacy rated mathematics learning as more valuable than teachers with low mathematical self-efficacy. A teacher's own belief of their ability to teach mathematics with conceptual understanding should positively impact student achievement.

Teachers' self-confidence in their mathematics teaching ability is related to student success in the classroom. Through the belief that a teacher holds in their capability to impart mathematical conceptual understanding to students, enhanced instructional quality is shown through "the three dimensions of cognitive activation, classroom management, and individual learning support" (Holzberger et al., 2013, p. 782). Conversely, teaching quality and success of students could be at risk if teachers do not possess confidence they are ready to teach with full understanding of the mathematics involved (Chang, 2010). Student mathematics achievement is associated with math teachers' self-efficacy in their belief of their mathematical teaching ability, signifying higher self-efficacy for teaching math results in stronger math achievement (Perera & John, 2020). Figure 3 constructed by Perera and John (2020) shows the link between teacher's belief in their teaching ability to higher student outcomes. Research has connected teacher self-efficacy to student outcomes through their teaching and pedagogical knowledge.

While teacher self-efficacy affects student outcomes, the confidence a teacher holds in their own teaching ability also affects a teacher's belief in students' capabilities to understand and perform mathematical skills and tasks at an elevated level of success. Riggs et al. (2018) concluded the following about student success in understanding math conceptually:

> Success in these areas depends partly on teachers' self-efficacy to teach mathematics with an emphasis on mathematical practices and conceptual understanding, and their outcome expectancy, that is, their belief that students are capable of learning mathematical concepts and engage effectively in mathematical practices. (p. 385)

Teacher self-efficacy is critical for teacher motivation, innovation, student engagement, and most of all, student performance (Mielke, 2021). On the other hand, Guskey (2020) found that while teacher self-efficacy and student outcomes are intertwined, the order differs from what other researchers believed. Guskey (2020) found that positive student outcomes preceded a change in teacher beliefs about their ability to teach mathematics conceptually. In either scenario, student outcomes and teacher beliefs in their teaching ability and students' learning abilities are irrevocably linked.

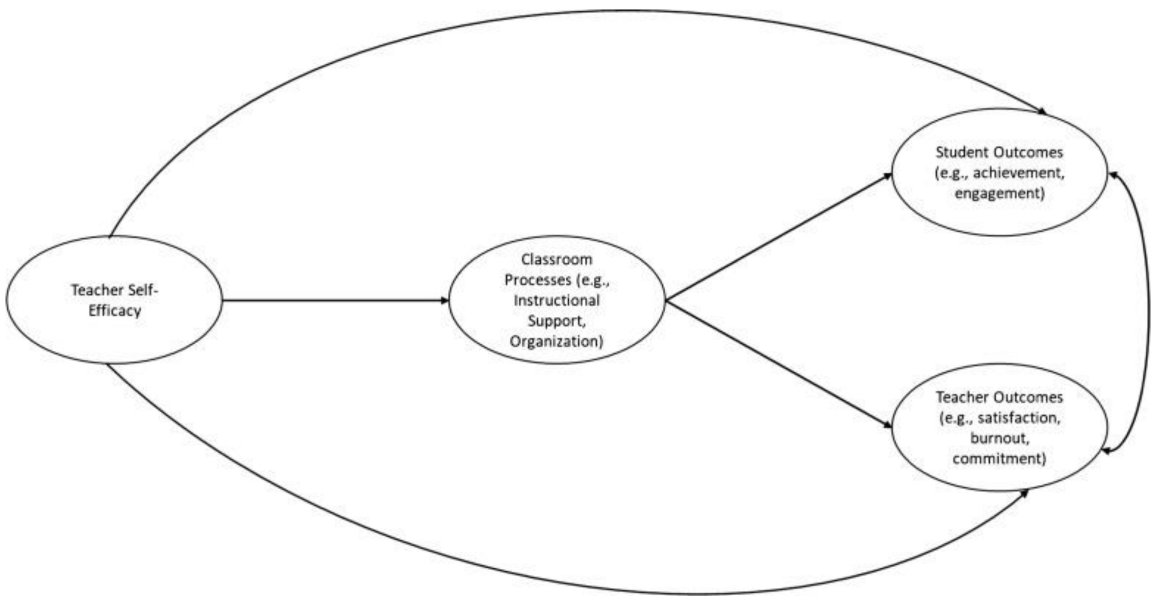

Figure 3

Heuristic Model of Teacher Self-Efficacy in Relation to Classroom Processes, Student Outcomes, and Teacher Outcomes by Perera and John, 2020.

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Student Self-Efficacy as Result of Teacher Self-Beliefs

A teachers' high belief in their ability to understand and teach mathematics with full understanding can impact a student's sense of self-efficacy generating positive math outcomes. Although a teacher's self-efficacy may affect a student's mathematical success, it only has an effect for the time the teacher is working with the student (Holzberger et al., 2013). When a student is experiencing math anxiety, or low self-efficacy, they remain in the cycle of hating math, avoiding mathematical tasks, low math achievement, back to feelings of worthlessness regarding mathematical thinking and problem solving, which bolsters their feelings of anxiety (Schubert, 2019). Counteracting the feelings of low self-efficacy, a teacher has the power to change students' thinking if that teacher possesses high self-efficacy. Miller et al. (2017) discovered teachers with positive self-beliefs in mathematical teaching influenced a larger increase in student achievement of remedial classes. Most likely, this was due to the teacher's belief that they were effective teachers. Increasing pre-service teachers' fluency in mathematics teaching causes affirmative beliefs in their teaching ability improving student outcomes as a result (Rushton et al., 2016). A main responsibility of math educators is to make certain students have positive mathematical experiences imparted with effective, proven instructional strategies that place an emphasis on conceptual understanding over correct answers (Schubert, 2019). To strengthen student mathematical self-efficacy and success, educators have the duty to enhance their own beliefs in their ability to teach mathematics with understanding.

Conceptual Understanding (vs. Procedural Skills)

Conceptual understanding and procedural skills are interrelated yet separate. Researchers defined procedural fluency as the ability to perform methods "flexibly, accurately, efficiently, and appropriately" (National Research Council, 2001, p. 5). Procedural skills involve following set processes or steps to solve a problem and may not be easily applied to any situation (Rittle-Johnson et al., 2001). Teaching procedural skills is comprised of showing students the exact steps to find a solution without necessarily revealing why those steps will produce an accurate answer (Mann & Enderson, 2017). On the other hand, conceptual understanding entails the deep comprehension of the rules and reasoning behind mathematical concepts (Rittle-Johnson et al., 2001). One definition of conceptual understanding is the "comprehension of mathematical concepts, operations, and relations" (National Research Council, 2001, p. 5). One can then apply this knowledge to different situations, and it becomes generalizable learning (Mann & Enderson, 2017). Without learning both the reasoning behind a math concept and how to solve a problem with an efficient procedure, incomplete mathematical knowledge hampers a student. As Van de Walle et al. (2014) described, "The ineffective practice of teaching procedures in the absence of conceptual understanding results in a lack of retention and increased errors" (p. 27).

Knowing the difference between procedural and conceptual understanding of math concepts influences how a teacher presents the information to students. Conceptual understanding involves not only knowledge of the reasoning behind the math but also the connections between concepts (Richland et al., 2012). Teachers must deeply understand the mathematics they are teaching to ensure students will be successful (Siegler & Lortie-Forgues, 2017). Understanding the distinction of procedural skills versus conceptual understanding is often determined by teachers' experiences with mathematics as learners themselves and what they believe knowing mathematics means (Bartell et al., 2013). Pre-service teachers bring their background experiences and learning with them and to increase their existing knowledge, educators should provide future teachers conceptual teaching activities that allows them to make connections between prior knowledge and new understandings (Johnson & Olanoff, 2020). A mathematics educator should understand and employ both procedural routines and activities that will enhance conceptual understanding to ensure student success.

The importance of students possessing mathematical understanding in a conceptual way cannot be emphasized enough. A worthy student goal is to develop a conceptual understanding of mathematical topics (Yao et al., 2021). Flexible thinking about numbers and patterns and finding connections between concepts is a high-level skill that all students should acquire (Richland et al., 2012). Researchers discovered students' conceptual understanding and attitudes about mathematics are the best way to forecast future performance in mathematics (Andamon & Tan, 2018). "By asking students to remember procedures but not to understand when or why to use them or link them to core mathematical concepts, we may be leading our students away from the ability to use mathematics in future careers" (Richland et al., 2012, p. 190). Students' future job prospects depend on their full understanding of mathematical concepts and the connections they make between those concepts.

To ensure students receive valuable instruction to develop mathematical conceptual knowledge, teachers must believe in their own ability to comprehend and teach conceptually and not solely rely on procedural knowledge. Yao et al. (2021) found 99% of educators in a teacher preparation program could perform procedural computations with division of fractions but had trouble understanding the conceptual understanding behind what they were doing. Johnson and Olanoff (2020) discovered pre-service teachers often felt they knew mathematics well enough to teach in elementary school classrooms, but further research proved they lacked the conceptual understanding needed. More than two-thirds of the future teachers said they learned with only procedurally based methods with an emphasis on following steps without understanding the purpose or reason for the steps (Johnson & Olanoff, 2020). When pre-service teachers do not have the background content knowledge needed to teach, they often cannot recognize the difference in student procedural responses and conceptual understanding (Bartell et al., 2013). To move to conceptual teaching, understanding, and higher self-efficacy, teachers should ask themselves if they possess the organizational ability and the instructional strategies necessary to teach at the preferred level and if so, what could be the possible outcomes produced by that teaching (Chang, 2010). Once educators achieve mathematical conceptual understanding, student instruction reaches a higher level of success.

Understanding mathematics conceptually involves using one's number sense. The ability to work fluently with numbers and make sense of relationships between numbers is at the crux of the meaning of number sense. According to Burns (2015),

> Students with good number sense can think and reason flexibly with numbers, use numbers to solve problems, spot unreasonable answers, understand numerical relationships, take numbers apart and put them together in different ways, make connections among operations, figure mentally, make reasonable estimates, and see numbers as useful. (p. 51)

On the other hand, students who do not possess good number sense are inclined to use procedures without reasoning and cannot understand or notice when their answer is unreasonable (Burns, 2015). Possessing number sense signifies an overall understanding of numbers and the capability to be flexible in mathematical thinking and the use of efficient strategies for operations (Mcintosh, 1992). Conceptual mathematical understanding encompasses the insight of how numbers relate and how to use numbers in ways that make sense. Having the ability to fully comprehend mathematical concepts and being able to employ number sense allows teachers to achieve the positive self-efficacy necessary to be effective educators.

Teacher Preparation Programs

Teachers' beliefs about their understanding of how to teach math conceptually clearly affects their math teaching ability. Confidence in their own mathematical problem-solving capabilities directly influenced a teacher's beliefs in their ability to teach math successfully (Briley, 2012; Ellez, 2020). When an educator understands how numbers work and possesses number sense, they will be better prepared to transfer that knowledge to the students in their classrooms (Briley, 2012; Courtney-Clarke & Wessels, 2014). On the contrary, when teachers do not feel as if they hold sufficient mathematical content knowledge, they can exhibit anxiety, which in turn impacts student learning negatively (Ozben & Kilicoglu, 2021). Teacher mathematical self-efficacy is a vital component of achieving the desired student outcomes.

One way that has promoted high teacher self-efficacy that in turn influences teaching ability is strong teacher preparation programs that contain courses that promote conceptual mathematical understanding. Teacher education programs can have powerful effects on growing teacher self-efficacy by providing meaningful activities, thought-provoking reflections and deep conversations and dialogue to construct positive mathematical beliefs (Briley, 2012; Peace et al., 2018). Teacher educators who teach both mathematical content and pedagogical strategies are most effective in building the belief that a teacher has the capability to impart conceptual understanding to students (Peace et al., 2018). Preservice teachers who exhibit high self-confidence in their ability to understand math display positive attitudes about teaching mathematics (Courtney-Clarke & Wessels, 2014; Ellez, 2020). A robust teacher preparation program that endorses full understanding of mathematical content and pedagogical knowledge will produce future educators whose beliefs and confidence are strong and will pass on this strength to their future students.

However, when educator programs do not provide adequate training in mathematical content knowledge and pedagogy, future educators do not feel prepared for teaching math conceptually. Researchers have discovered that many pre-service teachers do not feel their teacher preparation programs sufficiently equipped them for teaching math (Ozben & Kilicoglu, 2021). Many pre-service teachers presently in education preparation programs have limited number sense and feel that their mathematical understanding is very procedural and full of recall and memorization (Courtney-Clarke & Wessels, 2014; Peace et al., 2018). A longitudinal research study examining teacher self-efficacy from pre-service teachers through two years of teaching in the classroom, demonstrated an increase in teacher self-beliefs while they were in the teacher preparation program, but these beliefs changed as they moved into their own classrooms (Thomson et al., 2020). Thus, pre-service mathematics teachers “are a product of how and what they were taught in schools and will, without an appropriate education at tertiary level, carry the same practices forward to their own teaching at school" (Courtney-Clarke & Wessels, 2014, p. 2). When teacher preparation programs are ineffective, the pre-service teachers in these programs feel a sense of low self-efficacy leading to minimal confidence and doubts in their future teaching abilities (Chang, 2010). In preparing future teachers for a successful mathematics teaching career, teacher educators must give attention to increasing self-confidence in their mathematical understanding.

Professional Development

A need exists for effective professional learning to counteract low teacher self-efficacy in teaching math conceptually. In the past, professional development has been static and stagnant emphasizing procedural skills over conceptual knowledge (Heck et al., 2019; Taton, 2015). Professional learning that focuses on the transition to conceptual mathematics teaching should support the advancement of teacher self-efficacy (Gabriele & Joram, 2007). For example, concentrating on improving teachers' beliefs in their ability to understand and teach math with a deep understanding through professional development will influence teachers' content and pedagogical knowledge (Carney et al., 2016; Corkin et al., 2015). As a result, a teacher will use their knowledge of mathematical pedagogical teaching knowledge to influence their planning, pacing, activities, and responses to student understanding (Seago & Knotts, 2021), which useful professional learning sessions will use to impact teacher self-efficacy. Researchers have shown teachers with an elevated level of self-efficacy in mathematical understanding are more willing to incorporate their learning from professional development than teachers with lower self-efficacy (Zee & Koomen, 2016). Valuable professional development based on the format, length, and content of the planned sessions is crucial for boosting teachers' beliefs in their conceptual math teaching ability.

Job-embedded professional learning sustained over a longer period is much more constructive than a one-time training. Darling-Hammond et al. (2009) stated that nearly 90 % of teachers surveyed reported any professional development they had attended was of a short-term nature. To be effective in transforming teacher self-efficacy, presenters should hold sustained professional learning sessions and root the sessions within the environment of the classroom stretched over time to deeply cover mathematical concepts to assist teachers in understanding math conceptually (Althauser, 2015; Frances & Jacobsen, 2013; Henson, 2001). Researchers found that the format of the professional learning sessions; online, face-to-face, independent participation, or with a large group, is not a hindrance as much as the duration and relevance to teachers' needs that make the learning sustainable and important (Heck et al., 2019; Seago & Knotts, 2021). The necessity for spreading professional learning over longer interludes is also more effective when paired with targeted activities during the sessions that are relevant to the needs of the teacher.

Appropriate conceptual building activities for teachers to experience during professional learning can be the vital missing piece that will enhance a teacher's self-efficacy which can improve their teaching. Taton (2015) found teachers who experienced uninspiring professional learning filled with unrelated or insignificant activities were often unable to impart a love of mathematics to their students. On the other hand, activities that encouraged collaboration among teachers impacted their self-beliefs in conceptual math teaching (Francis & Jacobsen, 2013; Henson, 2001). "Active/practice-based learning" (Heck et al., 2019, p. 338) can strengthen a teacher's pedagogical and content knowledge which in turn influences self-efficacy. Problem-solving along with investigative challenges related to the concrete, relevant needs of teachers lead to changes in teacher beliefs (Althauser, 2015; Carney et al., 2016; Darling-Hammond et al., 2009). By fully immersing teachers in applicable professional learning experiences, an educator will start to believe in their own ability to understand math conceptually.

Professional development activities that are engaging and supportive of conceptual understanding of mathematical thinking will advance student understanding and attainment of their own mathematical identity. Activities that provide "direct guidance, example teaching models or positive and prompt feedback" (Chang, 2010, p. 294) improve future teachers' efficacy. Professional development learning sessions should use activities that link improving teacher self-efficacy to pedagogical content knowledge and include instructional coaching in the classroom environment (Livers et al., 2020). The goal of strong, effective experiences of math conceptual understanding is always to convey value-added learning for students increasing their efficacy through educator's professional learning (Tschannen-Moran & Woolfolk Hoy, 2001). Hands-on, conceptual knowledge of mathematical processes and concepts is best conducted through sustained professional learning activities that an educator can transfer into their classroom pedagogy to improve student achievement.

Closing Thoughts on Chapter II

The literature examined for this Record of Study demonstrated a need for high teacher self-efficacy in teaching math conceptually. Prior researchers have focused on pre-service teachers' mathematical self-efficacy and reasons explaining their level of self-belief. Conceptual understanding of mathematics (Bartell et al., 2013; Johnson & Olanoff, 2020; Siegler & Lortie-Forgues, 2017), teacher preparations programs (Briley, 2012; Peace et al., 2018), and professional development (Heck et al., 2019; Seago & Knotts, 2021; Taton, 2015) can enhance or detract from the self-efficacy level of educators. By examining the existing prior literature, a need emerged to study current in-service mathematics teachers' levels of self-efficacy focused on teaching math conceptually which researchers have not previously measured at the same level as pre-service teachers. Prior researchers (Carney et al., 2016; Corkin et al., 2015; Darling-Hammond et al., 2009) have demonstrated the possibility of increasing a teacher's self-belief by attending sustained professional learning sessions focused on mathematical conceptual understanding and sound pedagogical practices.

CHAPTER III

SOLUTION AND METHOD

Solution

The problem of practice for this study was that some of our district elementary math teachers do not believe they are capable of understanding or teaching mathematics at the conceptual level. A teacher who has low mathematical self-efficacy will often experience lower student outcomes (Riggs et al., 2018; Rushton et al., 2016; Tschannen-Moran et al., 1998). For this study, mathematical self-efficacy is defined as teachers' belief that they can teach mathematics conceptually and effectively for positive mathematical results. To address a teacher having diminished self-efficacy of mathematics understanding and instruction, one solution was to provide all elementary math teachers effective, sustained professional learning that modeled how to teach mathematics conceptually (Heck et al., 2019; Johnson & Olanoff, 2020). Previous research showed that sustained professional learning leads to improved student achievement (Darling-Hammond et al., 2009; Kennedy, 2016; Taton, 2015). In this study, professional development was over a course of five months and involved hands- on learning, time to implement learned strategies into classroom activities, and time to reflect (Birman et al., 2000; Loucks-Horsley et al., 2010). Incorporating sustained time and relevant content into the professional development program encouraged teachers to grow in their knowledge of successful math pedagogy thus increasing their self-belief in their ability to teach mathematical concepts effectively (Desimone & Pak, 2017; Kennedy, 2016).

Listening to elementary math teachers' thoughts and feelings about their own math experiences as students during math professional training drove the need to design a professional learning program that would address concerns of educators not understanding math concepts fully. I created an artifact consisting of a professional learning program with three separate sessions over five months focusing on teaching mathematical operations conceptually. The intentional spacing of the program ensured time for teachers to implement strategies they learned in a session and reflect on the effectiveness of their learning, thereby, increasing their self-efficacy in teaching mathematics with full conceptual understanding (Birman et al., 2000; Desimone et al., 2002; Harbour et al., 2022).

