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Professional Development Sessions For Conceptual Understanding Of Mathematics In The Primary Classroom To Promote A Positive Mindset And Problem-Solving Skills

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PROFESSIONAL DEVELOPMENT SESSIONS FOR CONCEPTUAL UNDERSTANDING OF MATHEMATICS IN THE PRIMARY CLASSROOM TO PROMOTE A POSITIVE MINDSET AND PROBLEM-SOLVING SKILLS

by

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CHAPTER ONE

Introduction

The enjoyment and mindset of mathematics differ from individual to individual. Some have or had a very positive experience and some a very negative one. Boaler (2009) stated that far too many students in the United States dislike mathematics and see it as a cause of anxiety and fear. She also states that interest and achievement in mathematics among children is low and that many adults do not enjoy the subject because of their past school experiences.

Boaler (2009) declared that many adults have passed through the school system learning through traditional or passive teaching practices, which is concerning in that many teachers stand at the front of the classroom and teach *at* students for 20 to 30 minutes while students take notes. The author stated that eventually students pick up on the fact that their way of thinking does not matter, and that they are required to watch the teacher and copy what they do. This way of learning seems to bring about the questions and thoughts of learners such as, "How can I memorize all these rules?" or "When am I ever going to use this?" Students who have been taught through a passive teaching approach often follow rules and memorization methods instead of learning to ask questions, be problem solvers, and learn through investigation (Boaler, 2009).

The purpose of this capstone is to provide educators with background knowledge as well as the best mathematical teaching practices that support conceptual knowledge, problem-solving skills, and a positive mathematical mindset for elementary school students. In this chapter, I explain the development of my research topic: *What are the best mathematical teaching practices for early elementary students to ensure* *they are prepared to transfer problem-solving skills to other areas of mathematics as well as other aspects of their lives?* and why it is so important to me. I also describe my personal mathematical experiences and how it impacts me now as an educator. I go on to inform about my teaching opportunities and why my research question is important for teachers, students and families in the community.

My Mathematical Experiences

My journey with mathematics was, unfortunately, on the negative side of the spectrum growing up. From elementary school to high school, I have always struggled with understanding the "why" questions and grasping the concepts to transfer mathematical skills in all aspects of my life. I saw math as a negative part of the day where my brain went elsewhere. We rarely ever used manipulatives or had "math talks" to better understand the concepts. Growing up, I struggled to memorize the rules and procedures; math was not enjoyable for me. Should math just be a short period of the day? Should it conclude when the one hour of instruction is over? These are some questions that have been stirring in my head, which led me to believe the learning of mathematical concepts and problem-solving skills should not just shut off after one hour of instruction. I believe these skills should be used throughout the day and in all aspects of people's lives.

Professional Experiences

After many years of learning the mathematical procedures, I found myself teaching first grade students in the same traditional way that I had been taught. My first year of teaching led me to a lot of reflection, especially in the area of mathematics. I realized this type of traditional teaching was not working for my first graders, and created frustration in all of us. They were not enjoying the learning, exploring different strategies, or transferring problem-solving skills in other areas throughout the day. With the understanding that "teaching to the test" was an inappropriate teaching method, I tried my best to find innovative ways to work around that, fostering more hands-on, problem-solving based learning. This was a small step in the right direction, but more guidance and research was needed in order for me to provide the best practices for my students, which guided me to my research question. This idea of having both conceptual and procedural knowledge in mathematical skills is something that I wish my previous instructors would have provided me in my early elementary years and beyond. I strive to find the best teaching practices to help develop life-long learning skills that can be transferred in all aspects of students' lives.

As a learner myself, I struggled with the understanding and reasoning of mathematics. Learning the mathematical rules and methods were never engaging for me, nor did the procedures ever link together. Research states that other individuals had similar experiences. For instance, Givvin, Stigler, and Thompson (2011) stated:

> No matter what kind of mathematical question we asked, students tended to respond with computational procedures, which they often applied inappropriately and incorrectly. Their knowledge of mathematical concepts appeared to be fragile and weakly connected to their knowledge of procedures. (p. 4)