Outline of the Solution

The design of the professional development program required some foundational steps to start. This is necessary because the format and structure of the program needed to be set in place before the study commenced. The study began with the creation of a professional learning structure called Curriculum Learning Communities (CLCs), with teacher facilitators leading the sessions. Utilizing district leaders' feedback, I ensured that the professional development program aligned with improved teacher self-efficacy in the action of successful conceptual mathematics teaching and positive student outcomes (Loucks-Horsley et al., 2010). The main purposes of the professional development (PD) structure were to:

- develop a sustainable, frequent, and ongoing job-embedded PD model,
- develop teacher leaders with a focus on building leadership skills,
- align ongoing content-specific professional development across the district,
- and align content-specific research-based practices across all classrooms.

The next step was to design a protocol for carefully choosing teacher trainers who were willing to learn and impart that information to a group of kindergarten through fifth-grade math teachers. Examining STAAR math scores and district common assessment scores from the past two years led to an initial list of possible facilitators who demonstrated that they possessed effective math content knowledge. Through classroom observations, I narrowed the list down by using the criteria of teachers who follow the district curriculum, use the Math Workshop Model (Lempp, 2017), get strong student results, have an effective classroom management system, have a growth mindset, and are effective and approachable when working with adults. Principal input, along with feedback from other content coordinators, and the director of professional learning helped in choosing the teachers based on cohorts within the district.

There were four cohorts for kindergarten through second-grade teachers with four to five campuses forming each cohort. In third through fifth grade, there were two cohorts with eight to nine campuses in each cohort. Due to the departmentalization of third through fifth grades, there are fewer math teachers in these grades as compared to the primary grades, thus requiring fewer cohorts. The two district instructional math coaches and I trained these facilitators before each professional learning session. The teacher facilitators then led the larger trainings with all elementary math teachers in the district while following the developed program.

The trainings consisted of hands-on activities based on computational strategies that focused on place value and the understanding of how and why the strategies work. Each session was approximately three hours in length. The trainings immersed teachers in the full student experience introducing them to a topic with an engaging opening, then taking part in activities that strengthened their understanding of mathematics, and finally culminating in a reflection time that connected the activity to the learning target for the session. The trainers gave the teachers a task to complete with their students in the intervening weeks before the next session. When meeting at the next training session, teachers had time to share the results of the activities with their students and any insights they had into the success of the implemented strategies.

Justification of Solution

A series of three professional development sessions designed for maximum effect on teachers' self-efficacy in teaching mathematics conceptually were the developed artifacts for this study. The creation of the professional learning program addressed findings found in the literature review primarily growing teacher self-efficacy by concentrating on conceptual understanding of math topics. When teachers have not had adequate preparation or training in pedagogical content knowledge and feel they have insufficient knowledge, they do not feel equipped to teach to the depth needed to achieve positive student outcomes (Ozben & Kilicoglu, 2021). The created professional development program helped train the teachers in effective ways to teach mathematics.

High-quality professional learning that is valuable has at least six factors as shown by research. Heck et al. (2019), found that effective professional learning experiences involve the fundamentals of 1) duration, 2) specific focus on content, 3) consistency in the message, 4) learning while doing or practicing, 5) collaboration, and 6) expert facilitators. The professional learning program presented to the math teachers strategically contained all these elements to maximize the learning of the participants. Capraro et al. (2016) emphasized that sustained professional development that includes high-quality components can improve teacher actions leading to increased student outcomes. Figure 4 shows how the artifact of the professional development program incorporated these explicit features of a successful professional learning event.

Teachers often learn best by immersing themselves in experiences that directly mimic what their students will undergo (Capraro et. al, 2016; Loucks-Horsley et al., 2010). A mathematics lesson that builds conceptual understanding modeled to the teachers increases teacher self-confidence when they can take back and implement that knowledge in their own classroom. Wolf and Peele (2019) asserted that teachers will continue using changes to their practice when involved in long-term and ongoing support through professional development. Collaboration between teachers on the same grade level enhanced the learning experience for all teachers and place value on the professionals who are participants and trainers in the learning (Loucks-Horsley et al., 2010).

Figure 4

Elements of a Successful Professional Learning Program

Rationale for Professional Development Activities

Each professional development session activity was purposefully chosen to meet the district's needs and to ensure that elements of high-quality professional development (Heck et al., 2019) are incorporated. I examined the STAAR math data and district common assessments data from the past three years and determined that the district's computational strategies were a low area. The data were reviewed with the teachers at the beginning of each session to clarify the purpose of learning how to teach computational strategies conceptually.

Each professional development session focused on upcoming computational strategies and the pedagogical knowledge needed to teach those strategies with conceptual understanding. I examined the district's math scope and sequence to determine what computation skills will be needed in the time between the professional development sessions. The first professional learning session concentrated on counting for kindergarten, addition strategies for first grade, subtraction strategies for second through fourth grades, and division for fifth grade. The second professional learning session had the overarching objectives of comparison of numbers for kindergarten, subtraction for first and second grades, and multiplication for third through fifth grades. The third professional learning session focused on addition and subtraction for kindergarten through second grades, multiplication for third grade, and addition/subtraction of fractions for fourth and fifth grades. All model lessons were chosen based on the upcoming computation focus and gathered from the district resources. The artifacts in Appendix F contain more detailed information on the activities and model lessons that were presented at the professional learning sessions.

Study Context and Participants

This study is situated in a fast growth local school district that currently has about 21,000 students. The current growth trend projects that the school district will gain an additional 1,200 students each year for the next five years. The district has 17 elementary schools for kindergarten through fifth grade. The district is comparable to other mid-size districts in the area in population and demographics. In academic achievement, the district is typically even with the region and state in science scores on STAAR but falls just short of matching region and state scores in math and reading for 3rd and 4th grades (TEA, 2021). The fifth-grade scores are usually slightly above the region and state scores on STAAR. I had access to work with all elementary math teachers in the district in my role as the elementary math curriculum coordinator. Consequently, I had a large pool of about 300 teachers who participated in the professional learning program.

The participants included math teachers in a north central school district from grades kindergarten through fifth grade. The educators teach a mathematics course for at least 60 minutes a day to be involved in the study. I invited the math teachers from the district to fill out a survey both before three scheduled professional learning sessions and after completing the whole program. The teachers come from varied educational backgrounds and experiences. There are teachers who completed a traditional teacher preparation and certification program and those who have an alternative certification who have no student teaching experience. The range of experience is from first-year teachers to those with over 30 years of experience. There are approximately 205 kindergarten through second-grade teachers and 102 third through fifth-grade math teachers. The primary teachers are all self-contained teachers meaning they teach one class of students all day for all content areas. Schools typically departmentalize the upper elementary teachers so that they usually teach either only math or a combination of math and science. The school district requires all elementary math teachers to attend and participate in professional learning programs throughout the 2022-2023 school year. Teachers had a choice of whether to fill out the surveys and take part in the data collection of the study.

A power analysis was conducted to determine the minimally detectable effect size given the number of participants expected in this study. To demonstrate if the design study will determine if there are statistically significant effects, a sensitivity power analysis was conducted for the overall research question of measuring the differences between the pre-test and post-test results on self-efficacy for all participants. Given the expected number of participants at 302, α =0.05, power equal to 0.8 (ß =0.20), the minimally detectable effect size (MDES) is as small as d = 0.14 to detect pre-post differences. This is a small effect size which indicates the study has an acceptable number of participants.

A second power analysis was conducted for the *t*-tests that will be performed comparing kindergarten through second-grade teachers to third grade through fifth-grade teachers. Using the same α = 0.05, power equal to 0.8 (ß =0.20) with a sample size of 200 for kindergarten through second-grade teachers and 100 third grade through fifth-grade teachers, the MDES is d = 0.30. This is a small effect size. Thus, the sample size is adequate.

Last, a power analysis was performed on the comparison of three groups of participants with levels of experience ranging from 0-1 years, 2-5 years, and more than 5 years of experience. An ANOVA statistical test will be used for this planned comparison. Again, for the power analysis, the α =0.05, power equal to 0.8 (ß =0.20), and the total sample size is 300 teachers divided into the three levels of experience groups. Given the total number of participants with an 80% power, the MDES effect size is as small as *d* = 0.18. This small effect size shows that the sample size of 300 is adequate to conduct the research study to detect small effects.

Even if there were not enough completed pre-and post-survey data, with an estimated 25% attrition rate, a power analysis was completed taking the MDES for kindergarten through second grade vs. third through fifth-grade comparison which had the largest MDES of *d* = 0.30. The study would still be able to detect an effect size as small as *d* = 0.40. Consequently, the sample size is adequately powered to detect an effect size that is small to medium. At a participation rate of approximately 225, the power analysis concluded the sample size would still be adequate.

Implemented Research Paradigm

The study used a quantitative, non-experimental, pre-and post-test design to study the influence of a professional development program on elementary math teachers' self-efficacy as it relates to the ability to understand and teach math conceptually (Creswell & Creswell, 2018; Evans et al., 2016). Grounded in Bandura's (1977) self-efficacy theoretical framework, which involves the belief that experiential knowledge will influence and alter self-efficacy, I chose the quantitative research approach to evaluate the relationship between sustained professional development on teaching math conceptually and teacher self-efficacy. Due to the considerable number of teachers participating in the study, I wanted to use quantitative research methods to discover if a professional development program sustained over five months that was intentional and purposeful in content and employed on a large-scale audience can influence a teachers' self-efficacy in teaching conceptual understanding of math.

A postpositivist paradigm will guide this study. Postpositivism states that a particular variable or causes put into place create outcomes (Creswell & Creswell, 2018). Quantitative research designs with a postpositivist paradigm start with a theory, gather data to prove or disprove the theory, adjust the theory, and perform additional research studies (Creswell & Creswell, 2018). In this quantitative research investigation, I assessed a theory that asserts a sustained over time, professional learning program focused on teaching conceptual mathematics will advance an educator's self-efficacy in teaching math conceptually in a positive manner. The implemented professional development program ran from August to January with a final reflection time in February. I gathered data through teacher pre-and post-surveys to identify any change in their self-efficacy. The data either supports or disproves the theory of sustained professional development enacting a positive change in teacher mathematical self-efficacy. I analyzed, reflected on, and discussed the data to see if I needed to make any changes in future professional development sessions.

Data Collection Methods

After obtaining Institutional Review Board (IRB) determination of "Not Human Research" from Texas A & M (see Appendix A) and IRB approval from the Deputy Superintendent of the school district, I collected data from a pre-and post-survey using the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) designed by Enochs et al. (2000) (See Appendix B). At the beginning of the professional development program, I invited approximately 300 math teachers to complete the survey. Through a video and email, I informed the teachers of the purpose of the study, which was to determine if a sustained professional development program on understanding mathematics conceptually would increase their self-efficacy in teaching math. I described any benefits or risks inherent in participating in the study. Increased student outcomes and improved mathematical understanding by the teacher are the benefits. Risks can include teacher vulnerability in expressing their lack of mathematical understanding, whether it be the admission of not understanding or not being willing to admit their lack of understanding due to feelings of shame. I apprised the participants of my plan to maintain anonymity throughout the study by assigning a unique number to each participant after matching their pre-and post-survey results. The study did not use any names. I will delete all data stored on a district computer at the end of a five-year period.

I delivered the survey electronically through Microsoft Forms with twenty-one questions from the original MTEBI using a Likert scale of 1 to 5 with 1 representing Strongly Disagree to 5 signifying Strongly Agree (slightly modified from the original to fit the digital format). The questions on the MTEBI focus on two areas, thirteen questions on the teacher's "Personal Mathematics Teaching Efficacy (PMTE)" and 8 questions on "Mathematics Teaching Outcome Expectancy (MTOE)" (Enochs et al., 2000, p. 194). In other words, the subscales of the survey evaluated a teacher's belief in their own ability to teach mathematics and their belief in what the student results will be based on the teacher's lessons. I added ten additional questions to examine the relationship between professional development in teaching computational strategies with conceptual understanding and teacher self-efficacy. I examined results from both pre-and post-surveys to gauge any changes in teacher self-efficacy after participating in the five-month professional learning program on mathematical conceptual understanding.

I added additional questions to the survey to gather demographic information. This aided in stratifying and categorizing the data and answering the research questions. The added questions include:

1. How many years have you taught (not including the current year)?

2. What grade level are you currently teaching?
3. Did you attend a traditional teacher preparation program (4-year university with student teaching involved)?
4. Did you receive a traditional teaching certification?
5. Did you attend an alternative teacher preparation program?
6. Did you receive an alternative teaching certification?

Maintaining confidentiality and privacy is paramount to conducting a valid research study. In the role of Elementary Math Curriculum Coordinator, I let participants know at the onset of the trainings that there will be no power imbalance as I am not an evaluator, nor will I share information with any potential evaluators. After collecting the data from the pre-and post-surveys, I removed any identifying information and assigned a unique identification number to each participant after matching the post-survey answers to the correct respondent's pre-survey answers.

Rationale for Additional Statements to Survey

Additional statements were added to the MTEBI that focus on specific teacher self-efficacy beliefs on teaching computational skills conceptually as compared to teaching data analysis and measurement skills effectively in a conceptual manner. I chose five statements from the original MTEBI that were easily adjusted to measure teacher self-efficacy on the specific concepts of computational strategies as that is the focus of the professional development sessions. These statements were chosen to add to the survey as they were most likely to be influenced by the designed professional development program. I added five extra measurement and data analysis statements as those concepts will not be covered in the professional development sessions.

Therefore, data analysis can be performed on the results of these additional ten questions and any difference in self-efficacy gains based on the professional development sessions.

Justification of Use of Instrument in Context

Enochs et al. (2000) created the MTEBI (Enochs et al., 2000) to analyze self-efficacy of pre-service math teachers. Researchers have used the MTEBI numerous times in multiple countries to measure teacher self-efficacy in mathematics understanding and instructional beliefs (Giles et al, 2016; Koutsianou & Emvalotis, 2019; Matney et al., 2016; Segarra & Julià, 2020). This survey was adjusted from the Science Teaching Efficacy Beliefs Instrument (Enochs & Riggs, 1990) to address mathematics beliefs specifically. The questions asked address a teacher's beliefs in how they teach mathematics and the outcomes they expect to receive from that instruction. By adding to the MTEBI to include demographic questions of participants, I received valuable information to help with the analysis of the participants' responses to the survey.

Data Analysis Strategy

The data gathered from the MTEBI survey given before the professional learning sessions and at the conclusion of the professional development program was evaluated using descriptive statistics (Urdan, 2017) with the IBM SPSS 25 statistical software program. In this quantitative study, the best data analysis tools to use were descriptive statistics which described and discovered any trends in teacher self-efficacy, meaning the teachers' beliefs in their ability to understand mathematics fully and their ability to teach math conceptually and effectively, from the studied sample and explored the relationship between the variables in the study (Ivankova, 2015; Urdan, 2017). All elementary math teachers in the district participated in the learning program.

The dependent variable is the teachers' mathematical self-efficacy measured by the MTEBI survey, whereas, the independent variable is the grade level taught, the years of experience, and the certification of the teachers. I scored the individual surveys by using the point system given to each answer through the Likert scale (see Appendix C). Eight questions were reverse scored to address the negative wording of the statements and create a consistent score across all questions (See Appendix D).

I averaged the scores for all questions from both the pre-and post-surveys and downloaded all data from the Microsoft Forms surveys onto an Excel sheet and uploaded into the SPSS program. The goal was to stratify the data into grade level bands of kindergarten through second-grade teachers and third through fifth-grade teachers. I stratified the data by teaching experience levels of zero to one year, two to five years, and veteran teachers with more than five years' experience. I applied a final stratification by educational training and certification to the data, traditional versus alternative certification. I found central tendencies of each category, such as mean and median.

Then, I used paired-samples *t*-tests to compare the data from the pre-survey results and the post-survey results with the overall self-efficacy category and analyzed any statistically significant differences between the means (Urdan, 2017). I matched the pairs of data as listed in Table 1 and used paired-samples and independent-samples *t*-tests and ANOVA to compare mean scores of the same group of teachers who completed the pre-survey and the post-survey (Pallant, 2020). The threshold used to determine statistical significance was $\alpha = 0.05$.

Table 1

Comparisons of Data Analyzed

Comparisons	**Outcome**	**Statistical Test**	**Comparison Group 1**	**Comparison Group 2**	**Comparison Group 3**
Self-Efficacy across all teachers	Differences in Self-Efficacy Gains between pre- and post-test scores	Paired Samples *t*-test	Pre-Survey Results	Post-Survey Results	NA
Self-Efficacy across all teachers	Differences in Self-Efficacy Gains between pre- and post-test scores on ten additional construct questions only	Paired Samples *t*-test	Pre-Survey Results	Post-Survey Results	NA
Grade Level	Differences between K-2 and 3-5 Self-Efficacy Gains	Independent Samples *t*-test	Kindergarten -2nd grade	3rd Grade-5th Grade	NA
Grade Level	Differences between K-2 and 3-5 Self-Efficacy Gains on ten additional construct questions only	Independent Samples *t*-test	Kindergarten -2nd grade	3rd Grade-5th Grade	NA

Table 1 (continued)

Experience	Differences between years of experience levels in Self-Efficacy Gains	ANOVA	Zero to One Year of Teaching	Two through Five Years of Teaching	More than Five Years of Teaching
Experience	Differences between years of experience levels in Self-Efficacy Gains on ten additional construct questions only	ANOVA	Zero to One Year of Teaching	Two through Five Years of Teaching	More than Five Years of Teaching
Certification	Differences between Traditional and Alternative Certification Self-Efficacy Gains	Independent Samples *t*-test	Traditional Training and Certification	Alternative Training and Certification	NA
Certification	Differences between Traditional and Alternative Certification Self-Efficacy Gains on ten additional construct questions only	Independent Samples *t*-test	Traditional Training and Certification	Alternative Training and Certification	NA

I used the data from the pre-survey as the basis for comparison with the resulting data from the post-survey. My reasoning behind using the survey as the main data collection tool was the ease of administering to a large group of participants and the ability to calculate the results using the SPSS data tool. The large-scale implementation of the professional learning program necessitated using a data collection tool that was accessible to multiple participants at the same time and in the same format.

Timeline

I conducted the study over a period of five months to follow the research from Darling-Hammond et al. (2017) that found a positive relationship between sustained duration of professional learning, teaching pedagogy, and student learning outcomes. The professional development sessions were held in person during staff development days previously scheduled in the district school calendar. The first stage of the study included proposal defense in August 2022. A committee including the Director of Professional Learning, content curriculum coordinators, Executive Director of Curriculum and Instruction, and the district calendar committee, created a district calendar of professional development days for the 2022-2023 school year in May 2022. With the guidance of other content coordinators and the Director of Professional Learning and Continuous Improvement, we designed the purpose and structure of the CLCs. During summer 2022, with principal input, I selected the trainer of trainers and recruited them to lead the professional development program with the district math teachers the following school year. The teacher trainers were compensated for their planning time outside the school contract hours at $30 an hour for 20 hours of training time totaling $600. The funding was provided by Title II, Part A, professional learning funds. Next, using the expertise and guidance of the district Instructional Math Coaches, I designed the artifact of three professional learning sessions during summer 2022.

The second stage involved the preparation of trainers, which occurred approximately a week before each district training. They received two full days of training in August to prepare them to present to and work with adults. Teacher trainers also received trainings on content and pedagogical strategies for teaching math computational strategies conceptually. As the researcher and Elementary Math Curriculum Coordinator, I was the trainer of trainers and designer of the professional development sessions. Teachers underwent three district-wide professional learning sessions, each three hours long, facilitated by selected math teachers from grades kindergarten to fifth grade. The trainings occurred in September 2022, October 2022, and January 2023. I gave a pre-survey to all participants to measure their self-efficacy in teaching mathematics conceptually at the first training in September 2022.

The third stage included a final meeting in February 2023 of all participants to procure the post-survey on teacher self-efficacy. At that point, I collected all data and analyzed it in spring 2023. The chairs of the ROS scheduled the defense of the study in summer 2023. See Table 1 for the time table of this study.

Table 2

Time Table of Study

Preparation for Research Study				
Month/Year	**Activity**	**Stage**	**Collected/Analyzed**	**Product**
May 2022	Created calendar for district professional development days in 2022-2023, purpose, and structure of CLCs	Stage 1	Feedback from stakeholders on best days for PD	District Professional Development Calendar document with purpose and structure of CLCs
August 2022	Proposal Defense	Stage 1		Proposal Approved
Summer 2022	Identified, selected, and recruited teacher trainer of trainers	Stage 1	Teacher trainer of trainers	Trainer of trainers list

Table 2 (continued)

Month/Year	Activity	Stage	Collected/Analyzed	Product
Summer 2022	Created professional development artifacts-3 PD sessions of 3 hours each	Stage 1	Guidance and expertise from district math instructional coaches	Agenda and activities for professional learning program for trainer of trainers
Summer 2022	Created online Microsoft Forms survey and link	Stage 1		Digital Survey of MTEBI
August 2022	Boot Camp for Trainer of Trainers	Stage 1	Feedback from trainer of trainers	Agenda and activities for PD program for teachers
		Research Study		
September 2022	Pre-survey	Stage 2	Collected pre-surveys from all participants	Pre-survey numeric data in Microsoft Forms-transfer to Excel sheet
September-February 2022	PD with trainer of trainers and then math teachers in district	Stage 2	Feedback from trainer of trainers and math teachers in district	
February 2023	Post-survey	Stage 3	Collected post-survey results from all participants	Post-survey numeric data in Microsoft Forms-transfer to Excel sheet
February 2023	Paired pre-and post-survey data by participant	Stage 3		Paired survey data on Excel Sheet
March 2023	Ran statistical analysis on survey data with SPSS and create data tables	Stage 3		Descriptive analysis and *t*-test data results in data tables
June 2023	Analyzed data results for conclusion	Stage 3		Data Analysis and Conclusions

Reliability and Validity Concerns

According to Enochs et al. (2000) who performed a factorial validity test on the MTEBI, the survey instrument appeared to be both reliable and a valid instrument measuring "mathematics teaching self-efficacy and outcome expectancy" (p. 6). Using Cronbach's alpha to analyze reliability of the scores obtained from the instrument generated an internal consistency alpha coefficient of 0.88 for the teacher efficacy scale and 0.77 alpha coefficient for the outcome expectancy scale (Enochs et al., 2000). Due to local dependence between questions, Kieftenbeld et al. (2011) suggested moving a few of the questions away from each other to reduce that dependence. I used their suggestions when reproducing the survey for the elementary math teachers and separated questions 5 and 6 farther away from each other, as well as 12 and 13, and 20 and 21 (See Appendix C). This reduced the participant's dependence on one question to another. Local dependence can occur when two or more questions are close together that have similar wording and participants answer both questions similarly due to how they responded to the first question in the series (Kieftenbeld et al., 2011). I also calculated Cronbach's alpha on the sample for each scale to ensure internal consistency. If the scales did not achieve minimally acceptable reliability, I would have removed any survey items that were problematic.

Reliability concerns for this study included the use of multiple teachers as trainers in the professional development program. The scale of the program is too large to house in one place; therefore, I used 28 trainers in various locations across the district but occurring at the same time to impart the learning. To ensure the reliability, or consistency of the training (Creswell & Creswell, 2018), I held a separate training for the trainers approximately one week before each professional development session. This enabled the teacher trainers to fully experience the sessions as a participant and gave them the tools and knowledge they needed to replicate the learning in the role of facilitators with the elementary math teachers. Along with the district math coaches, I led the trainer of trainers' sessions to safeguard the consistency and fidelity of the structure and content of the professional learning program. The trainers had the agenda, all activities, and time to prepare for the trainings with the teachers before they presented the learning sessions. All trainers shared their presentations with me to ensure they presented the material they were trained on and consistency across the cohorts remained. I also administered a feedback form to all trainers after each professional development session to capture if any content was adjusted and what needed to change before the next training session. Due to the nature of our professional learning structure, the reliability concern of generalizing any results to a population outside of this district should not happen.

Administering the identical survey to the same participants on two different dates addressed the issue of reliability of the scores produced from the survey (Pallant, 2020). I administered the pre-survey in September 2022. I dispensed the post-survey in February 2023. All participants were given the surveys in the exact same way with the same questions and answer choices. This addressed the test-retest reliability (Pallant, 2020). Teacher self-efficacy and their beliefs in student outcomes due to their teaching are the measured constructs.

Confirmatory factor analysis (CFA), which dealt with construct validity, assessed the validity of the instrument (Enochs et al., 2000). The CFA showed a good fit of the survey with the criteria assessed. This analysis also revealed that the two scales of teacher efficacy and outcome expectancy were independent (Enochs et al., 2000). This adds to the construct validity assessment of the MTEBI which shows the instrument is measuring the constructs of teacher self-efficacy and student outcome expectancy as the researchers who created the test intended (Ivankova, 2015).

Closing Thoughts on Chapter III

Professional development has often been the one size fits all cure for much that is wrong in education. Without explicit components of professional learning in place, such as coherence, time, and specific content focus (Desimone & Garet, 2015; Heck et al., 2019), the success of professional development has not performed at the level expected. Incorporating these factors into the design and structure of the professional learning program affected teacher self-efficacy in teaching mathematics conceptually as well as student outcomes in a positive way.

The goal of this study was to enhance elementary math teachers' self-efficacy in their belief they can teach mathematics concepts successfully and give them the tools they need to improve student outcomes. By meeting teachers where they are in the learning process and creating a professional development program that enhanced their teaching skills, positive results in teacher self-efficacy and improvement in student math successes developed. The discoveries of this study should enhance future professional learning for all educators and, specifically, math teachers.

CHAPTER IV

ANALYSIS AND FINDINGS

Introducing the Analysis

The purpose of this study was to determine if a sustained professional learning program on understanding and teaching math conceptually, specifically in computational strategies, would influence elementary mathematics teachers' self-efficacy. Before designing the study, I reviewed the extant literature to determine reasons for low teacher self-efficacy in mathematical conceptual understanding. The literature identified teacher professional development as a key area for improving teacher knowledge and self-belief. I employed this path to create a sustained PD program incorporating key elements of effective PD, one of which is using content experts to guide the training. The teacher trainers chosen to lead the PD programs were coached before the PD training and given opportunities to share feedback after each session. To contextualize the results, I will briefly discuss the facilitator feedback in the results section. After the implementation of a professional learning program from August to February, I analyzed the data that were collected from a pre-survey and post-survey to determine the impact on teachers' self-efficacy. To further examine the effects of the PD program on elementary teachers, I examined three additional key areas to investigate: differences in self-efficacy gains between grade level bands, between years of experience, and between methods of training and certifications. I used a pre-and post-survey design from the MTEBI to capture the results of any teacher self-efficacy changes. Here, I first report the descriptive statistics, which are followed by inferential statistical tests on the data. In this chapter, I present the findings of these data analyses in the order of the research questions.

Presentation of Data and Results of Research

I analyzed the survey responses from the participants who completed both the pre-survey and post-survey. Several teachers had resigned from teaching in between the pre-and post-survey. A few teachers were on family leave and five retired before the post-survey. Several teachers were not present at either the first PD session and did not complete the pre-survey or were unable to attend the last PD session and did not fill out the post-survey. This narrowed the list of available surveys to 231 participant surveys for analysis. The characteristics of the remaining participants in the survey are listed in Table 3.

Table 3

Characteristics of Teacher Participants in Survey

Variable	Number	Percentage
Total Number of Participants	231	100.00%
Grade Level Currently Teaching		
K-2	161	69.69%
3 -5	70	30.30%
Years of Teaching Experience		
0-1 year	34	14.72%
2-5 years	49	21.21%
More than 5 years	148	64.07%
Teaching Certification		
Alternative	46	19.91%
Traditional	185	80.09%

The pre-and post-survey administered to participants was used to collect data to answer the following research questions:

1. What is the impact of elementary teachers' participation in professional development focused on teaching math conceptually on teacher self-efficacy?
2. What are the differences in the gain scores of teacher self-efficacy when teaching math conceptually between kindergarten through second-grade teachers and third through fifth-grade teachers?
3. What are the differences in the gain scores of teacher self-efficacy when teaching math conceptually between beginning teachers and experienced teachers?
4. What are the differences in the gain scores of teacher self-efficacy when teaching math conceptually between teachers who received alternative training and certification and teachers who received traditional training and certification?

Reliability of Survey Items

I conducted a reliability analysis on each of the four sections of the modified MTEBI (Enochs et al., 2000). A Cronbach's alpha scale was calculated for each subconstruct. I used SPSS to conduct the tests. Generally, a score of .70 or higher is an acceptable reliability score (Urdan, 2017). Each of the four subconstructs reported a reliability score of higher than .70. Reliability was confirmed for all sections of the quantitative survey used as the data collection tool. Table 4 reports the reliability levels for all four subconstructs.

Table 4

Reliability of Subconstructs of Modified MTEBI

Subconstruct	Reliability
PTME	.83
MTOE	.77
PD	.73
NONPD	.72

Note: PTME= Personal Teaching Mathematics Efficacy, MTOE = Mathematics Teaching Outcome Expectancy, PD = Topics Covered in PD, NONPD = Topics Not Covered in PD

Impact of PD on Elementary Teachers' Self-Efficacy

My primary purpose was to investigate the impact professional development had on elementary teachers' self-efficacy regarding teaching math conceptually, specifically computational strategies. To answer that question, a modified MTEBI (Enochs et al., 2000) pre- and post-survey was administered to a total of 231 teachers who participated in all parts of the study including the pre-survey, three professional development sessions of three hours each, time between sessions to implement the presented strategies, reflection time, and the post-survey. Table 5 displays the means and standard deviations for all participants based on teacher self-efficacy in each of the four subconstructs: Personal Teaching Mathematics Efficacy (PTME), Mathematics Teaching Outcome Expectancy (MTOE), topics covered in PD (PD), and topics not covered in PD (NONPD). There was an increase in the means for all subconstructs from the pre-survey to the post-survey except for the MTOE which showed a decrease in self-efficacy scores.

Table 5

Means for the PTME, MTOE, PD, and NONPD Pre-and Post-Survey Scales in Overall Teacher Self-Efficacy

Variable	PTME M (SD)	MTOE M (SD)	PD M (SD)	NONPD M (SD)
Self-Efficacy Pre-Survey	4.04(0.43)	3.50(0.46)	4.04(.46)	3.86(0.48)
Self-Efficacy Post-Survey	4.11(0.44)	3.45(0.48)	4.14(.46)	4.02(0.46)

Note: PTME = Personal Teaching Mathematics Efficacy, MTOE = Mathematics Teaching Outcome Expectancy, PD = Topics Covered in PD, NONPD = Topics Not Covered in PD. M = Mean, SD = Standard Deviation

A paired samples *t*-test was conducted to evaluate the impact of the sustained professional learning program on teachers' self-efficacy (PTME) scores on the MTEBI. The results are shown in Table 6. There was a statistically significant increase at *p* value set for 0.05 level in PTME scores from the pre-survey ($M = 4.04$, $SD = 0.43$) to the post-survey ($M = 4.11$, $SD = 0.44$), $t(230) = 3.17$, $p = .002$ (two-tailed). The mean increase in PTME scores was 0.07 with a 95% confidence interval ranging from 0.03 to 0.12. The eta squared statistic (.04) indicated a small to moderate effect size. These results indicate that overall, there was a positive impact on teachers' teaching self-efficacy by participation in the sustained professional development program. Even though the effect size was not large, the data suggest that teachers benefited by attending a professional learning program designed with explicit instruction using hands-on activities on conceptual understanding of how computation operates and why algorithms work the way they do.

The mathematics teaching outcome expectancy for students (MTOE) did not follow the same pattern as PTME. The mean scores decreased from the pre-survey to the post-survey. However, there was no statistically significant difference at *p* value set for 0.05 level between the outcome expectancy scores in the pre-survey (*M* = 3.50, *SD* = 0.46) and the outcome expectancy scores in the post-survey (*M* = 3.45, *SD = 0.48)*, *t*(230) = -1.47, *p* = .144 (two-tailed). In Figure 5 the results from one of the survey's outcome expectancy statements are shown. Pre-survey results show about 78% of teachers agreed or strongly agreed with the following statement from the MTEBI: "When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher" (Enochs et al., 2000). In the post-survey, only 69% of teachers agreed or strongly agreed with this statement.

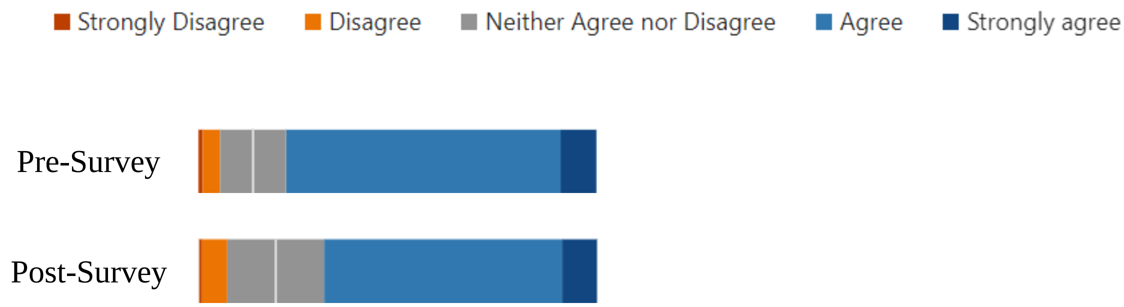

Figure 5

An Outcome Expectancy Statement Result from MTEBI

Examining the questions that were added to the MTEBI concerning topics covered in the PD sessions led to a positive outcome. A paired samples *t*-test was conducted to evaluate the impact of the PD program on teachers' self-efficacy specifically related to conceptual understanding of computational strategies. The facilitators modeled these hands-on strategies for addition, subtraction, multiplication, and division at the appropriate grade levels. The teachers participated as if they were students using manipulatives and engaging with the concrete, representational, and abstract model. There was a statistically significant increase at *p* value set for 0.05 level from the pre-survey (*M* = 4.04, *SD* = 0.46) to the post-survey (*M* = 4.14, *SD* = 0.46), *t*(230) = 3.73, *p* = 0.001 (two-tailed). The mean increase in PD scores was 0.10 with a 95%

confidence interval ranging from 0.05 to 0.15. The eta squared statistic (.06) indicates a moderate effect. This suggests the PD program was successful in increasing teacher self-efficacy specifically relating to conceptual understanding of how to teach computational strategies.

To determine if the PD sessions were due to the Hawthorne effect or more likely due to actual increases in teacher self-efficacy, five questions were added to the MTEBI survey on mathematical concepts *not* covered in the PD sessions. Specifically, measurement and data analysis strategies were not presented in the PD program. These additional five questions explored a teacher's beliefs in their teaching skills on these two concepts. In an unexpected twist, the biggest increase in means was on the subconstruct NONPD, the topics not covered in the PD sessions.

The paired samples *t*-test was conducted to evaluate the impact of the PD sessions on teacher self-efficacy on topics not offered in the PD trainings. There was a statistically significant increase at p value set for 0.05 level in NONPD scores from the pre-survey ($M = 3.86$, $SD = 0.48$) and the post-survey ($M = 4.02$, $SD = 0.46$), $t(230) = 5.02$, $p = 0.001$ (two tailed). The mean increase in NONPD scores was 0.16 with a 95% confidence interval ranging from 0.10 to 0.23. The eta squared statistic (.09) indicated a moderate to large effect size. Given that this study was a type of control comparison, no effect on the NONPD survey questions would have given more validity to the increases observed in the topics covered by the PD. Since increases were also observed in the topics not covered, the observed increase in the topics covered by the PD may not be replicable.

Table 6

Differences in Measures of the PTME, MTOE, PD, and NONPD Using Paired Samples t-tests

Measures	Mean Difference	95% CI	*t*	*df*	Two-tailed p	η^2
PTME	0.07	0.03, 0.12	3.17	230	.002	.04
MTOE	-0.05	-0.11, 0.02	-1.47	230	.144	.01
PD	0.10	0.05, 0.15	3.73	230	.001	.06
NONPD	0.16	0.10, 0.23	5.02	230	.001	.09

Note: PTME = Personal Teaching Mathematics Efficacy, MTOE = Mathematics Teaching Outcome Expectancy, PD = Topics Covered in PD, NONPD = Topics Not Covered in PD

Comparison of K-2 Teachers and 3-5 Teachers

Once the initial research question had been examined, the aim was to stratify the teachers into two groups of grade level bands to answer the research question of what the differences in teacher self-efficacy are when teaching math conceptually between kindergarten through second-grade teachers and third through fifth-grade teachers. The first group consisting of K-2 teachers totaled 161. These teachers are responsible for all core content, including reading and math. The other group consisted of 3-5 teachers, totaling 70 educators. These teachers teach either Math and Science or only Math. A few from the second group are self-contained classroom teachers and teach all core content areas. The descriptive statistics for this stratification are shown in Table 7. The assumption was the early grades teachers would increase in self-efficacy more than the upper-grade teachers due to the fact they are generally not content experts. Upper-grade teachers are more likely to specialize in math and have more training and content knowledge. Remarkably, the opposite occurred. Upper-grade teachers showed a greater gain in self-efficacy in the areas of personal efficacy, concepts taught in the PD sessions, and even concepts not presented in the PD sessions. Both grade level categories showed a decrease in student outcome expectancy.

Table 7

Mean Differences Between the PTME, MTOE, PD, and NONPD Pre-and Post-Survey Scales by Grade Level Band

Variable	PTME MD (SD)	MTOE MD (SD)	PD MD (SD)	NONPD MD (SD)
K-2nd Grade Teachers (*n*=161)	0.02(0.33)	-0.03(0.50)	0.06(0.38)	0.12(0.48)
3rd – 5th Grade Teachers (*n*=70)	0.18(0.35)	-0.08(0.45)	0.19(0.46)	0.27(0.53)

Note: PTME = Personal Teaching Mathematics Efficacy, MTOE = Mathematics Teaching Outcome Expectancy, PD = Topics Covered in PD, NONPD = Topics Not Covered in PD. MD = Mean Difference, SD = Standard Deviation

I utilized independent-samples *t*-tests to compare the two groups of teachers by grade level bands, to evaluate the mean difference scores on the continuous variable of self-efficacy for the two independent groups. In each of the categories of PTME, MTOE, PD, and NONPD, the independent samples *t*-test was utilized to calculate any differences between the two grade-level groups. The results are shown in Table 8.

An independent-samples *t*-test was conducted to compare the self-efficacy scores in the measure of PTME for kindergarten through second-grade teachers and third through fifth-grade teachers. There was a statistically significant difference at *p* value set for 0.05 level in scores for K-2 teachers (M = 0.02, SD = 0.33) and 3-5 teachers (M =0.18, SD = 0.35), $t(229) = -3.18$, p =.002, two-tailed). The magnitude of the differences in the means (mean difference = -0.15, 95% CI [-0.25, -0.06]) was small to moderate (η^2 = .04). The third through fifth-grade teachers exhibited a greater increase in self-efficacy scores than the kindergarten through second-grade teachers.