People hold different beliefs about mathematics and have had different learning experiences. My negative experiences as a learner is partly what is driving me to provide better opportunities for those whom I have the chance to teach. I was never able to know how manipulatives could support my learning, or given the time to explain my answers or thinking, which led to my poor grasp on why these skills were purposeful in other aspects of my life. According to Boaler (2016), “Explaining your work is what, in mathematics, we call reasoning, and reasoning is central to the discipline of mathematics” (p. 28). I know that I had very little understanding and reasoning of basic skills that were needed to help grow my mathematics problem-solving skills beyond elementary school. Something was missing. My learning was in no way personalized or tailored to fit my personal needs. My individual observations are corroborated by others. Givvin et al. (2011) had many encounters with teachers who have narrow views of what it means to know and do mathematics. The authors noted that these teachers viewed mathematics as the application of rules versus the purpose to understand the underlying concepts.

Over the past three years of teaching, I have had opportunities to test out various teaching approaches with new students each year. I have invested much time in reflecting on what seems to work best for students to promote problem-solving skills and persistence, as well as what has not worked. I started noticing a need for more useful teaching practices that promote conceptual knowledge when many of my first grade students showed concrete understanding of single digit addition as they count with single counting cubes, but then struggle to understand what to do with the same two numbers in a simple story problem. This is a prime example of the lack of a deeper understanding of addition.

The school district I work in has had an optional mathematics curriculum called *Math Expressions* (Fuson, K. C., 2011), for educators to pull resources from, which has its positives and negatives. This curriculum is old and many teachers opted out of using it to create more of their own, personalized lessons for their students. We have essential learning outcomes (ELO's) that must align with the teaching we do each day. On the positive side, I have had free range to create my own innovative personalized lessons, execute them, and tweak the lesson afterwards for the next teaching opportunity. I am also able to take advantage of the teachable moments, meaning wherever the kids' questions go, that is where we go. There is no set date for curriculum units, which provides opportunity for us to go deeper and beyond a lesson, or move on when necessary. The negative effects of not teaching from a curriculum have been the teacher time spent personalizing these lessons, or the fact that an essential learning outcome might be missed or skipped based on personal teacher preferences. Along with those innovative, personalized lessons, come the overlooked, bland, and unengaging lessons as well.

Overall, in my opinion, teaching from a curriculum has its pros and cons. With that said, my school district is starting a new mathematics curriculum in the fall of 2018 called, *Bridges in Mathematics* (Deerwater, Fischer, Snider, & Smith 2007), that will be required for all teachers to follow and implement. The authors explain *Bridges in Mathematics* curriculum as a PK-5 curriculum that provides teachers with the tools to help develop deeper understanding in mathematical concepts and complex problem-solving skills. This switch from an optional curriculum to the required *Bridges in Mathematics* curriculum, which promotes conceptual understanding and problem-solving skills, has provoked my research interest. The significance of this research is to provide the best possible mathematical teaching strategies for the primary classroom teacher to implement while following the newly adopted curriculum. I will be creating a professional development for new teachers, veteran teachers, and parents to support this new learning. My students are my motivator in researching this topic. This project will provide me, as well as many of my colleagues, with the best teaching strategies to provide our students in their first few years of school.

The Significance

The best possible response a teacher can get from a child is, “Can we keep doing this?” or “I don’t want to stop!”. This is when I know I have provided the best possible engaging, innovative lesson that creates something the child can invest their time and energy on. According to Kuhn and Dempsey (2011), a child who is engaged in a task and thinks something is exciting and challenging, leads them to understand its relevancy and ignites their interest. The type of engaging lessons that feed a child’s learning hunger are the ones they care about, are interested in, and have a purpose. A student of mine once said to me, “Can we do this kind of stuff every day?!”, which led me to think, once more, that hands-on, problem-solving learning is what needs to happen every day. Families that I have connected with and who have reached out to me have mentioned many times how their mathematical upbringing looked so much different than their child’s. Families seem to have a piqued interested in some of the deeper, critical thinking lessons that I have tried out and shared with them as well. I hope to provide students with the best possible opportunities to go deeper in their understanding of mathematical concepts. As for teachers, I hope that my research helps them in supporting and understanding student learning as well as explain some pros and cons of the best teaching approaches so they are able to decide what works best for their students.

Summary

In all, I want to give my students an experience that promotes their personalized thinking skills. My upbringing in learning mathematics has impacted me and motivates me to provide better opportunities for other young students. As an educator, and passionate about student learning, I want all teachers to be provided background knowledge as well as the tools needed to teach their students with the best possible strategies available, which is the purpose of this capstone. This purpose leads me to my research question: *What are the best mathematical teaching practices for early elementary students to ensure they are prepared to transfer problem-solving skills to other areas of mathematics as well as other aspects of their lives?*

There has been an interest in this research topic over the years, so Chapter Two will provide more information on the data, studies, and conversations around the biggest themes in the teaching and learning of mathematics. Misconceptions and mathematical mindset will be discussed in Chapter Two along with the definition and comparison of conceptual and procedural knowledge in mathematics. The research summarized will also provide reasoning for the need of transferable problem-solving skills in students.

CHAPTER TWO

Literature Review

Overview

It seems as though mathematics in many primary classrooms is not living up to its full potential in creating engaging, effective environments that allow children to dig deeper into problem-solving and conceptual knowledge of skills. Research by American College Testing (2006), Ofsted (2008), and Toner (2011) suggested that, "Many students leave school unable to apply mathematics to real-world, work-based and advanced study contexts" (as cited in Jones, Swan, and Pollitt, 2015, p. 151). The authors explain that many students are not transferring their mathematical knowledge and skills later in life. They also mention that teaching mathematics has been solely on how to pass tests rather than developing a flexible understanding of conceptual knowledge.

This literature review explores research with a focus on this question*: What are the best mathematical teaching practices for early elementary students to ensure they are prepared to transfer problem-solving skills to other areas of mathematics as well as other aspects of their lives?*

This chapter outlines the biggest themes in the teaching and learning of mathematics, and describes how these themes relate to the goal of the project. Misconceptions about mathematics are first addressed. I then look into the mathematical mindset of learners to determine if this has any effect on their knowledge and confidence of skills, as well as motivational factors. Next, I explore different teaching practices as well as two different types of mathematical knowledge:

conceptual knowledge and procedural knowledge. These concepts are defined as well as being compared and contrasted. A summary of the research on problem-solving skills is then provided to further raise awareness of what might be the cause of mathematical difficulties in many students. To conclude the chapter, I look into the next steps for further research and explain my project plan that shares the development of what mathematics should look like, sound like, and feel like in the primary grade level classrooms.

Misconceptions

The subject of mathematics seems to draw a variety of misconceptions. It has been claimed by Boaler (2016) that:

> …the difference in mathematics is not because of the nature of the subject, as many people believe; rather, it is due to some serious and widespread misconceptions about the subject: that math is a subject of rules and procedures, that being good at math means being fast at math, that math is all about certainty and right and wrong answers, and that math is all about numbers. (p. 31)

Additionally, it is argued by Skemp (1997) that many students have misconceptions that are generally a result of not understanding the underlying mathematical concepts and misusing the rules and procedures (as cited in Holmes, 2012, p. 58). Interestingly, Henderson, Merritt, Berry, and Rimm-Kaufman (2018) identified a clear need for the use of representations and discourse in the classroom to help support student's misunderstanding. Representations such as visuals, pictures, or manipulatives can aid in clearing up some of those misconceptions led by students. Huinker and Bill (2017) found that, "representational competence in mathematics is students' ability to work successfully with and move flexibly among varied representations" (p. 103). In addition, it is noted by Henderson et al. (2018), that mathematical discourse plays an important role in the classroom. Discourse, in this context, is defined as discussions or other forms of work such as visual or written work about one's ideas and reasoning (Huinker and Bill, 2017). It is concluded that mathematical discourse can promote student thinking, and in turn, bring about those mathematical errors or misconceptions that can be addressed by the teacher (Henderson et al., 2018).

Henderson et al. (2018) explained that research on student misconceptions has recently focused on the need for students to become problem solvers and allow for more opportunities for them to learn the meaning behind the skills. The authors went on to say that effective teachers often understand that many students carry misconceptions, so they allow time within their plans to address those and have transparent conversations with their students. This research will help me in connecting the literature to my capstone project to ensure teachers are informed and understand how we can better assist our students in the area of mathematics.