To compare the self-efficacy scores on the measure of MTOE for the two grade band levels, another independent-samples *t*-test was performed on the data. There was no statistically significant difference at *p* value set for 0.05 level in scores for kindergarten through second-grade teachers (M = -0.03, SD = 0.50) and third through fifth-grade teachers (M = -0.08, SD = 0.45), $t(229) = 0.74$, $p = .46$, two-tailed). Both groups of teachers showed a decrease in their belief that student outcomes are a result of teacher self-efficacy.

Another independent-samples *t*-test was conducted to compare the teachers' self-efficacy based on the concepts of computational strategies (PD) with a deep understanding imparted during the professional development sessions for both groups of grade levels. There was a statistically significant difference at *p* value set for 0.05 level in scores for kindergarten through second-grade teachers (M = 0.06, SD = 0.38) and third through fifth-grade teachers (M = 0.19, SD = 0.46), $t(229) = -2.32$, $p = .02$, two-tailed). The magnitude of the differences in the means (mean difference = -0.14, 95% CI [-0.25, -0.02]) was small ($\eta^2 = .02$). Although both categories of grade levels improved in self-efficacy scores on the PD concepts, the third through fifth-grade teacher group had a larger increase in the difference between the pre-and post-survey means.

The last independent-samples *t*-test was conducted to compare the teacher self-efficacy scores on concepts not discussed in the PD sessions (NONPD) for the two categories of grade levels. There was a statistically significant difference at *p* value set for 0.05 level in scores for K-2 teachers (M = 0.12, SD = 0.48) and 3-5 teachers (M = 0.27, SD = 0.53), $t(229) = -2.14$, $p = .03$, two-tailed. The magnitude of the differences in the means (mean difference = -0.15, 95% CI [-0.029, -0.01]) was small ($\eta^2 = .02$). The increase of self-efficacy on the concepts not taught during the PD sessions for the third through fifth-grade teachers was more than double that of the kindergarten through second-grade teachers.

Table 8

Differences in Measures of the PTME, MTOE, PD, and NONPD Using Independent-Samples t-tests by Teacher Grade Level Band

Variable	Mean Difference	95% CI	*t*	*df*	Two-tailed p	η^2
PTME	-0.15	-0.25, -0.06	-3.18	229	.002	.04
MTOE	0.05	-0.09, 0.19	0.74	229	.46	.002
PD	-0.13	-0.25, -0.02	-2.32	229	.02	.02
NONPD	-0.15	-0.29, -0.01	-2.14	229	.04	.02

Note: PTME = Personal Teaching Mathematics Efficacy, MTOE = Mathematics Teaching Outcome Expectancy, PD = Topics Covered in PD, NONPD = Topics Not Covered in PD

Comparison of Beginning and Experienced Teachers

To answer the research question concerning studying the self-efficacy mean differences between groups sorted by teaching experience, a one-way between-groups ANOVA statistical test was used to compare the self-efficacy differences between the pre-and post-survey amongst teachers categorized into three levels, beginning teachers in their first or second year of teaching, teachers who have taught between two and five years of teaching, and experienced teachers who have been in the classroom more than five years. The purpose was to determine if one group of teachers demonstrated more self-efficacy gains than the other groups. The mean differences and standard deviation for each of the subconstructs of the MTEBI are listed in Table 9.

Table 9

Mean Differences Between the PTME, MTOE, PD, and NONPD Pre-and Post-Survey Scales by Teacher Experience

Variable	PTME MD (SD)	MTOE MD (SD)	PD MD (SD)	NONPD MD (SD)
0-1 years' experience (*n* =34)	0.05(0.29)	-0.06(0.47)	0.04(0.41)	0.15(0.46)
2-5 years' experience (*n* =49)	0.11(0.32)	-0.01(0.53)	0.12(0.35)	0.18(0.41)
5+ years' experience (*n* =148)	0.06(0.36)	-0.05(0.48)	0.11(0.43)	0.16(0.53)

Note: PTME = Personal Teaching Mathematics Efficacy, MTOE = Mathematics Teaching Outcome Expectancy, PD = Topics Covered in PD, NONPD = Topics Not Covered in PD. MD = Mean Difference, SD = Standard Deviation

While all three groups of teachers increased their self-efficacy on the levels of personal efficacy, concepts covered in the PD sessions, and topics not covered in the PD sessions, the student outcome expectancy mean differences scores decreased from the pre-survey to the post-survey. The group of teachers who taught between two and five years saw the greatest increase in self-efficacy gains across the three categories of PTME, PD, and NONPD. None of the groups experienced gains in the subconstruct of MTOE. All three groups of teachers by experience decreased on those scores.

A one-way between-groups ANOVA was conducted to examine the impact of the PD sessions on three levels of teacher by experience as measured by the modified MTEBI (Enochs et al., 2000). Table 10 displays the results of those statistical tests. Participants were divided into three groups according to their level of teaching experience (0-1 years' experience, 2-5 years' experience, and more than five years' experience). There was no statistically significant difference at the $p < .05$ level in the PTME, OE, PD, and NONPD scores for the three groups of experienced teachers. All *p* values were above .05. Due to no statistically significant differences between any of the groups, additional post-hoc comparisons using the Tukey HSD test were not appropriate.

Table 10

Differences in Measures of the PTME, MTOE, PD, and NONPD Using One-Way Between-Groups ANOVA Statistical Test by Teacher Experience

Variable	*df*	*F*	*p*	η^2
PTME	2, 228	.39	.68	.003
MTOE	2, 228	.16	.86	.001
PD	2, 228	.43	.65	.003
NONPD	2, 228	.06	.94	.001

Note: PTME = Personal Teaching Mathematics Efficacy, MTOE = Mathematics Teaching Outcome Expectancy, PD = Topics Covered in PD, NONPD = Topics Not Covered in PD

Comparison of Alternatively Certified and Traditionally Certified Teachers

The final research question was to examine any differences in teacher self-efficacy when teaching math conceptually between teachers who received alternative training and certification and teachers who received traditional training and certification. Independent-samples *t*-tests were performed on each of the four subconstructs, PTME, MTOE, PD, and NONPD for the stratification of training and certification. Table 11 lists the mean differences and standard deviations for the two groups of teacher training and certification.

The data show the alternatively trained and certified teachers gained more in their self-efficacy on the concepts presented in the PD sessions and in the concepts not presented in the PD sessions. In the PTME, overall teacher mathematical self-efficacy, the two groups were almost identical in their gains. Whereas in the subconstruct of MTOE, both groups decreased in their mean differences with the alternatively trained and certified teachers having a much larger drop in scores than the traditionally trained and certified teachers.

Table 11

Mean Differences Between the PTME, MTOE, PD, and NONPD Pre-and Post-Survey Scales by Teacher Training and Certification

Variable	PTME MD (SD)	MTOE MD (SD)	PD MD (SD)	NONPD MD (SD)
Alternative (*n*=46)	0.07(0.36)	-0.16(0.62)	0.13(0.29)	0.18(0.43)
Traditional (*n*=185)	0.07(0.34)	-0.02(0.44)	0.09(0.43)	0.16(0.51)

Note: PTME = Personal Teaching Mathematics Efficacy, MTOE = Mathematics Teaching Outcome Expectancy, PD = Topics Covered in PD, NONPD = Topics Not Covered in PD. MD = Mean Difference, SD = Standard Deviation

An independent-samples *t*-test was conducted to compare the self-efficacy scores for the Personal Teaching Mathematics Efficacy (PTME) category between alternatively and traditionally trained and certified teachers. The results of those statistical tests are displayed in Table 12. There was no statistically significant difference at *p* value set for 0.05 level in scores for alternatively trained and certified teachers (M = 0.07, SD = 0.36) and traditionally trained and certified teachers (M = 0.07, SD = 0.34); $t(229)$ = -0.89, p = .93, two-tailed. The mean scores for these two groups were almost identical. Therefore, in mathematical self-beliefs, it did not make a difference if a teacher had been alternatively or traditionally trained and certified. Both groups of teachers increased their gains in self-efficacy in teaching mathematics by about the same amount.

Comparing the Mathematics Teaching Outcome Expectancy (MTOE) of students between the two groups of teachers by training was determined by using another independent-samples *t*-test. Again, both groups showed a decrease in their belief that a teacher is responsible for student outcomes in mathematics from the pre-survey to the post-survey. Although, the traditionally trained teachers showed less of a decrease than the teachers who were alternatively trained. There was no statistically significant difference at *p* value set for 0.05 level in scores for teachers with an alternative certification (*M* = -0.16, *SD* = 0.62) and teachers with a traditional certification (*M* = -0.02, *SD* = 0.44); *t*(229) = -1.47, *p* = .15, two-tailed. The PD program did not have much of an effect on increasing teacher self-efficacy in their beliefs that they are crucial in mathematical student outcomes.

Once again, the mathematics teaching outcome expectancy scores dropped from pre-survey to post-survey. Another example of one of the outcome expectancy statements is “Students’ achievement is directly related to their teachers’ effectiveness in mathematics teaching” (Enochs et al., 2000). The participant responses dropped from 54% on the pre-survey either agreeing or strongly agreeing with the statement as opposed to only 48% of teachers on the post-survey agreeing or strongly agreeing with the statement. Figure 6 displays the results for that outcome expectancy statement on the MTEBI.

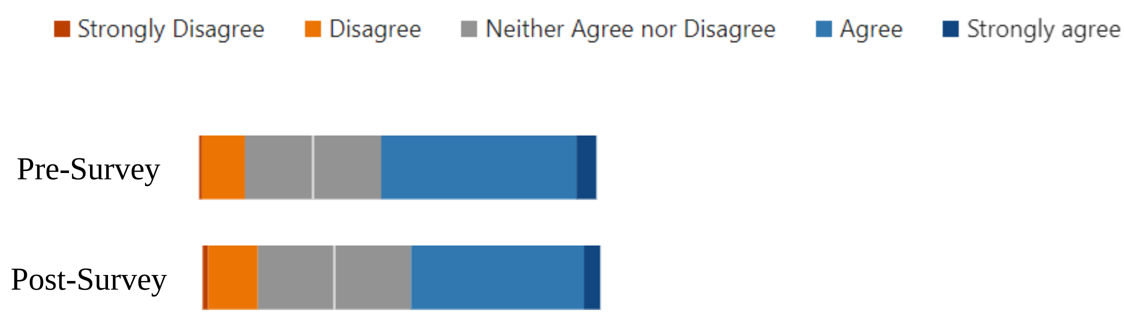

Figure 6

An Additional Outcome Expectancy Statement Result from MTEBI

Another independent-samples *t*-test was conducted to compare the self-esteem scores, specifically on the computational strategies concepts that were presented in the PD sessions (PD), for teachers with alternative and traditional certification. There was no statistically significant difference at *p* value set for 0.05 level in scores for alternatively trained and certified teachers (M = 0.13, SD = 0.29) and traditionally trained and certified teachers (M = 0.09, SD = 0.43); $t(229) = 0.60$, $p = .13$, two-tailed. The last independent-samples *t*-test was conducted to compare teacher self-efficacy scores on concepts not presented in the PD sessions (NONPD) between the alternatively and traditionally certified teachers. There was no statistically significant difference at *p* value set for 0.05 level in scores for alternatively trained and certified teachers (M = 0.18, SD = 0.43) and traditionally trained and certified teachers (M = 0.16, SD = 0.51); $t(229) = 0.21$, $p =$ .84, two-tailed. The gains in self-efficacy scores on the NONPD scores were very close between the two groups of teachers. Thus, there was not much difference between the teachers with alternative certification and educators with traditional certification on the concepts of measurement and data analysis which were not presented during the professional learning sessions.

Table 12

Differences in Measures of the PTME, MTOE, PD, and NONPD Using Independent-Samples t-tests by Teacher Training and Certification

Variable	Mean Difference	95% CI	*t*	*df*	Two-tailed p	η^2
PTME	-0.01	-0.12, 0.11	-0.89	229	.93	.003
MTOE	-0.14	-0.34, 0.51	-1.47	229	.15	.01
PD	0.03	-0.75, 0.14	0.60	229	.56	.13
NONPD	0.02	-0.14, 0.18	0.21	229	.84	.0002

Note: PTME = Personal Teaching Mathematics Efficacy, MTOE = Mathematics Teaching Outcome Expectancy, PD = Topics Covered in PD, NONPD = Topics Not Covered in PD

Interaction between the Research and the Context

How the Context Impacted the Results

In my particular context, we have a PD design that utilized three planned dates that the Director of Professional Learning and Continuous Improvement and the Chief Academic Officer created within the district calendar for the current school year, so this study fit naturally. Having the availability of these scheduled dates with time in front of teachers, presented the opportunity to study the effects of a sustained professional development plan on teachers' mathematical self-efficacy. The study was spread over six separate locations for each session with all the professional development training led by different teacher facilitators. Holding the PD sessions in six locations made it impossible for me to be on-site at each training. I chose to be at one location, my two district coaches at two of the locations, and three instructional coaches at the last three sessions to oversee any issues.

Utilizing 28 different facilitators for the sessions could possibly have a slight impact on the quality and consistency of the learning and affect the results. To counteract that possibility, a team of principals, the district math instructional coaches, and I carefully selected the facilitators. A six-hour trainer of teacher session ahead of each of the professional learning opportunities helped to mitigate any discrepancies in the presentations. All teacher facilitators were provided with the same training to present and allocated time to practice their sessions with the two district math coaches and me to answer any questions. We modeled the sessions first and then provided the facilitators with the PowerPoint and all documents needed to present. The participants spent the rest of the training session reviewing and becoming comfortable with the information to be presented to the teachers.

To further understand the results of my study's context, I administered a feedback survey to the facilitators after each professional development session to understand their needs and how the sessions were received. Every facilitator felt prepared and was excited to be part of the team. We garnered great feedback that helped us improve our training sessions each time. One facilitator commented:

> I feel like as the year has gone on more and more people are sharing and asking questions. I think as people are starting to see the benefits of this, they are starting to use it as a [place] for collaboration.

It was beneficial to use consistent facilitators with the same group of teachers for each of the three professional learning opportunities. The facilitators and the participants grew together as a team and sought each other out beyond the planned sessions for further collaboration.

The three PD sessions varied in participation and engagement throughout the study. The first session was more subdued as teachers were getting to know one another at the beginning of the year. They were learning to trust each other and how to collaborate. Facilitators commented on the difficulty of presenting to adults and how it was harder than working with students. The second training was by far the most engaging session and full of active participation. Facilitators were more comfortable with sharing their knowledge and presenting in front of an adult audience. Teachers had now been working with their students for two months and were more willing to hear ideas on how to improve their math instruction. Participants enjoyed working with manipulatives and finding diverse ways to incorporate the concrete, representational, abstract model for computational strategies into their lessons.

Unfortunately, teacher engagement was not as high in the third session. I determined after speaking with several teachers and all the facilitators that the timing of the third session was hard to overcome. The district calendar required teachers to come back to school on January 2, 2023, the day after the Christmas break, for professional learning. Many of the teachers commented that this day was a federal holiday, and many other people were not working. Surrounding districts also had the day off so some teachers' children who attended other districts were at home. Daycare was hard to find and the motivation to come back to work and be in a PD session was lacking. Teachers participated and were engaged in gaining knowledge, but the level of excitement was not as high as at the second session in October. This might have negatively affected the results of the post-survey as this session was the last training before the post-survey was administered.

Anecdotally, I did find that many teachers were very willing to participate in the study and were happy to fill out the pre- and post-surveys. Participants were also agreeable to completing feedback surveys after each session to help the study make any adjustments or improvements as needed. As is often true when using technology, there was a slight glitch during the pre-survey. When the survey opened at the first PD session for approximately 300 teachers, the last few questions disappeared. I had to immediately re-enter the questions and have the participants either finish the survey or re-do the survey if they had already submitted it. This caused frustration among some of the participants as was evident because they chose not to start the survey again. Therefore, I had to discard those survey responses due to incomplete data. Most teachers appeared happy to complete or redo the pre-survey during the first PD session. Several teachers commented, though, they had to read carefully as some questions contained positive wording and some negative wording. This could have affected any results on the MTEBI. Where there were two pre-survey entries for a participant, I deleted the incomplete survey and kept the completed one. No participant made any remarks about being resistant to participating in the study. If they chose not to complete the surveys, it was the teacher's choice. They still participated in the PD sessions as expected by their administrators.

How the Research Impacted the Context

I shared the results from the study and the feedback surveys for both participants and facilitators with the district through the Deputy Superintendent, the Chief Academic Officer, the Executive Director of Elementary Services, and the Director of Professional Development and Continuous Improvement (PD and CI). I chose to share with these stakeholders as they are the ones who will be most impacted by the results of the study. The reactions of these individuals were overwhelmingly positive and hopeful for the future. The Director of PD and CI requested all the feedback survey responses and more time to discuss the implications of the feedback on future professional learning sessions for all content areas, not just math. I have also been requested to create short professional development videos on focused concepts to upload to our newly created district digital PD site. The calendar for next year has already been adapted to address the January PD session issues with an additional day between returning to work and the holiday break in December.

Due to the nature of the PD sessions and the conceptual understanding of computational strategies, principals and instructional math coaches observed more hands-on learning from the participants and students during the periods between the professional learning sessions than ever before. Teachers regularly commented that their students were catching on to concepts that were previously a struggle. As I observed in many classrooms, teachers were engaging students using manipulatives to help them develop meaning and conceptual understanding. Students could explain how the abstract algorithms worked by representing their thoughts with manipulatives, drawings, and models.

Feedback from both facilitators and participants demonstrated a need to differentiate parts of the professional learning sessions to accommodate for different experience levels and varying needs of the participants. A plan will be implemented to address individual teacher needs and wants for the last hour of each PD session next year. Participants will have a choice of four to five sessions to attend that will focus on topics and concepts gathered from an interest survey at the beginning of the year. One common refrain I heard from teachers was in the application of manipulatives. Participants wanted to know how to use manipulatives effectively and with certain concepts beyond computational strategies. Upper elementary teachers wanted to know how to use manipulatives or hands-on activities to strengthen both teachers' and students' fraction knowledge.

Suggestions from the teachers included providing sessions for new teachers that need more in-depth knowledge of strategies and the district math framework while more experienced teachers could benefit from additional information on data analysis and what the next steps for instruction would encompass. Having time all together to ensure that everyone hears the same conceptual understanding strategies at the beginning of the PD sessions benefits all learners. Providing some PD time to teachers' requests for differentiated learning will also benefit teachers and meet them where they are in their knowledge and pedagogy ultimately benefiting students and their education.

The research was deemed useful and purposeful as the data that were found corroborated the need for a sustained professional learning program. Therefore, this study's PD plan will continue in the coming years while implementing the suggested improvements. It was a valuable study in understanding where adjustments to the program should be made. District administrators and school site personnel are always searching for ways to improve professional learning practices and make learning meaningful for students and easy to implement.

Summary

The data collected and analyzed in this study showed interesting trends. Overall, the participants' self-efficacy scores presented a statistically significant difference between the pre- and post-survey in all the sub-areas except for the MTOE. The teachers showed improvement in their mean scores from the beginning of the study to the end of the study, indicating the PD program was effective in raising participants' self-efficacy in teaching and understanding mathematical computational strategies conceptually.