Mathematical Mindset

This section will define mathematical mindset, describe two different types of mindsets, mention the importance of reflecting on your own mathematical opinions, and explain what happens when a learning mistake is made.

According to Van De Walle (2004), mathematical mindset refers to students' attitudes and beliefs about mathematics and their motivation and confidence for performing mathematical tasks (as cited in Westenskow, Moyer-Packenham, & Child, 2017, p. 2). It is observed that people work hard at things they are interested in and that are relatable to them, so considering what keeps your students motivated in the learning is a must, as well as remembering that all students are different and enjoy different things (Fink, 2013). Interestingly, Cotton (2004) said that research has suggested many students throughout the years of school make a dramatic shift in mathematical mindset from a positive attitude towards mathematics as they enter school to a negative attitude towards mathematics as they progress through grades (as cited in Westenskow et al., 2017, p. 2). Clayton, Burton, Wilson, & Neil (1998) stated that students with a negative outlook on math have much anxiety and doubt about their own abilities which may cause habits of avoidance and negative feelings to develop (as cited in Westenskow et al., 2017, p. 2). Van De Walle (2004) also believes that these feelings hinder mathematics development, and students become locked into the cycle of failure (as cited in Westenskow et al., 2017, p. 2). In contrast, there are also students who have a positive mindset about mathematics and see those skills as valuable and achievable. Those students have a motivational drive that keeps them engaged and enjoying their mathematical experiences. Dweck (2008) stated that these two mindsets are described as a fixed mindset and growth mindset. The author described a fixed mindset as a negative outlook, whereas a growth mindset is seen as a positive outlook. Studies have shown that a person's mindset can change from fixed to growth over time and when that happens, their outlook on learning becomes much more positive (Boaler, 2016). See Figure 1 for a depiction of the two types of mindsets.

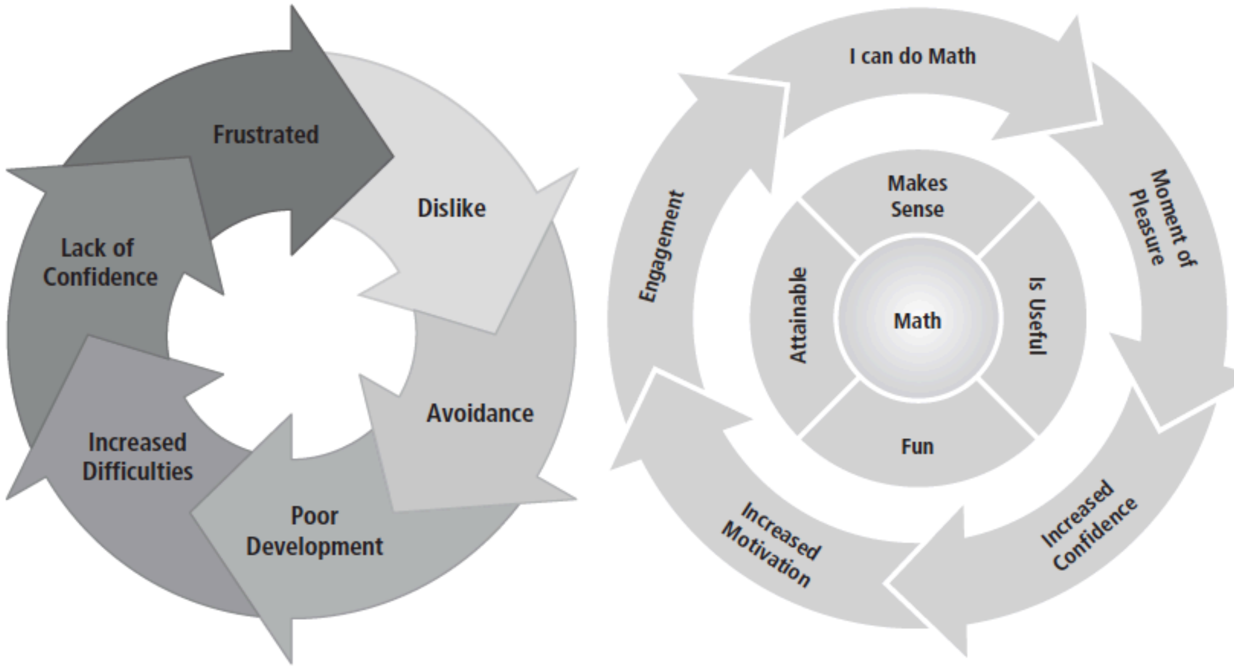

Figure 1. The Cycle of Failure and Cycle of Positive Mindset or Disposition. (Westenskow et al., 2017).

Fink (2013) described people who have a growth mindset as trusting in themselves that they have the knowledge and ability to work through difficult tasks, and that hard work will pay off. In contrast, according to Fink, the author notes that people with a fixed mindset often believe that ability and aptitude are fixed qualities.

Boaler (2016) stated that it is important for teachers to reflect on their own mathematical mindsets and experiences in order to change students' mindsets from a fixed state to a growth state. The author claimed that this is especially important for those who teach elementary students because some of those teachers may have been told they cannot do mathematics and eventually develop a lack of confidence about the subject, which may pour into their students' mindset. Boaler (2016) also stated that students often pick up on their teacher's fears, with more of a connection of girls with their female teachers. Interestingly, the author suggested that this is due to the girls' stronger connection with their female teacher and their quick ability to pick up on their female teacher's mathematical perspectives. In addition, Boaler (2009) concluded that while it is important that students work with high quality materials provided through a curriculum, the most important factor is the teacher. A good teacher can make the learning exciting and engaging. This research will be important to consider in the development of my capstone project.

A statement from Carol Dweck (n.d) reportedly shocked many teachers: "Every time a student makes a mistake in math, they grow a synapse" (as cited in Boaler, 2016, p. 11). This is a significant statement because it speaks to the value and meaning of making a mathematical mistake. Making mistakes over and over again and struggling does not mean you are not a "math person" or that you do not have the "math gift". Making a mathematical mistake is an opportunity for the learners to grow their brain, even if they have not realized a mistake was made. Boaler (2016) stated that mistakes in life are what separate the more successful people from the less successful people, as more successful people are willing to make more mistakes, and in fact do so. We gather from the evidence that the positivity of making a mistake in the young minds of students is imperative and speaks to how we, as teachers, should respond to mistakes.

Givvin et al. (2011) stated that some students who were once curious and tried to understand the deeper concepts of mathematics may get discouraged by their teachers later on. The teaching of mathematics in the primary grade levels mainly focuses on procedures with little connection to the concepts, which leads to the result of many students believing that mathematics means rules. The authors noted that, in turn, this leads to a disorganized application of rules with very little consistency when applying these procedures in real world situations.

Thus far, the literature review in this chapter leads us to believe that a student's mathematical mindset is directly related to their past mathematical experiences, their relationship with their teacher, their willingness to make a mistake, and their confidence to be competent in their mathematical skill sets. This information will help connect to the creation of the content in the professional development materials for this capstone project. It will help paint the picture for teachers on how important mathematical mindset is and the significant role they play in the mindset of their own students. This will lead into the next section which examines the different instruction that students experience and how it relates to their transfer of skills in other areas of mathematics.

Teaching Practices

This section of the literature review will differentiate between the different types of mathematical knowledge and teaching strategies that are defined in the learning of mathematics. Conceptual knowledge, procedural knowledge, and a comparison of the two will be defined and discussed. The main purpose of this review is to examine the pros and cons of each type of knowledge and determine if one should be taught before the other, or if they should be interwoven during instruction. Scholars have been clear on how students should learn and be taught mathematics, as well as what type of knowledge is most important when considering the two types; conceptual knowledge and procedural knowledge (Hiebert & Lefevre, 1986, p. 18). As stated by Hallett, Nunes, Bryant and Graesser (2010), some research suggests that children learn conceptual knowledge before procedural; some learn procedural knowledge before conceptual knowledge; and others learn them collectively and simultaneously.