When comparing the different stratifications of the study, the comparison between primary and upper elementary grade levels showed a statistically significant difference. Surprisingly, the third through fifth-grade teachers improved on self-efficacy at a higher level than the primary-grade teachers. Again, the MTOE mean differences decreased for both sets of teachers by grade level. In the grouping by years of experience, there were no statistically significant differences in gains of self-efficacy scores. The comparison of alternatively and traditionally trained and certified teachers yielded no statistically significant difference, either. When considering the results of the different stratifications of teachers, there was an indication that the sustained professional learning program impacted teacher self-efficacy. I report more on these outcomes in Chapter V.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary of Findings from Chapter 4

Math scores from the state assessment have not improved to the level the district would prefer. One of the possible reasons is a lack of mathematical self-efficacy in elementary teachers. If educators were not trained in conceptual understanding of mathematical concepts in their teacher training programs or their primary education journey, they will be unable to impart that knowledge to their students (Schubert, 2019). Through my ROS, I delved into examining the effects of a sustained, content-focused, active, and collaborative professional learning program given by consistent, expert facilitators on a teacher's mathematical self-efficacy. Furthermore, through my study, I explored the differences in teacher self-efficacy gained after participating in the PD program between primary (K-2) teachers and upper grade (3-5) teachers. Another stratification of the participants was by their years of experience (0-1 year, 2-5 years, and more than 5 years). The last comparison performed on the study data was between alternatively trained and traditionally trained teachers who had experienced some level of student teaching before gaining their first teaching job.

Using a modified version of MTEBI (Enochs et al., 2000), the analyses of data showed some interesting trends. There were four subconstructs of the pre-and post-survey administered to all the participating teachers. These include personal self-efficacy (PTME), student outcome expectancy (MTOE), questions about the conceptual understanding of computational strategies that the professional development program (PD) presented, and questions on concepts not presented in the program, such as measurement and data analysis (NONPD). In the paired-samples *t*-tests, the PTME indicated educators gained self-efficacy from participating in the professional learning sessions, teaching the chosen lesson to their students, and reflecting with their fellow teachers on the lesson and results. There was a statistically significant difference between the pre- and post-survey results that produced a small to moderate effect size. The self-efficacy gains on the concepts presented in the PD were also statistically significant with a moderate effect. Even the NONPD self-efficacy scores increased. The only decrease in scale scores was the MTOE. Educators indicated they did not feel their efforts increased student outcomes.

Through my study, I also compared the differences in those same four subconstructs by teachers' grade levels. There was a statistically significant difference between the two groups of teachers (K-2 vs. 3-5) but surprisingly, the results leaned towards more growth with the upper-grade teachers. Again, the effect size was small to moderate. There was no statistically significant difference between the three groups of teachers by years of experience in any of the subconstructs. It did not matter how much experience a teacher had, they all seemed to gain about the same amount of self-efficacy by participating in the PD program.

The alternatively trained and certified teachers made more gains but there was no statistically significant difference in self-efficacy on the concepts taught during the PD and those not taught during the PD than the traditionally trained teachers. There were equal gains in overall self-efficacy. Again, the student outcome expectancy scores decreased from the pre-survey to the post-survey.

Discussion of Results in Relation to the Extant Literature or Theories

Self-efficacy as defined by Bandura (1977) is the idea that people can be successful at a task if they believe that they can perform the task and attain the desired result. Tschannen-Moran et al. (1998) expanded on the definition and stated that self-efficacy is not actual proficiency but the belief that the person has in themselves that they are competent. This study aligned with this theoretical framework as the participants answered the survey questions on their perceived self-efficacy with teaching and understanding math conceptually and not on actual outcomes of their teaching or student work.

Bandura (1977) declared that people form self-efficacy through four different foundations. These include successfully performing a task, seeing another person be successful with the task, hearing from another person that they are capable of success, and how they are emotionally feeling within the situation of the task. The results of this study show that by participating in the modeled lessons during the PD sessions, seeing a competent teacher perform the lesson, hearing how they can be successful when teaching the lesson to their students, and feeling comfortable with their cohort, the teachers gained self-efficacy in the world of conceptual mathematical understanding. The social cognitive theory asserts that the self-beliefs of a person, along with their actions and their surroundings help affect their outcomes (Bandura, 1977; Schunk & Pajeares, 2002). The gains in self-efficacy scores on the PTME of the overall modified MTEBI support this theory in that the action of participating in the PD program in a cohort of teachers in similar positions positively affected their self-efficacy scores with a significant increase.

In contrast, the scores from the MTOE did not support the literature on the self-efficacy of teachers influencing their belief in improved student outcomes. Perera and John (2020) asserted student achievement in math is related to a teacher's belief in their ability to teach mathematics at a deep level. The MTOE results diverged from the literature in that the teachers' self-efficacy increased but their belief that their teaching capability impacts student outcomes decreased. Perera and John's (2020) heuristic model showed how teacher self-efficacy leads to classroom processes that lead to both positive student outcomes and optimistic teacher outcomes did not line up with this study's results. The teacher outcome did make positive gains, whereas the belief in student outcomes declined negatively. I believe this will change with time, though. The more teachers experience success with students' mathematical understanding, the more they will believe in their influence over those positive outcomes.

As the school year progressed, the participants' beliefs that what they are doing was directly related to student achievement decreased. As Bandura's self-efficacy theoretical framework states, one of the four informational sources for self-efficacy is "verbal persuasion" (Bandura, 1977, p. 198). Facilitators telling participants that they are capable of teaching mathematical concepts with full student understanding is one way to increase teacher self-efficacy, but it is one of the weakest forms of improving their belief in themselves. Participants will often need to see and experience the proof themselves. In other words, after experiencing the CRA lessons in computational strategies themselves as active participants, the need arose to teach the lesson to students and see the results. Although the study designed time to implement lessons in the classroom, the reflection time at the following PD session showed that teachers needed more practice with applying what they had learned. With more practice and teacher understanding, I am hopeful student outcomes will increase thus improving the teaching outcome expectancy beliefs of teachers. As stated earlier, as continued experiential activities that show effective strategies for teaching math concepts will increase teacher self-efficacy, then teacher confidence in positive student outcomes will hopefully increase in time, also.

As most previous researchers examined the self-efficacy of pre-service teachers, there was little literature investigating the influence of an intentional, sustained PD program on current teachers. This study did align with the earlier research on pre-service teachers, teachers who increased their self-efficacy in understanding math conceptually displayed confident attitudes about their mathematical teaching ability (Courtney-Clark & Wessels, 2014; Ellez, 2020). The analysis of data from this study from the PD questions demonstrated a marked improvement in teacher self-efficacy and teachers felt more self-assured in their ability to teach math. However, in this study, regardless of their training (traditional or alternative), there was not a statistically significant difference in their self-efficacy gains.

The results from the pre-and post-survey questions on the topics covered during the professional development training (PD) showed an increase in self-efficacy gains related to the design of the sessions. My study incorporated the six elements of a highly effective professional learning program such as the duration of the program over five months and each session lasting three hours, the sessions focused on computational strategies with conceptual understanding, consistent trainers who are experts in the field of mathematics, active engagement of participants through hands-on learning, and collaboration between the teachers (Heck et al., 2019). The artifacts consisting of the three professional development sessions are exhibited in Appendix F.

After participating in the PD sessions, the teachers had a statistically significant increase in self-efficacy on the concepts presented during the professional learning sessions. There was a moderate effect size indicating that the designed PD program that integrated the elements of effective professional development as defined by Heck et al. (2019) was successful in increasing teacher mathematical self-efficacy. Likewise, the PD program incorporated strategies for computational problem-solving in an exploratory manner with the teachers, and as previous researchers stated that led to the improvement of teachers' beliefs in their ability to understand and teach mathematical concepts (Althauser, 2015; Carney et al., 2016; Darling-Hammond et al., 2009).

Despite the hypothesis that the scores on the NONPD questions would remain unchanged they, in fact, increased. One explanation for the increase in mean scores on the NONPD subconstruct was the teachers' knowledge and application of the concrete, representational, abstract model for computational strategies were able to be applied to the concepts of measurement and data analysis. Even though the sessions did not explicitly teach hands-on activities with these concepts, by the end of the program, the trainers exposed participants multiple times to that model of teaching and teachers could have ascertained ways to teach measurement and data analysis utilizing hands-on methods. Another possible explanation is the Hawthorne effect which implies that teachers may have responded to all items positively because they knew this was part of a study and they were being observed.

As teachers participated in the PD sessions on computational strategies, they discussed how to expand their knowledge into other concepts not presented in the PD sessions. This could also explain how the NONPD mean differences in self-efficacy scores increased even though the concepts of measurement and data analysis were never explicitly taught during the professional learning sessions. Collaboration time was given to the participants and conversations between participants happened that were not guided to stay on the computational strategies topic. Although these concepts were not the focus, it is of benefit to all that teachers use what they are learning and apply the CRA model to other concepts.

In comparing the K-2 teachers to the 3-5 teachers, the third through fifth-grade teachers showed the highest gains in PTME mean differences than any other group or comparison in my study. The expectation at the beginning of the study was that there would be a greater gain in self-efficacy scores with the kindergarten through second-grade group due to the upper-grade teachers generally having more content knowledge. It was surprising the primary-grade teachers did not make major growth changes in PTME. In contrast, the upper-grade teachers made greater gains in self-efficacy.

A few of the third through fifth-grade teachers have struggled in the past with teaching conceptually and usually bypass those strategies and begin teaching with standard algorithms. The expectation is that by the time students reach these grade levels, there is not much need for manipulatives or connecting the algorithms to concrete models and representations. As I observed in the PD sessions, I heard several teachers mention they did not know how to incorporate manipulatives and models into their lessons. In the feedback after the last PD session, one question asked was to name something the teachers have learned that they will implement or revise within their classrooms. Many teachers responded about using manipulatives and the CRA model of instruction.

Discussion of Personal Lessons Learned

I learned several lessons by moving through the process of a quantitative, non-experimental design study. One of the lessons I learned was understanding the importance of the teacher's voice. After each PD session, I sent out a feedback survey to the participants asking what they would incorporate in their classrooms from the training and what information they would like to hear more about in the next session. Each PD session modeled a particular lesson that was planned to be taught in the next few weeks for each grade level on how to teach a computational strategy with conceptual understanding using the CRA model. In the feedback after these sessions, I received numerous pieces of information stating the teachers wanted to know how to effectively use manipulatives. I was, frankly, surprised. I did not know this was an obstacle for a lot of teachers. These educators had not learned mathematics in the early grades using manipulatives and models and were exposed to it very little in their teacher preparation programs. They wanted to know how to use fraction strips and tiles to add and subtract fractions, how to use place value disks to add and subtract with regrouping, and how to use arithmetic frames, such as a rekenrek, in the primary grades to add and subtract basic facts with reasoning strategies.

Using manipulatives and models or representations increases both teacher and student understanding. If I had not sent the survey to the teachers, I would not have known the need for teachers to understand how to use the manipulative tools they have in their classrooms to engage students to promote a greater understanding of math concepts. I did not realize the depth of the lack of knowledge. This feedback provided me with insights that not only helped shape the rest of the PD sessions for this study but also gave me PD suggestions for next year. I also gained an understanding of where the greatest teachers' needs lie.

Additionally, I learned how important it was to have teachers experience the lessons as students. Having the teachers go through the same activities and learning as their students ensures that they will instruct their students in the same manner. When the participants came to the subsequent PD sessions and reflected on how their lessons were enacted in their classrooms, we heard a lot of exclamations on how their students were catching on to the concepts of computation faster and with an easier time. I learned the importance of modeling. We ask our teachers to model strategies for their students. I now realize how valuable modeling can be for teachers.

A beneficial lesson I learned was how to collect the data in a very orderly, intentional way and use the SPSS program to analyze the data. In my current job as the district Math Curriculum Coordinator, my leaders often ask me to analyze assessment data. I feel by going through this process of examining the data in multiple ways to answer specific research questions is something I can apply to my current job. Too often we go from assessment to assessment or problem to problem and try to correct the problem without giving actual time and thought to ask the correct questions that truly understand what we want to know. The act of deciding on the correct statistical test to apply to the data and finally analyzing the results is powerful in furthering knowledge. This was truly a learning experience for me and one I hope to continue to use in my career. I value the lessons I learned from designing a study, implementing the action steps, gathering the data, analyzing the data, and reflecting on the study. I understand the importance of following the process with intentionality and integrity. So much significant information can be discovered by research!

Implications for Practice

When examining the results of the study, one implication for practice that surfaced was the continued need for intentional professional development. All teachers experienced gains in self-efficacy after the PD sessions. Upper-grade (3-5) teachers made greater gains than the primary-grade level teachers but that does not translate into only training the third through fifth-grade teachers. All teachers can benefit from a professional development program focused on their needs.

At the beginning of the year, the district should administer a survey to teachers to determine their mathematical knowledge and pedagogical needs and develop a sustained focused PD program from the results of the data. The district will maintain the cohort idea for leaders of the sessions and hold valuable day-long training for the facilitators.

Consistent trainers that are experts in their math knowledge made a difference in the professional learning sessions. Feedback showed that teachers appreciated hearing from fellow educators who were experiencing the same issues in class as they were. We will continue to recruit educators who fit the parameters of this study's guide and continue the training sessions beforehand with them to ensure consistency and clarity.

Another implication for practice that surfaced was how powerful it was to model the lessons for the teachers. I see the need for this to continue in future professional development sessions and for instructional campus coaches to incorporate these pedagogical practices into their planning sessions with teachers. Teachers' understanding of exactly what the lesson should look and sound like was extremely helpful, especially to those who did not have confidence in their math skills. Even experienced teachers gained knowledge from participating in the modeled lessons. They experienced the need for the use of manipulatives and moving between concrete, representational, and abstract models for students. The practice of active experiences with the content is a strategy to expand on for future professional learning sessions.

Finally, one last implication for practice is the need for working directly with alternatively certified teachers in a more focused, timely, and sustained fashion became clear. They made self-efficacy gains when learning about the mathematical concepts most relevant to them at the time. When we taught the teachers how to present the material to the students right before the concepts came up in the lessons, the alternatively certified teachers realized the benefits. Continuing to put into practice the use of modeling and conceptual understanding before teachers present the lesson to students will advance all teachers' understanding and confidence, but especially for those who have not been trained to the extent needed before stepping foot into a classroom. As we are currently realizing, more people are entering education with no student teaching experience or classroom observations. They need guidance on what works with students and why math functions the way it does.

Connect to Context

The context of professional learning on conceptual understanding using the CRA model led me to understand that more training on the use of manipulatives was crucial. I found that many teachers, especially the third through fifth-grade teachers were not comfortable utilizing manipulatives themselves and therefore, did not know how to introduce mathematical concepts to the students with them. All teachers knew what the manipulatives were and had them available but had not connected the use of concrete objects with the algorithms of computational strategies.

There was still a taboo feeling about using manipulatives, particularly with older students. When the teacher facilitators showed the participants effective ways to use manipulatives the teachers could see the purpose behind the use and the need to extend that knowledge to their students. For example, when the trainers used physical area models on graph paper to show the strategy of halving and doubling for multiplication, they could see the understanding dawn on the participants. Cutting the area model rows in half and moving one half physically down to double the columns did not change the area of the model but made for an easier problem to solve. Many teachers said they had not attempted this lesson before as they felt it was too hard for students to try. It was the lack of teachers' understanding of this strategy that made it difficult. Once they could physically move pieces around, the participants could experience what was happening when you double and halve a multiplication fact to make an easier problem.

Another connection to the context that was a pleasant surprise was that principals sat in on the learning sessions and learned new strategies to teach students computation. I had several casual conversations with principals afterward and they were excited to know what to observe in a math classroom. Once teachers took the lesson back to their classrooms to present to students, principals commented they saw a lot more manipulative use and student talk in lessons they observed. We need to continue the training on the use of manipulatives not only with teachers but also with administrators so they can be a support for teachers and students.

Connect to Field of Study

The connection to the field of study is the importance of a well-crafted professional learning design that will impart the most effective math strategies for teaching conceptually to learners from all backgrounds, both teachers and students. As stated previously, past researchers have focused on pre-service teachers and their self-efficacy in teaching math. I could not locate many studies that showed the impact of a sustained, content-focused professional learning program on teachers currently in the classroom to the extent as pre-service teachers had been examined. Researching the differences in self-efficacy growth between lower and upper elementary grade teachers and alternatively and traditionally certified teachers became an important comparison to investigate.

Through this study, I examined the need for analyzing current educators' self-efficacy in the conceptual understanding of math. Several prior researchers (Carney et al., 2016; Corkin et al., 2015; Darling-Hammond et al., 2009) believed in the ability of a sustained program to boost the self-efficacy of teachers in the field of mathematical pedagogy and knowledge. The results from this study point to the overall benefit of a sustained professional development program for increasing teacher self-efficacy among all teachers but also among alternatively trained teachers. Further studies could be conducted with only alternatively trained teachers after attending a year-long training program on mathematical concepts and the effects on their self-efficacy.

The practical significance of PD sessions on specific concepts taught with conceptual understanding shows adhering to this professional learning program would be beneficial to all teachers, but especially to alternatively trained and certified teachers who may not have had the opportunity to learn about specific mathematical concepts. Due to the shortened educational training for teachers who received certification through an alternative means, there arises a need for more focused mathematical training and how to teach conceptually using the CRA approach. The effect size of the alternative versus traditional teachers in self-efficacy gains was the largest effect size of all the statistical tests run on the data. Therefore, the participants who gained the most from the PD sessions were the alternatively trained and certified teachers.

With an understanding of the need for pre-service teachers to gain mathematical knowledge and self-confidence in teaching math conceptually, the need to study current classroom teachers is also crucial. The results from this study benefit the field of increasing self-efficacy about mathematical knowledge by studying the results of a PD plan in action with present-day teachers.

Lessons Learned

The greatest lesson learned in conducting this study is that all teachers benefitted from and gained self-efficacy in mathematical conceptual understanding after participating in a prolonged professional learning program that was content-focused, led by the same experts each time, and filled with experiential activities to further understanding. Although there was little difference in self-efficacy gains from the pre-survey to the post-survey between teachers with varying levels of experience, they all still made gains. Teachers that actively participated in the PD sessions and took lessons back to their classrooms to try out increased their self-efficacy gains in the belief in their ability to teach math, especially the upper-grade level teachers. Alternatively trained teachers proved the need for a relevant, focused training program after they started teaching to increase their self-efficacy in teaching math. All teachers advanced their belief in themselves about teaching mathematics.

The need for more in-depth training for alternatively certified teachers became clear when examining the results of comparing self-efficacy gains between the teachers with traditional training and certification and those who attended an alternative teacher program. The teachers who had not attended a traditional teacher training program gained more self-efficacy than those who had traditional training when presented with specific mathematical concepts and how to teach them in a conceptual way with concrete objects, representations, and abstract models. The lesson learned is that more training with relevant content just-in-time for teachers is crucial for improving the pedagogy and self-belief in all teachers, but especially those who start their teaching career with less training than others.

Another lesson learned was the barriers teachers faced when participating in the PD program and the expectation of teaching the conceptual understanding of lessons to their students. Some teachers lacked an understanding of the CRA model and needed a refresher on its meaning and how to incorporate it into multiple lessons and concepts. We discovered some campuses did not have the manipulatives needed or lacked the understanding of how to effectively use the manipulatives they did have to engage their students. Campus support in the form of encouragement and accountability was also an obstacle to the study at certain campuses. When conducting a study that includes time to bring the lesson back to the students and reflect on the outcomes, it is crucial to have support on campus. It is also necessary to have the support of the principals to encourage teachers to attend all the training and implement the strategies in the classrooms.

Finally, a critical lesson learned from conducting this study is the importance of teacher reflection time. The time between the PD sessions became a particularly important part of the study. It gave teachers time to process what they learned, implement new strategies in their classrooms, and time to reflect on what worked and what did not work. Each PD training allowed for time in the beginning for teachers to gather in small groups or with partners and discuss how their lessons were enacted. I found that in listening to the groups some teachers were thrilled with how their students responded to the lessons and saw growth in their student outcomes which led to higher self-efficacy in the teachers. Others struggled with the lessons taught to the students and after reflection realized they did not understand the computation strategy presented and needed more clarification. This reflection time provided feedback not only to me but to the teachers themselves.

Recommendations

While the quantitative, non-experimental pre-and post-survey design served the purpose of examining the effect of a large-scale professional learning program on elementary teachers' self-efficacy about teaching math conceptually, further studies are warranted adding a qualitative component. After the participants complete the post-survey and data are collected and analyzed, I believe more in-depth information could be obtained by interviewing participants. Future studies should use an interview protocol to examine what parts of the PD program participants found useful and how to improve the program to increase a teacher's self-efficacy in conceptual understanding of mathematics. A researcher could query the participants who gained the most in their self-efficacy scores and those who gained the least or made no gains. The qualitative data gleaned from these interviews could provide greater insights into how to build the most effective training program to boost teacher self-efficacy in conceptual understanding of mathematics.

Mielke (2021) stated the self-efficacy of an educator is crucial to affect student outcomes. Through this study, I found teacher self-efficacy increased but the belief in the results of students due to increased participant self-efficacy did not increase. When a future researcher adds the qualitative piece, they may gather additional information to determine why the participants' belief in student outcomes did not rise at the same level as their belief in themselves. One purpose of my quantitative study was to examine the impact of a large-scale PD program on teacher self-efficacy. Therefore, interviewing the 231 teachers that participated in the study was considered too time-consuming for this study. In future studies, narrowing the number of participants and conducting a mixed methods study might gather a unique perspective.

To expand on the idea of adding a qualitative component to the study, I would recommend adding more time to the study. The decrease across the board in MTOE raises the question of why teacher self-efficacy improvement did not increase the belief that what they do affects student learning. More time may be needed in future studies to show teachers the positive outcomes of improved teaching. I conducted this study over five months with three professional development sessions. A future study should consider a two-year professional learning plan to give time for teachers to see what student progress happens because of the educator's increased mathematical self-efficacy. Riggs et al. (2018) determined that students would succeed in learning math once the teacher believes in their ability to teach mathematical concepts with deep understanding and believe that students can learn these concepts with meaningful comprehension. The data from this study suggested that teachers had not reached the same level of belief in student outcomes as they did in their own mathematical understanding. More time and more experiential activities for the participants to implement in the classroom should show an increase in student outcomes which will then improve the teachers' student outcome expectancy as measured by the subconstruct MTOE. In future studies, the duration of the study can be lengthened to determine if more time will impact the outcome expectancy of students at a rate comparable to the growth in teacher self-efficacy. Teacher self-efficacy often comes before they believe in student outcomes. I would like to determine if the student outcome beliefs from teachers increase after they see the results of increasing their own understanding of math conceptually.

A final recommendation would be to conduct the study using the modified MTEBI with administrators at the campus level. A slightly revised professional learning program could be designed from a principal's perspective and within the scope of time they can devote to learning.

I believe if the campus administrator experiences the same training as the teachers, their self-efficacy in the content knowledge will increase and they will be able to support their teachers in their pursuit of a deep understanding of mathematical concepts. It is vital to have the support of administrators in this endeavor to increase teachers' self-efficacy. Without the support and encouragement of the principals, the motivation on the participants' part to fully embrace the learning from the PD program tends to wane as the year goes on. When administrators are confident in their ability to understand mathematical concepts with understanding, they will be able to impart immediate feedback to the teachers while observing their classrooms. Prompt and timely feedback will impact a teacher's self-efficacy immediately (Chang, 2010). I would be interested to see if a sustained PD program had as much of an effect on administrators' self-efficacy as it did on teachers.

Closing Thoughts

The last few years in education, especially since the pandemic, have shown districts around the country will need to hire more teachers who do not have traditional training and certification due to fewer students entering traditional teacher training programs. These teachers may not have had any student teaching opportunities or even observed in classrooms before being in control of their groups of students. A greater need than ever before occurs to meet all teachers where they are in their content and pedagogical knowledge and move them forward to utilizing effective and proven successful teaching strategies.

District leaders need to think outside of the box when designing professional learning programs. Teachers do not want or find one-and-done training useful. Educators need time to collaborate, process, implement, and reflect on what they are learning. Professional development programs should have an ongoing goal that is relevant to a teacher's needs and presented throughout the year or over two years to ensure enough time is provided to see results in both teacher and student outcomes. Through this study, I attempted to do just that.

While the study results showed a statistically significant difference in the participants' self-efficacy overall and in the concepts presented in the PD sessions, the belief in the teachers' influence on student outcomes did not increase. The MTOE scores decreased from the pre-survey to the post-survey. As I stated before, future similar studies should allot more professional learning time. Once teachers experience student outcomes increase, then they will begin to believe in the power of their self-efficacy and how that can affect the results through the lessons they enact in their classrooms. If professional development can change and improve to address the needs of teachers, self-efficacy will increase in both teachers and ultimately students.

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APPENDIX A

IRB DETERMINATION LETTER

DIVISION OF RESEARCH

TEXAS A&M UNIVERSITY

NOT HUMAN RESEARCH DETERMINATION

February 07, 2022

Type of Review: Initial Review Submission Form
Title: Effects of Conceptual Mathematics Professional Development on Self-Efficacy of Elementary Teachers: A Quantitative Study
Investigator: Radhika Viruru
IRB ID: IRB2022-0160
Reference Number: 137787
Funding: N/A

Dear Radhika Viruru:

The Institution determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations.

Further IRB review and approval by this organization is not required because this is not human research. This determination applies only to the activities described in this IRB submission and does not apply should any changes be made. If changes are made you must immediately contact the IRB about whether these activities are research involving humans in which the organization is engaged. You will also be required to submit a new request to the IRB for a determination.

Please be aware that receiving a 'Not Human Research Determination' is not the same as IRB review and approval of the activity. IRB consent forms or templates for the activities described in the determination are not to be used and references to TAMU IRB approval must be removed from study documents.

Of note, according to the application, data gathering efforts are intended only for the student's record of study and will not yield generalizable data.

If you have any questions, please contact the IRB Administrative Office at 1-979-458-4067, toll free at 1-855-795-8636.

Sincerely,
IRB Administration

Appendix: Reviewed Study Documents.

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Type	Document Name	Version	Date Submitted into Workflow
Submission Form:			
Submission Form	Initial Review Submission Form	Version 1.0	02/05/2022 11:38:41 AM CST
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Application	IRB Application (Human Research)	Version 1.0	02/05/2022 11:38:41 AM CST

APPENDIX B

MTEBI-Digital Format-Original Order

Please indicate the degree to which you agree or disagree with each statement below by choosing the appropriate numbers below for each statement.

5-Strongly Agree 4-Agree 3-Uncertain 2-Disagree 1-Strongly Disagree

1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.
2. I will continually find better ways to teach mathematics.
3. Even if I try very hard, I will not teach mathematics as well as I will most subjects.
4. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.
5. I know how to teach mathematics concepts effectively.
6. I will not be very effective in monitoring mathematics activities.
7. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.
8. I will generally teach mathematics ineffectively.
9. The inadequacy of a student's mathematics background can be overcome by good teaching.
10. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.
11. I understand mathematics concepts well enough to be effective in teaching elementary mathematics.
12. The teacher is generally responsible for the achievement of students in mathematics.

13. Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.
14. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.
15. I will find it difficult to use manipulatives to explain to students why mathematics works.
16. I will typically be able to answer students' questions.
17. I wonder if I will have the necessary skills to teach mathematics.
18. Given a choice, I will not invite the principal to evaluate my mathematics teaching.
19. When a student has difficulty understanding a mathematics concept, I will usually be at a loss as to how to help the student understand it better.
20. When teaching mathematics, I will usually welcome student questions.
21. I do not know what to do to turn students on to mathematics.

APPENDIX C

MTEBI-Digital Format-Revised Order

Please indicate the degree to which you agree or disagree with each statement below by choosing the appropriate numbers below for each statement.

5-Strongly Agree 4-Agree 3-Uncertain 2-Disagree 1-Strongly Disagree

1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.
2. I will continually find better ways to teach mathematics.
3. Even if I try very hard, I will not teach mathematics as well as I will most subjects.
4. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.
5. I know how to teach mathematics concepts effectively.
6. I do not know what to do to turn students on to mathematics.
7. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.
8. I will generally teach mathematics ineffectively.
9. The inadequacy of a student's mathematics background can be overcome by good teaching.
10. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.
11. I understand mathematics concepts well enough to be effective in teaching elementary mathematics.
12. The teacher is generally responsible for the achievement of students in mathematics.

13. I will not be very effective in monitoring mathematics activities.
14. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.
15. I will find it difficult to use manipulatives to explain to students why mathematics works.
16. I will typically be able to answer students' questions.
17. I wonder if I will have the necessary skills to teach mathematics.
18. Given a choice, I will not invite the principal to evaluate my mathematics teaching.
19. When a student has difficulty understanding a mathematics concept, I will usually be at a loss as to how to help the student understand it better.
20. When teaching mathematics, I will usually welcome student questions.
21. Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.

APPENDIX D

Additional Survey Questions

Topic: Computational Strategies

1. I will continually find better ways to teach computational strategies.
2. I will typically be able to answer students' questions about how the concrete, representational, and abstract sequence of computational strategies connect with each other.
3. I understand computational strategies well enough to be effective in teaching elementary mathematics.
4. Even if I try very hard, I will not teach subtraction as well as I will most other subjects.
5. I will find it difficult to use manipulatives to explain to students why computation strategies work.

Topic: Measurement and Data Analysis

6. I know how to teach measurement skills in a conceptual way effectively.
7. I will generally teach data analysis concepts ineffectively.
8. I understand measurement concepts well enough to be effective in teaching elementary mathematics.
9. I will find it difficult to use manipulatives to explain to students how measurement concepts work.
10. I will typically be able to answer students' questions about data analysis concepts.

APPENDIX E

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) Scoring Instructions

Step 1. Item Scoring: Items must be scored as follows:

5=Strongly Agree; 4=Agree; 3=Uncertain; 2=Disagree; and 1=Strongly Disagree

Step 2. The following items must be reversed scored in order to produce consistent values between positively and negatively worded items. Reversing these items will produce high scores for those high and low scores for those low in efficacy and outcome expectancy beliefs.

Item 3	Item 15	Item 25
Item 6	Item 17	Item 26
Item 8	Item 18	Item 28
Item 13	Item 19	Item 30

In SPSSx, this reverse scoring can be accomplished by using the recode command. For example, recode ITEM3 with the following command:

RECODE ITEM3 (5=1) (4=2) (2=4) (1=5)

Step 3. Items for the two scales are scattered randomly throughout the MTEBI. The items designed to measure Personal Mathematics Teaching Efficacy Belief (PMTE) are as follows:

Item 2	Item 11	Item17
Item 3	Item 13	Item 18
Item 5	Item 15	Item 19
Item 6	Item 16	Item 20
Item 8		

Items designed to measure Outcome Expectancy (OE) are as follows:

Item 1	Item 9	Item 14
Item 4	Item 10	Item 21
Item 7	Item 12	

Items designed to measure impact of professional development program on conceptual understanding of computational strategies (PD)

Item 22	Item 25
Item 23	Item 26
Item 24	

Items designed to measure compare against professional development concepts (NonPD)

Item 27	Item 30
Item 28	Item 31
Item 29	

Note: In the computer program, DO NOT sum scale scores before the RECODE procedures have been completed. In SPSSx, this summation may be accomplished by the following COMPUTE command:

COMPUTE SESCALE = ITEM2 + ITEM 3 + ITEM5 + ITEM6 + ITEM8 + ITEM11 + ITEM13 + ITEM15 + ITEM16 + ITEM17 + ITEM18 + ITEM19 + ITEM20 / 13

COMPUTE OESCALE = ITEM1 + ITEM4 + ITEM7 + ITEM9 + ITEM10 + ITEM12 + ITEM14+ ITEM21/ 8

COMPUTE PDSCALE=ITEM22 + ITEM23 + ITEM24 + ITEM25 + ITEM26/5

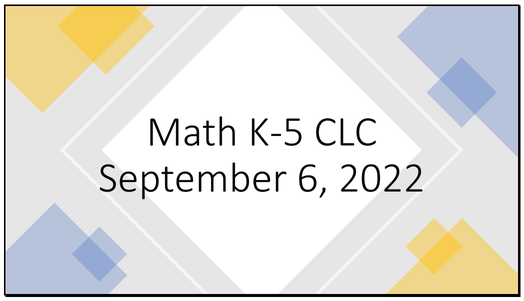
COMPUTE NONPDSCALE=ITEM27 + ITEM28 + ITEM29 + ITEM30 + ITEM31/5

APPENDIX F

Professional Development Artifact

First Professional Development Training in September

Slide 1

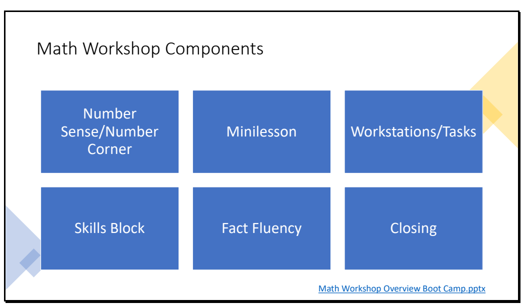


Sign in on sign-in sheet, Welcome, agenda for the morning

Slide 2

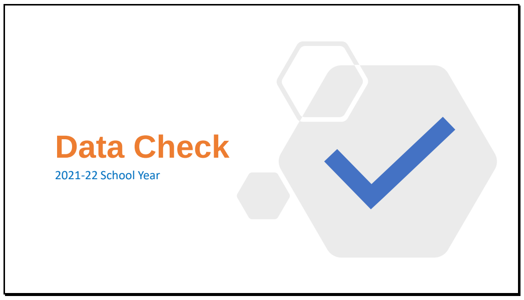
10 min
Explain the study and give pre-survey.

Slide 3



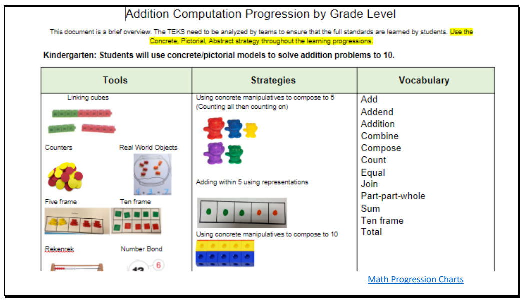
Review Math Workshop as district framework. Have teachers break into 6 groups of 4-5 people. Each group will research and design a slide to teach the different components.
2 min – Introduction to activity –
8- Research and Design Slides to teach your different component.
15 min Explain Share out Procedure – have them grab a playing card from the folder-red stays at the table to present to others, and black visits different tables to hear short presentations

Slide 4



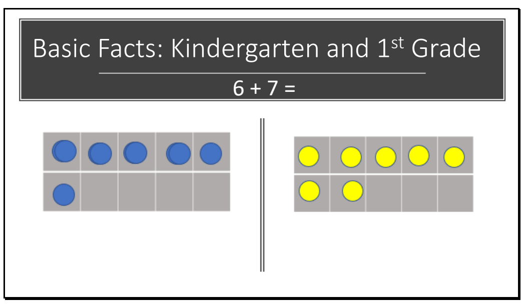
15 min
Will put copies of STAAR item analysis, 2nd Grade DCA 4 data, and EOY Istation k-2 on tables
What do you notice, what do you wonder – What will we do differently next year?
Data shows low areas include computation skills and word problems with computation. Gives purpose for PD and activities today.

Slide 5



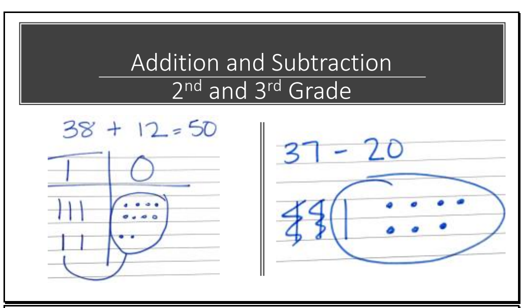
Review the computation progression charts found in Canvas (link on slide)
Each grade level looks at student work from their slide and finds where the student is on the progression chart and discusses ways to move them to a more efficient strategy- where to go on the chart and steps to move students forward

Slide 6



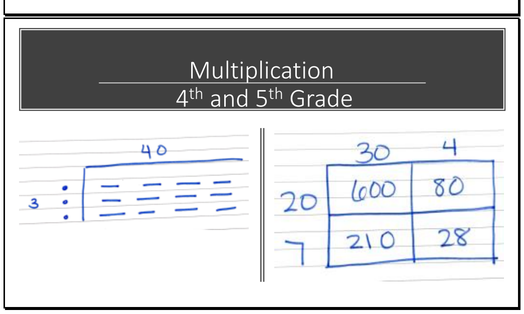
K-1
How to move from concrete to representation of drawing 10 frames to the abstract of using doubles plus one

Slide7



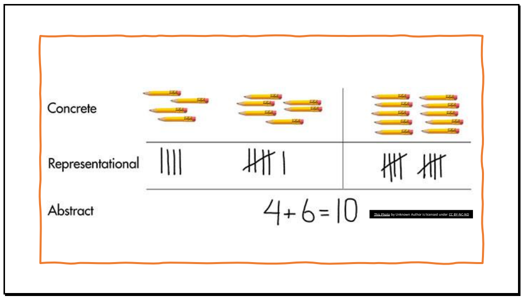
2-3
How to move from representation of base 10 blocks to abstract of decomposing by place value with numbers and adding or subtracting

Slide 8



4-5
How to move from area models of division and multiplication to decomposing by place value with digits

Slide 9

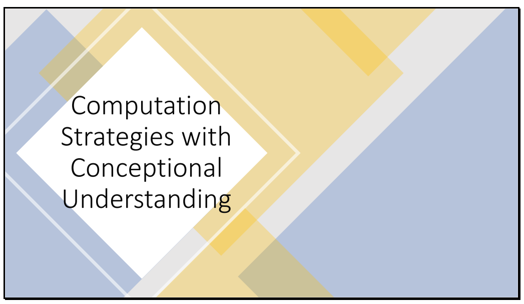


What does concrete, representational and abstract mean and do students move linearly through these steps?

Slide 10

Watch an 8.5-minute video about connecting concrete, representational, and abstract methods for computation and discuss with table groups their takeaways.

Slide 11



50 minutes
Look at upcoming TEKS for computational strategies.
Then each grade level will look at its slide and the trainer will model how to teach an upcoming computational lesson from scope and sequence with hands-on concrete models, representations, and abstract methods of solving problems. They will weave back and forth connecting all three ways to solve.

Slide 12

Kinder	1st	2nd	3rd	4th	5th
K.2B	1.3D	2.4C	3.4A	4.4A	5.3C
K.2H	1.3F	2.4D	3.2A	4.4H	5.4B
	1.5D				5.4F

1st Nine Weeks
Power TEKS

Here is the 1st 9 weeks POWER TEKS on computation

Slide 13

Kindergarten: Teachers give lesson- Investigations Unit 2- Lesson 1.8 Counting Jar
Learning Target: We will count items up to 20 and know the last number said is the number of items.
Mini lesson- Teacher will show counting jars (different containers with different amounts of counters in them

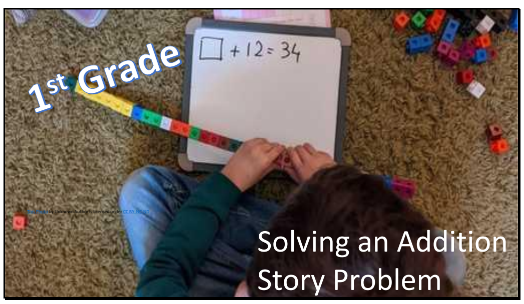
to differentiate for students). The class will do one jar together. The goal is to count the objects in the jar in any way. They can count by ones, twos, fives, tens, or any way that makes sense to them. After grouping and counting, they will draw a picture of how they counted with tally marks or circles. Then write the total. Discuss how the counters, pictures, and numbers are connected.