Conceptual knowledge. Hiebert and Lefevre (1986) explained the difference between the two types of mathematical knowledge, i.e., conceptual knowledge and procedural knowledge. Conceptual knowledge is typically defined as:

> ... knowledge that is rich in relationships. It can be thought of as a connected web of knowledge, a network in which the linking relationships are as noticeable as the discrete pieces of information. Relationships pervade the individual facts and propositions so that all pieces of information are linked to some network. (Hiebert & Lefevre, 1986, p. 21)

Byrnes (1992) also agreed that conceptual knowledge is knowing that two or more represented entities are linked (as cited in Hallett et al., 2010, p. 236). According to the scholars, these descriptions of "rich in relationships" and "linked" suggest that conceptual knowledge is the interconnectedness of skills rather than routine and memorization. I believe it is the deeper knowledge that lies behind the individual skills. This is the information that will be important to share with other teachers as background knowledge.

Crooks and Alibali (2014) classified conceptual knowledge into six main parts and provide examples from other researchers. These six parts are as follows: connection knowledge, general principle knowledge, knowledge of principles underlying procedures, category knowledge, symbol knowledge, and domain structure knowledge. See Figure 2 for a description and example for each part.

Definition	Explanation	Example
Connection Knowledge	Relationships within a domain	"…knowledge that is rich in relationships. It can be thought of as a connected web of knowledge, a network in which the linking relationships are as prominent as the discrete pieces of information" (Hiebert & Lefevre, 1986, pp. 3-4)
General Principle Knowledge	General rules, facts, and definition	"…static knowledge about facts, concepts, and principles that apply within a certain domain." (De Jong & Ferguson-Hessler, 1996, p. 107)
Knowledge of • Principles Underlying • Procedures	The basis for procedures	"…conceptual underpinning of the subject specific procedures" (Pardhan &Mohammad, 2005, p. 7)
Category Knowledge	The categories that organize information	"Subtypes of concepts include taxonomic categories…" (Byrnes, 1992, p.236)
Symbol Knowledge	Symbol meanings	"…conceptual knowledge can be defined as the awareness of what mathematical symbols mean…" (Ploger &Hecht, 2009, p. 268)
Domain Structure Knowledge	The organization of mathematics	"…understanding of the underlying structures of mathematics" (Roberinson & Dube, 2009a. p.193)

Figure 2. Summary of conceptual knowledge and definition types. (Adapted from Crooks & Alibali, 2014, p. 348).

The authors noted that conceptual knowledge provide a great deal of benefits and explain that there are a number of ways where conceptual knowledge has been proven useful. For example, conceptual knowledge helps the student in understanding what procedure is appropriate to evaluate the skills. This is where procedural and conceptual knowledge are seen as linked. Crooks and Alibali (2014) believed that conceptual knowledge also enhances a student's problem-solving skills, are able to help in understanding how to work a problem, and to check back to see if it is reasonable. The National Governors Association Center for Best Practices and Council of Chief State School Officers (2010) noted that… "teaching conceptual knowledge in addition to procedures is a way to instill deeper and longer-lasting mathematical understanding" (as cited in Crooks and Alibali, 2014, p. 345). In other words, conceptual knowledge plays a considerable role in the teaching and learning of elementary school students. Likewise, Boaler (1998) argued that students who have the opportunity to learn in an open-ended, project-based way, develop a conceptual understanding of the skills which are needed to provide them with advantages in a variety of assessments and real-world situations.

As described by Hiebert and Lefevre (1986), the development of conceptual knowledge is reached by the knowledge of relationships between the mathematical pieces of information and skills. This linking process can be information already stored in your memory or newly learned material. The authors describe conceptual knowledge on two different levels; the primary level and the reflective level. An example given by Hiebert and Lefevre (1986) helped in explaining that the primary level would be understanding adding and subtracting decimal numbers to the relationship of adding tenths to tenths, hundredths to hundredths, and so on. If students are able to make that connection, they understand the primary relationship. The authors stated that the reflective level is often reached when a student is able to step back and reflect on the information being connected. In the previous example, the student might mentally recall that you line up numerals and look for common denominators, and ultimately end up adding same size pieces together. The connection between the position of the number and lining up the decimal points, to adding decimal numbers is recognizing that you are always adding things that are alike. This is a higher level of knowledge than the primary level because the student is able to step back and see the pathway in which all these concepts are linked together (Hiebert & Lefevre, 1986).