Explore: Students will work in partners or independently to count their own jars. Can choose jars for students based on needs.

Discussion/Reflection about this lesson will be at next CLC.

Closing: Discuss how students counted and choose one or two representations for students to share their thinking.

Slide 14



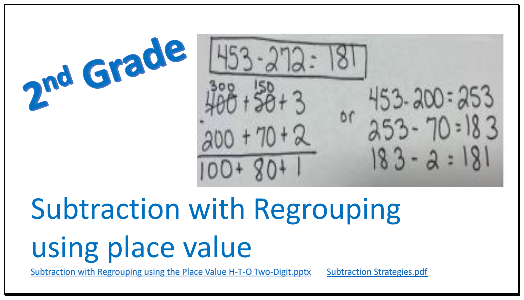
!st Grade: Investigations Unit 3 Session 1.8
Solving an Addition Story Problem
Learning Target: We will use objects and models to solve addition word problems.

Minilesson: Read story about finding total number of toy cars Sam (6) and Kim (7) have. Discuss what is happening in the story. Let students act it out with counters. Give students a chance to solve the problem individually with any strategy (drawing, acting it out, counting by ones, doubles plus one) and tools (ten frames, counters, rekenreks, number path, snap cubes). Have students pair up and share their thinking and strategy.

Explore: Give 3 more addition stories for students to solve.

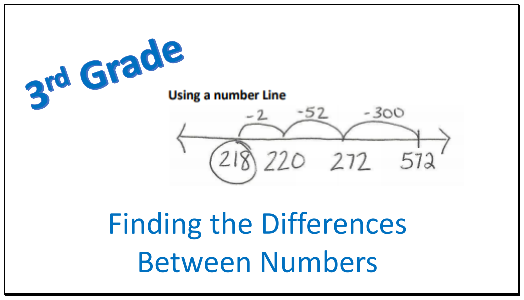
Closing: Find 2-3 students to share with the whole class and connect what they each did with the other students' strategies. Show the concrete, drawings, and addition sentence together to make the connection.

Slide 15



2nd Grade: Curriculum Writer made the lesson Subtraction with Regrouping using Place Value H-T-O Strategy Two-Digit Lesson and subtraction strategies anchor charts.
Learning Target: We will subtract two-digit numbers using place value to solve.
Minilesson: Show slides with place value chart of hundreds, tens, and ones. Ask students: Why would we need to make new groups? In math, we create new groups to make it more simple and easier to count.
First example: 1 dime equals the same as 10 pennies. I'm trading the dime for 10 pennies. When we are regrouping, we are trading for the same amount. 10 pennies equals 10 cents. 1 dime equals 10 cents. That's an equal amount, so we can trade that. Second example: I can trade a base 10 rod for 10 ones because they are equal amounts. Third example: I can trade 1 hundred flat for 10 rods because they are equal amounts. Both equals 100.
Model how to subtract with regrouping using expanded form as your strategy, then pictorial form, then using a number line as your strategy for subtraction.
Explore: After each guided example, give students a problem to complete on own with each strategy.
Closing: Discuss how decomposing by place value shows what is really happening when subtracting with regrouping.

Slide 16



3rd Grade: Investigations Unit 3 Session 3.5

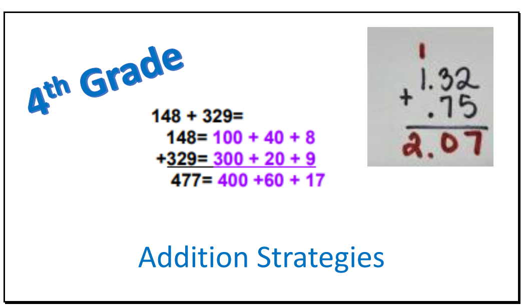
Learning Target: We will solve one and two step subtraction problems using strategies of place value and relationship between addition and subtraction.

Minilesson-Using a number line taped down on floor, have students stand at two points on line (45 and 16). Discuss subtraction is not always just about taking away an amount but also finding the difference between two numbers. Have class decide how to find the difference between the students using the number line. Work through different strategies such as adding up, subtracting back, and using friendly or landmark numbers of 10, 5, and 1. Find the difference together. Have a student show what was done on the number line with counters/Base 10 blocks. Have another student draw the number line and what steps were taken. Write the steps of the solution on the board and connect the concrete, representation, and abstract.

Explore-Give several travel problems (SAB p. 58) for students to solve independently or with a partner.

Closing-As students work, move around the room, and choose 2-3 students to share their strategies with the class.

Slide 17



4th Grade: Investigations Unit 5 Session 4.4A (Texas TEKS book)

Learning Target: We will add whole numbers using place value to decompose and connect it to the standard algorithm.

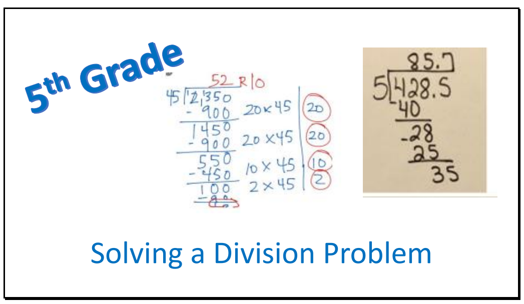
Minilesson-Whole class looks at problem given (283-137) and works on whiteboards to show how they would solve and shares with their partner how they would explain to a 3rd grader how to solve. Students can use base 10 blocks to explain, too. Share those who decomposed both subtrahend and minuend by place value to subtract and those who only decomposed the subtrahend and kept the minuend whole.

See the example in the teacher guide p. TX50.

Explore- More subtraction problems SAB. P. 62C in pairs or independently- (must draw a representation of strategy along with abstract)

Closing-As students work, move around the room and choose 2-3 students to share their strategies with the class. Make sure to connect what is happening when they use the standard algorithm to subtract. Connect it to concrete (base 10 blocks) and representation (number lines, decomposing by place value equations), and abstract (standard algorithm).

Slide 18



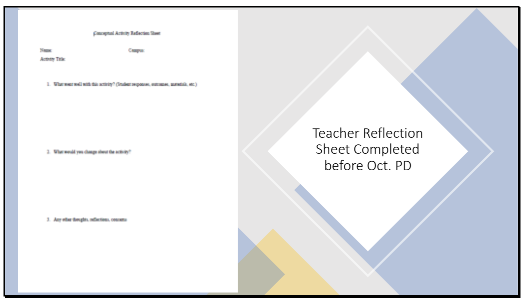
5th Grade: Investigations Unit 1 Session 3.1

Learning Target: We will find the quotient of a 4 digit by 2 digit problem using strategies and the standard algorithm.

Minilesson- Using paper money (pennies, dimes, ones, tens, and hundreds) ask students how you would divide the money ($428.50) by 5 students evenly. As students work together to find a solution, listen for possible solutions to represent on board. Move from representing fair shares (circles on board and divvying up money) to standard algorithm. Constantly refer to what value each digit represents and connect the steps to what the students did to share. Do not use acronyms to memorize steps. Reason through what is happening with each step by reenacting the sharing of the paper money. Have

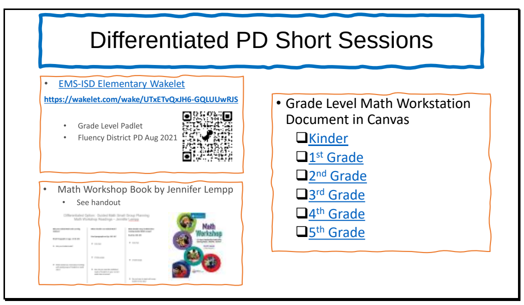
students complete a money division problem on whiteboards and share with their shoulder partner their thinking.
Explore- Use Lead4ward, Each one, teach one strategy. Each student solves a division problem on a card and then the class moves around the room finding a partner to share how they solved the problem. Once they share, they trade cards and then must explain the strategy and solution to a new partner.
Closing-Class back together and share what they learned in sharing their strategies with partners.

Slide 19



Teachers must complete lesson and reflection sheet before coming to the second PD session in October.

Slide 20



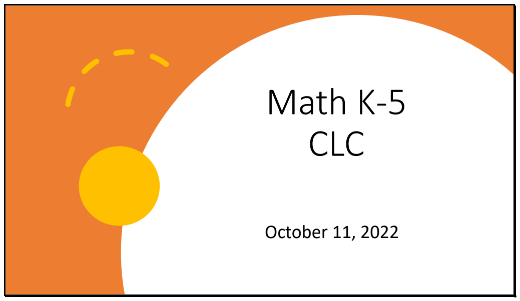
25 minutes
Teachers decide where their need is and choose the option to support that need.

Slide 21

1. Answer the first question yourself at your table.
Gathering resources, meeting with your coach for more support, Meeting with your grade level campus team to ensure lesson will be taught with fidelity and reflection sheet filled out
2. GO TO 4 CORNERS
Find a partner – discuss next steps

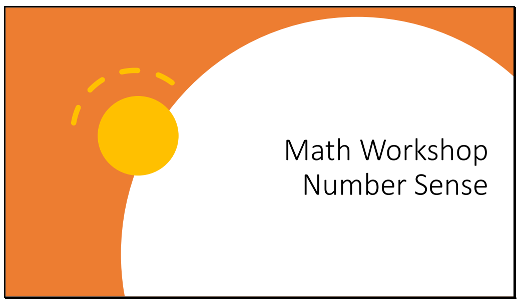
Second Professional Development Training in October

Slide 1



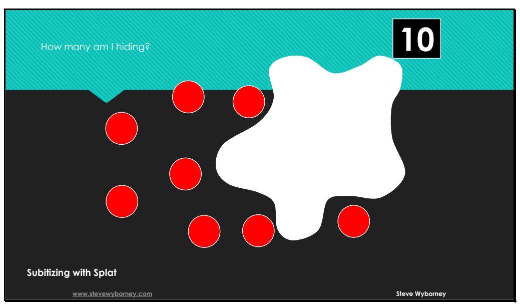
Sign in to sign in sheet, PowerPoint, write names down for door prizes later

Slide 2



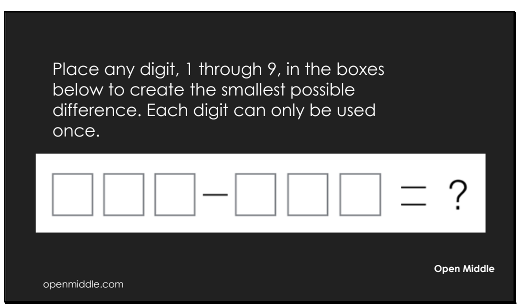
10 min
Look at Instructional Guide – Show where number sense slides are.

Slide 3



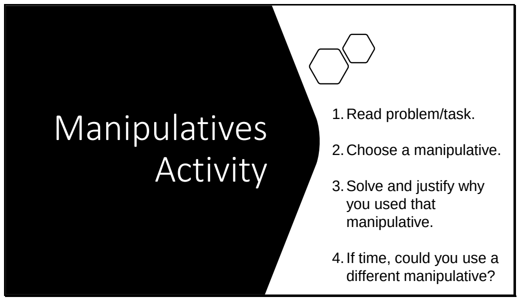
K-2 number sense slide-

Slide 4



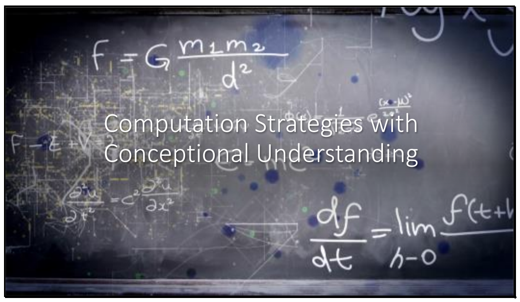
3-5 number sense slide

Slide 5



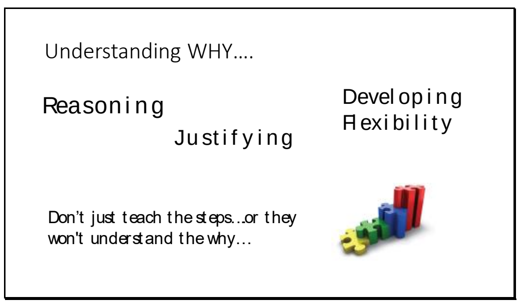
10 – 15 minutes
Give word problems for each grade level and have teachers choose a manipulative to solve the problem with and justify why they used those manipulatives

Slide 6

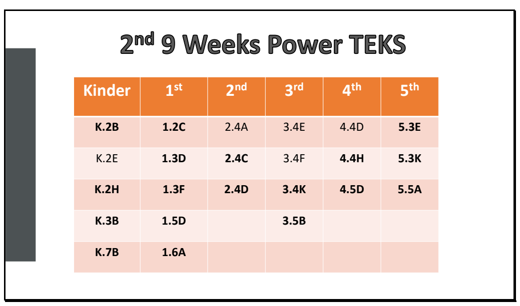


20 min

Slide 7

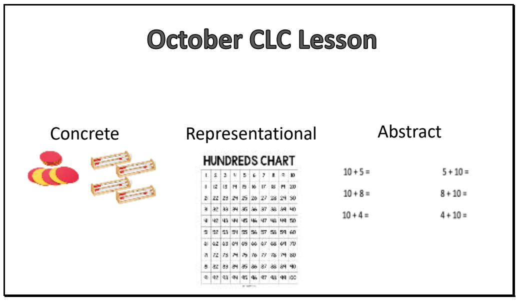


Slide 8



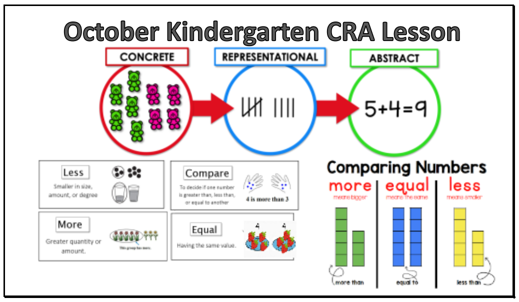
Kinder	1st	2nd	3rd	4th	5th
K.2B	1.2C	2.4A	3.4E	4.4D	5.3E
K.2E	1.3D	2.4C	3.4F	4.4H	5.3K
K.2H	1.3F	2.4D	3.4K	4.5D	5.5A
K.3B	1.5D		3.5B		
K.7B	1.6A				

Slide 9



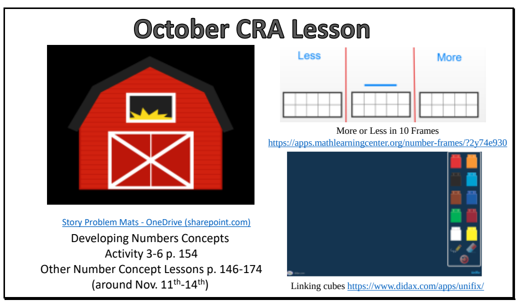
Reminder of CRA method

Slide 10



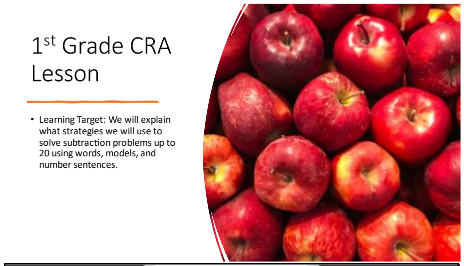
K Learning Target: We will compare sets of objects using comparative language.
Minilesson: Show two towers of cubes explain that they are equal, then take some away. What happened to my towers? Which tower has more? How do you know? Which tower has less? How do you know? How many more does the tower need to make it equal again?

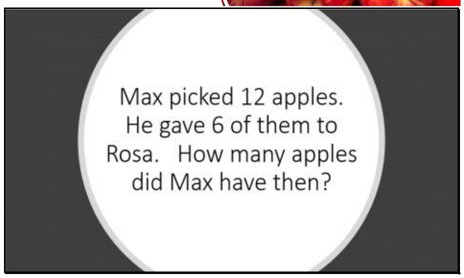
Slide 11



Explore: Story Problem Mats -Pass out barns and 7 chips, Establish rules; allow time to play.
This is concrete and abstract, representation would be representing on a tens frame or draw a picture
Inside vs. outside (more and less),
Red vs. yellow (toss the chips)
Closing: Show one example of 7 chips on barn and outside barn to represent a subtraction problem. How could we represent this on a ten frame? What number sentence would show what happened with the chips?

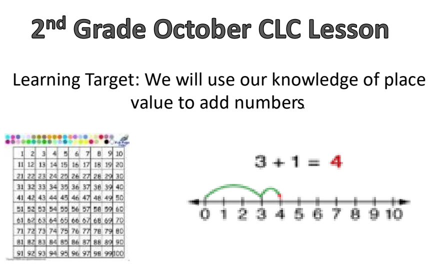
Slides 12 and 13





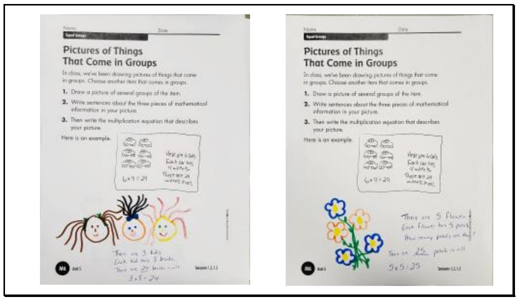
1st Grade Lesson
Minilesson- Read problem on next slide. Have students retell story to a partner. Ask, "Will Max have more or fewer than 12 apples?" Have students identify what manipulatives they would like to use to solve this problem during Explore time.
Explore: Students will solve the problem and go to a workstation for review of subtraction.
Closing: Bring student work back to circle. Have students share how they solved the problem.

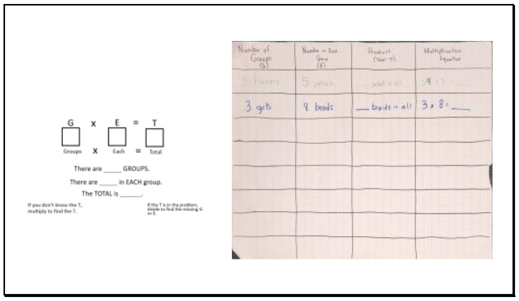
Slide 14



2nd Grade Lesson-Minilesson: Have students answer these problems (10 + 5, 10 + 8, 10+ 4, 6 + 10, 3+ 10, 7 + 10) How did you solve the problems? Could you use manipulatives? Which would be the most helpful to use? Show 100 chart and number line to solve these problems. Work in pairs to solve addition cards (Ex: 8 + 10, 10 + 8)
Explore: Work through problems about tens and ones, (Ex: Franco has 76 cards. If he puts them in rows of 10, how many rows will he make? How many will be left over?)
Closing: How can knowing how to add 10 help with this problem- 26 + 10.

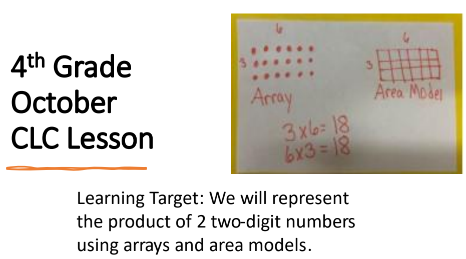
Slides 15 and 16





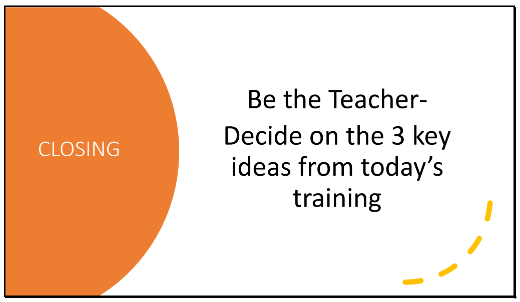
3rd Grade Lesson-Learning Target: We will represent multiplication facts using equal-sized groups.
Minilesson: Remind students of pictures they have been making of things that come in groups. Create a picture of a group of items. Write sentences that describe the picture mathematically. Use manipulatives to act out story. Write a multiplication equation together that describes the picture. See examples of braids and flower petals. Show GET poster on next slide and discuss what each letter represents (Number of Groups X Number of each item in group = Total/Product) Fill out poster with examples completed together.
Explore: Students will create 2-3 of their own multiplication stories and equations.
Closing: Share stories and fill in 2-3 more lines on GET poster.

Slide 17



4th Grade Lesson
Minilesson: Introduce doubling and halving strategy for multiplication problems using physical arrays on paper that columns can be cut in half and placed underneath to double rows. Have students cut after you show example. They can also use counters and move half to double and half the array. Is this equation true? 15 X 8 = 30 X 4 Can you prove it? Does that make the problem easier to solve?
Explore: Complete multiplication cluster problems using double and half as one strategy. Multiplication workstation games if completed early.
Closing: Discuss benefit of doubling and halving as multiplication strategy to make a difficult problem easier.

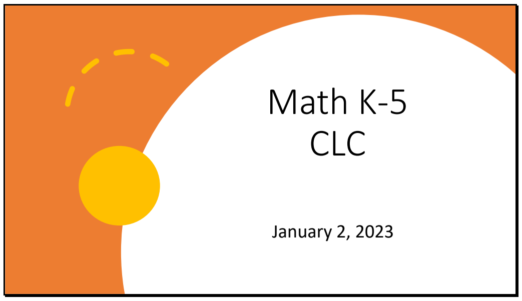
Slides 18 and 19



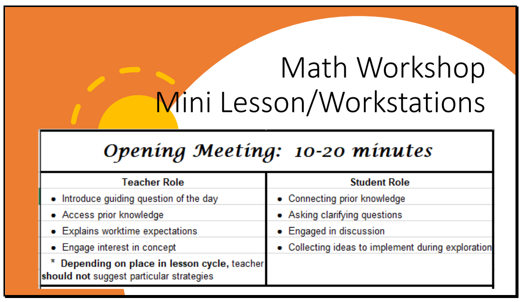
- 5th Grade Lesson-Minilesson: Have students solve 24 X 16, 24 X 1.60, 24 X 0.16- Ask what students notice about problems and solutions. Highlight each problem is multiplying 24 and 16, all the answer contain digits of 3, 8, and 4, and the placement of the decimal point changes the magnitude of the number. Why is the decimal point in a different place each time? What is the relationship between 16 and 1.6, between 1.6 and 0.16? Is that the same relationship between the products?
- Explore: Students work in partners to complete worksheet of multiplication of decimals. Use reasonableness to determine where to place the decimal point in the products. Use base 10 blocks (as decimal values) to help see what is happening.
- Closing: Create rule together for multiplying by decimals. Accept answers that are reasonable, but students must apply the rule to 42 X 36 and 42 X 3.6 to see if rule is correct. (Estimation of multiplication of whole numbers and then place decimal point that corresponds with estimate, same number of decimal places in answer as in problem)

Third Professional Development Training in January

Slide 1

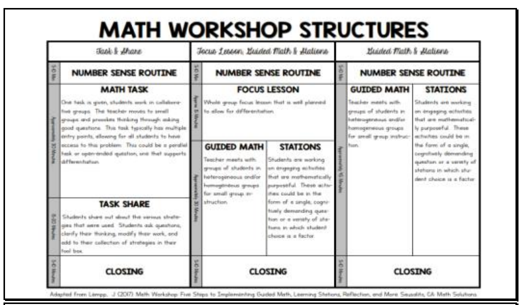


Slide 2



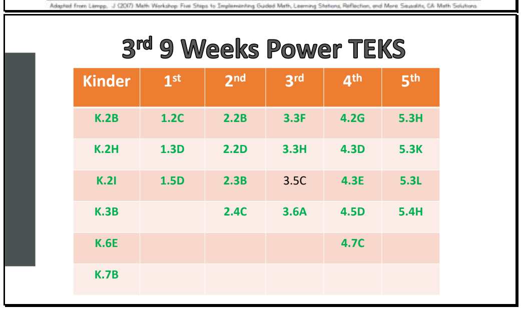
Review criteria of minilesson
Bring attention to time for mini-lesson and what teacher and students are doing during this time-document
Workstations-document- how to set up

Slide 3



Review different structures math workshop can use.

Slide 4

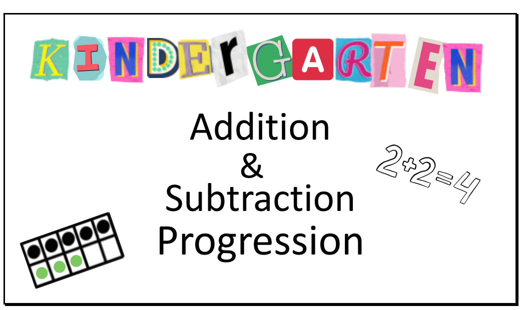


3rd 9 Weeks Power TEKS

Kinder	1st	2nd	3rd	4th	5th
K.2B	1.2C	2.2B	3.3F	4.2G	5.3H
K.2H	1.3D	2.2D	3.3H	4.3D	5.3K
K.2I	1.5D	2.3B	3.5C	4.3E	5.3L
K.3B		2.4C	3.6A	4.5D	5.4H
K.6E				4.7C	
K.7B					

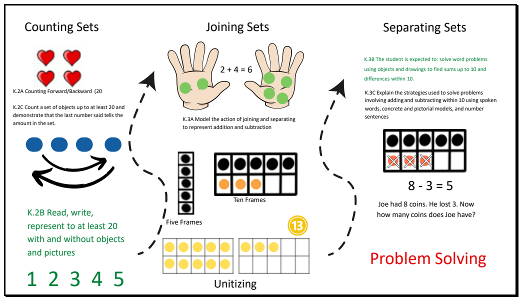
These are the upcoming power standards for the 3rd 9 weeks.

Slide 5



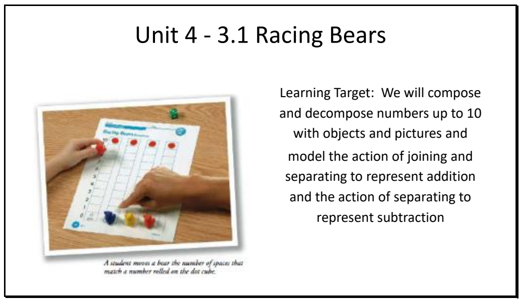
Kinder

Slide 6



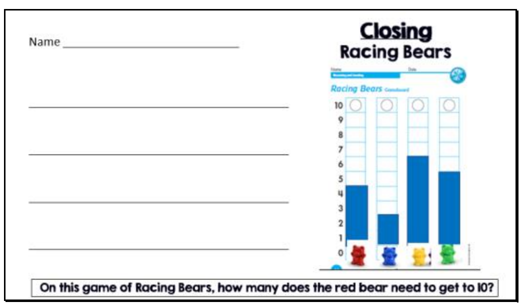
Kinder
Show the progression of addition and subtraction. Discuss how CRA fits into this progression.

Slide 7



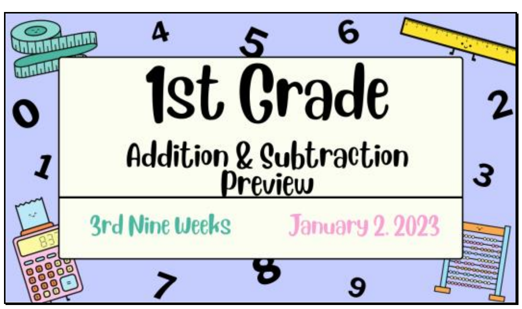
Minilesson: Teach students how to play Racing Bears. The goal is to compose the number 10 with addends by rolling die.
C- could use cubes to build the number on the dice
R- placing cubes on the path
A- write the number
Stop and look at row 2... Students answer the stem I have ______, I need _______ more to get to 10.

Slide 8

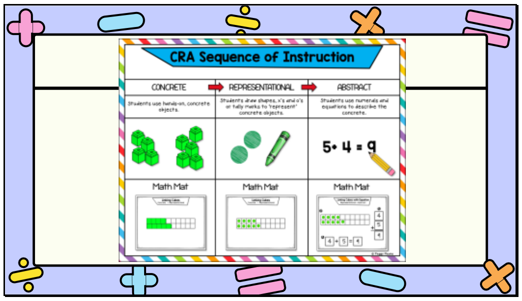


Explore: Students will pair up and play Racing Bears.
Closing: Exit Ticket shown on slide.
Have students complete and discuss in closing.

Slide 9

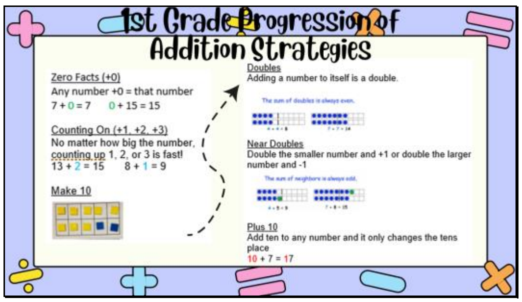


Slide 10



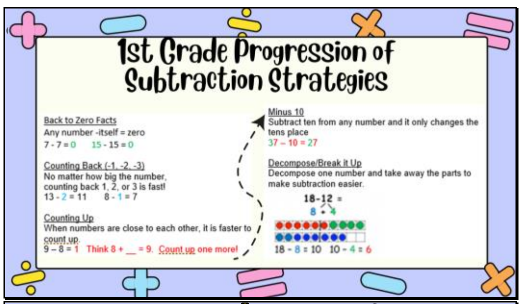
1st Grade

Slide 11



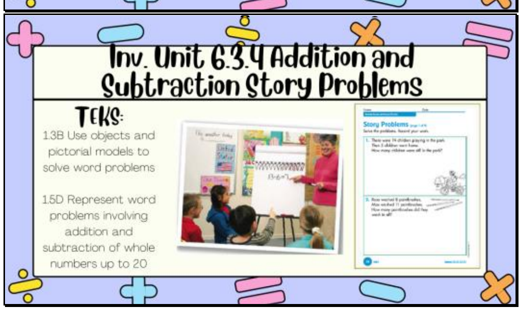
1st Grade- Mini Lesson: Review addition strategies and subtraction strategies (on next slide).

Slide 12



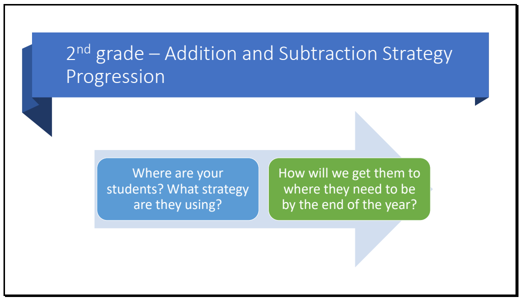
1st Grade

Slide 13

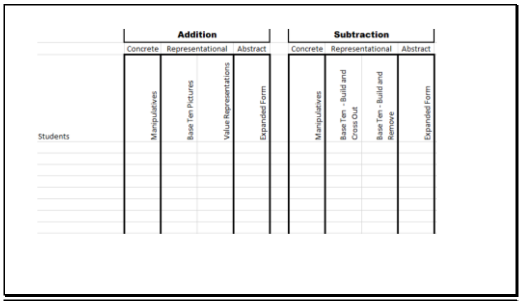


1st Grade
Explore: Solve word problems using an effective strategy using concrete objects, representations, and number sentences.
Closing: Choose 2-3 student solutions to compare strategies and make connections between them.

Slide 14

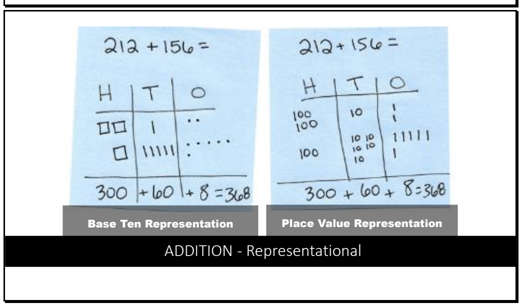


Slide 15



Checkoff sheet to gauge where your students are and place in partners/groups. This is available digitally for you to modify to meet your needs.

Slide 16



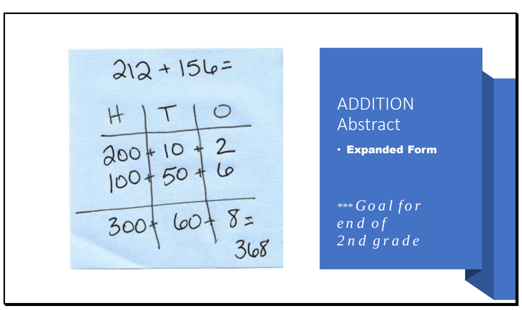
2nd Grade-Learning Target: We will add and subtract three-digit numbers using place value to decompose and solve.

Minilesson: Review how to decompose by place value as we did with two-digit numbers (with base 10 blocks, pictures, representing the value of each addend, and connecting the strategies.

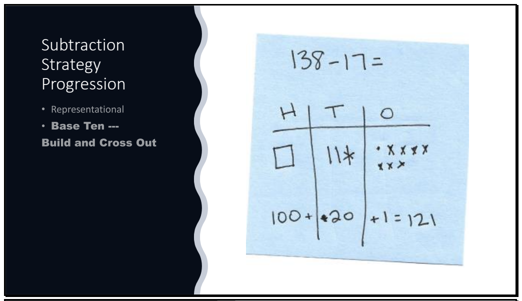
Explore: Students will solve several addition and subtraction problems with a partner by decomposing the numbers.

Closing: Partners will share with another pair of students one solution and justify their thinking. Share one or two pairs' work to whole group.

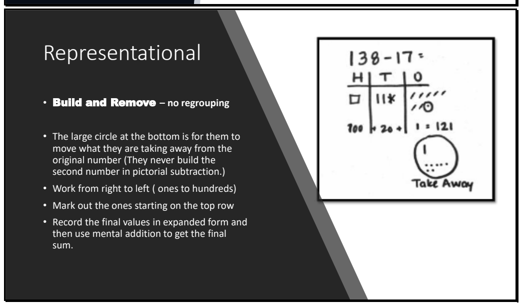
Slide 17



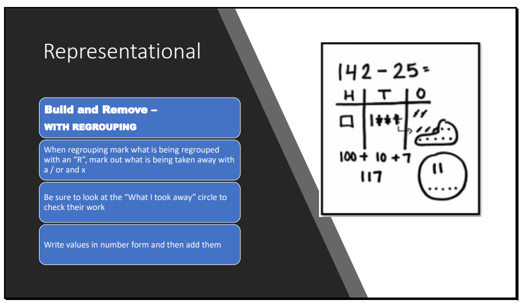
Slide 18



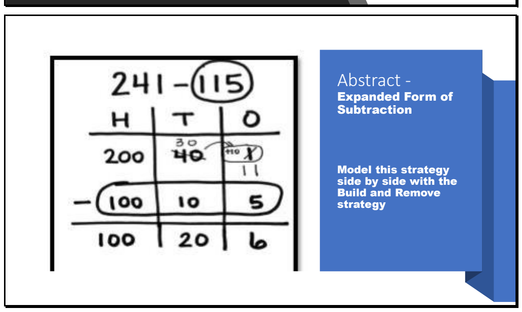
Slide 19



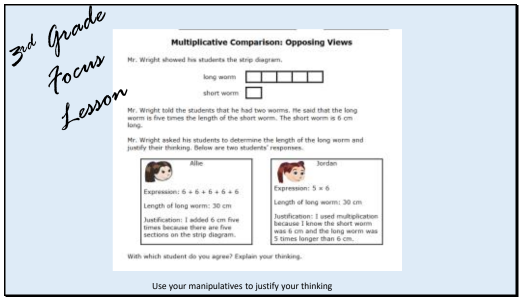
Slide 20



Slide 21

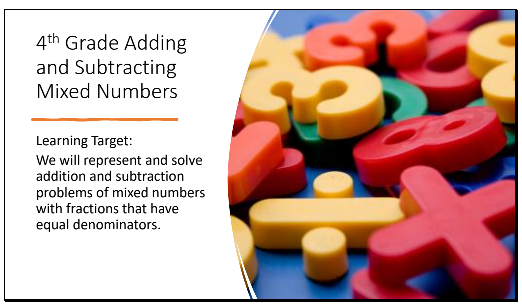


Slide 22



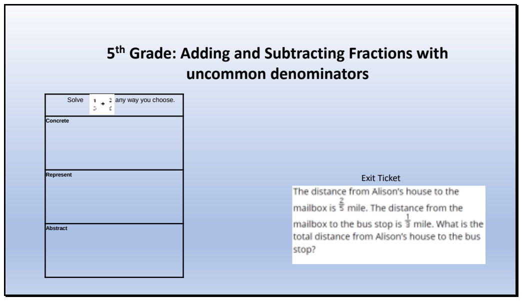
3rd Grade: Learning Target: We will describe a multiplication expression as a comparison such as 3 X 24 represents 3 times as much as 24.
Minilesson: Using snap cubes and strip diagrams, model multiplicative comparison stories together. Write equation by each model. Connect the concrete, representation, and abstract.
Explore: Solve problem show.
Students must justify their thinking by using manipulatives and pictorial representations.
Closing: Have students move to one side of the room or the other based on who they agreed with in the problem. Together come up with a justification and try to persuade the other group to join you based on your justification.

Slide 23



4th Grade: Mini-lesson-Activity 1 Data on a line Plot -Draw line plot (dot plot) on board and fill in.
Beginning of Activity 2: Butterfly Wingspan-Use fraction tiles, circles, cuisenaire rods, or bar models for concrete. Draw strip diagrams or circles for representation and write equation for abstract.
Explore Time: Students finish workbook p48 and 49 in partners or individually
Discuss learning for the day Activity 3 Review vocabulary.

Slide 24



5th Grade Learning Target: We will represent and solve addition and subtraction of fractions with unequal denominators.
Opening/Number Sense Routine-Sue wants ½ of a rectangular pan of cornbread. Dena wants 1/3 of the same pan of cornbread. How should you cut the cornbread so that each of the girls gets the size portion she wants? Solve this problem any way you choose.
Minilesson: Adding and Subtracting Fractions -Whole Group – Using Template, Model, represent, estimate, and solve an addition and subtraction of fractions problem. Let students choose Cuisenaire rods, bar models or fraction bars or strips to solve problems. Be sure to have students estimate before solving to make sure their answer is reasonable. Possible Extension: Have students write a word problem to make the equation.
Explore: Adding and Subtracting Fraction Practice- Represent, estimate, and solve the fraction addition and subtraction problems.
Closing/Reflection-Have students represent, estimate, and solve the EXIT TICKET. They can solve any way they choose.

Slide 25

Pass It On
Fold your paper into 4 sections.
Write your name in the upper left box.
Think of an important idea you have learned or that has really stuck with you from today.
Write it in the box with your name.
Pass the paper
Read what's already written
Write something different with your name in the next box (Can be the same thing you wrote on your page if it is different from what's already on your page.)
Repeat process until all boxes are filled or time is up.