Procedural knowledge. Procedural knowledge is defined in terms of two parts according to Hiebert and Lefevre (1986), "One part of procedural knowledge is the formal language or symbol representation of mathematics. The second part of procedural knowledge consists of rules, procedures, and algorithms for unravelling mathematical problems" (p. 23). Byrnes (1992) defined procedural knowledge as the "knowing how" to do something such as memorization and knowing how to follow a sequence. These definitions of procedural knowledge being "rules" and "following a sequence" lead to the ability to get the right answer to a problem (as cited in Hallett et al., 2010, p. 396).

As noted, procedural knowledge is made up of two distinct parts according to Hiebert and Lefevre (1986). The first part relates to the awareness of the features or written symbols used to represent mathematical ideas, but does not include knowledge of meaning. For example, a student might understand that 7 + _ = 10 is written in an acceptable manner and that 7 + =_ 5 is not written in an acceptable manner. A learner with this type of procedural knowledge recognizes these syntactic expressions but may not grasp the logic behind it. The second part that Hiebert and Lefevre (1986) explained, consists of the rules or algorithms to solve a mathematical task. These are step-by-step teachings that are carried out in a linear sequence. An example of this given by the authors is simply applying the rules to multiply two decimal numbers such as 3.82 x 0.43. In this case, you need to remember the sequence of first, writing the problem appropriately, then calculating the numerical part of the answer, and finally placing the decimal point in the answer correctly. This example follows a set of rules that are carried out in order.

Research has shown that in many cases children apply procedures correctly before they have an understanding of the "why" or conceptual understanding of the skill (Hallett et al., 2010). For example, Peck and Jencks (1981) interviewed hundreds of sixth graders about how well they understood fractions. Less than 10% of these students demonstrated a solid conceptual knowledge of fractions and about 35% understood the procedure for the problem but lacked the deeper understanding (as cited in Hallett et al., 2010). In addition, Kerslake (1986) found that many children were unable to explain why their procedure worked when using strategies for adding fractions (as cited in Hallett et al., 2010). They went on to quote one of the children stating, "You're taught something, you're never taught why" (as cited in Hallett, et al., 2010, p. 397). A study by Boaler (1998), looked at students who attended a school where dedicated teachers effectively followed and taught by the traditional textbook approach. The results showed students developing an unmotivated knowledge of procedures that were useful only in those isolated textbook situations. It will be imperative to note the importance of relating real world mathematical situations throughout the creation of my capstone project.

In contrast to previous research, an analysis done by Bodovski and Farkas (2007) with a Kindergarten cohort, revealed greater time in procedural instruction led to a higher mathematics performance (as cited in Bachman, Votruba-Drzal, Nokali & Heatly, 2015). Procedural mathematics instruction was linked to growth in math skills during the initial years of elementary school, but slowly decreases as children progress in grade level. Procedures translate conceptual knowledge into something observable and without the known procedures and our ability to use that knowledge, we would not know it was there (Hiebert & Lefevre 1986).

Comparison of conceptual and procedural knowledge. There is a difference in understanding the two types of knowledge and many researchers are now suggesting that both procedural and conceptual knowledge are important, and should be aimed at in instruction. Seethaler and Fuchs (2010) stated that procedural skills are the skills developed around computational fluency or memorizing facts, whereas conceptual knowledge is having a solid understanding of number sense or problem-solving skills (as cited in Morin, Watson, Hester & Raver, 2017). Additionally, Hiebert and Lefevre (1986) stated that the most widely recognized distinction between the two is skill and understanding. The authors stated that the connection between conceptual knowledge and procedural knowledge is effective when teaching and learning mathematical skills. It has been widely observed that researchers suggest that possessing conceptual and procedural knowledge as independent systems is almost unheard of, and that both knowledges are essential components to mathematical competence (Hiebert & Lefevre 1986). Conceptual understanding and procedural fluency should both be considered as key components of a student's mathematical competency according to Huinker and Bill (2017). Interestingly, Rittle-Johnson and Alibali (1999) found, "the two types of knowledge lie on a continuum and cannot always be separated; however, the two ends of the continuum represent two different types of knowledge" (p. 175). Huinker and Bill (2017) also proposed that students with a growth mindset about mathematics have the motivation to engage in deep conceptual understanding of these skills and students who have that strong understanding are able to use procedures effectively because they understand how and why they work. The authors suggested both types of knowledge should be taught together and state that deep conceptual understanding of mathematical ideas should be the base. Once that is established, students can eventually move into the learning of basic number sense, formulas, and procedures. Rushing students into learning procedures prematurely can possibly affect students' mathematical mindset and reasoning skills. This can also cause students to think of mathematics as unconnected knowledge (Huinker & Bill, 2017).

An example by Ngu and Phan (2016) gave the equation $x + 2 = 5$, and in order to balance this equation the learner must understand the operation or procedure (procedural knowledge). The learner must also understand that $x + 2 = 5$ is the same as $x + 2 - 2 = 5 - 2$, implying that the learner has a solid understanding of the relationship between the parts on both sides (conceptual knowledge). Success in solving an equation is deeply rooted in how well a learner has grasped both the conceptual and procedural knowledge related to the skill. The authors note that these two types of knowledges may not be totally separated from each other or be taught in isolation from each other. Students who possess both have a clearer understanding and are more competent in mathematics. Vazquez (2008) emphasized that in order to effectively teach mathematics, teachers must understand that correct answers, procedural fluency, and conceptual knowledge are all important to knowing the what, how, and why of any problem.

This information informs my capstone project of implementing professional development sessions to better inform teachers about the two types of mathematical knowledge's and how they co-exist and should both be important during instruction.

Problem-Solving Skills

A growing concern in teaching mathematics is that many students are able to learn and grow in the area of mathematics for up to eleven years or more, but then are unable to convert those skills outside of the classroom and use them in context later in life (Boaler, 1998). Along with Boaler, Jones, Swan, and Pollitt (2015) acknowledged that children spend many years in the classroom studying mathematics, but do not transfer those skills in the workplace, even those who are among the most successful and perform strongly on their school assessments. Similarly, other researchers, including Lave, Murtaugh, and de la Rocha, (1984); Masingila, (1993); Nunes, Schliemann, and Carraher, (1993), supported the fact that in many real-world mathematical situations, people do not use the rules and procedures that were taught and drilled in school (as cited in Boaler, 1998). The authors have said that students are unable to translate these problem-solving skills and mathematical procedures because they lack a true deep understanding of them. Supporters of this view have argued that if students are given open-ended, practical, and investigative work that require them to make their own decisions, pave their own mathematical pathway, find their own method, and apply what they already know, will ultimately benefit (Boaler, 1998). Boaler (2009) also stated that employers seek out people who actually solve problems and that strive for flexibility, continuous learning, and teamwork.

Huinker and Bill (2017) argued that implementing tasks that promote reasoning and problem-solving gives opportunity for students to engage in high-level tasks. These authors concluded that a high-level task is a task that promotes mathematical reasoning and allows multiple entry points and a variety of strategies to solve problems. See Figure 3 for an example of a high-level task given to third-grade students.

<table>
<tr><td colspan="2">Solve the Multiples of Ten task and the Band Concert task (shown below). Make note of the mathematical knowledge you drew upon and the strategies you used to solve each task.
1. What features of each task lead you to use particular strategies to solve it?
2. In what ways are the two tasks similar and different in regard to the targeted mathematical ideas?
3. Which task is more likely to promote reasoning and problem solving among students? Why?</td></tr>
<tr><td>Multiples of Ten Task</td><td>The Band Concert Task</td></tr>
<tr><td>Solve the following multiplication problems:

7x10= _____
7x20= _____
5x50= _____
40x7= _____
10x9= _____
5x20= _____
3x20= _____
30x4= _____</td><td>The third-grade class is responsible for setting up the chairs for the spring band concert. In preparation, the class needs to determine the total number of chairs that will be needed and ask the school’s engineer to retrieve that many chairs from the central storage area. The class needs to set up 7 rows of chairs with 20 chairs per row, leaving space for a center aisle. How many chairs does the school’s engineer need to retrieve from the central storage area?</td></tr>
</table>

Figure 3. High-Level Task. This figure gives a comparison of two multiplication tasks. (Adapted from Huinker & Bill, 2017, p. 39)

Figure 3 compares a “Multiples of Ten Task”, which asks the students to simply follow a procedure to solve the problems and “The Band Concert Task”, which provides students an opportunity to use their choice of strategy for solving the task. In the band concert task, no solution strategy is stated, so the authors suggest that the students must put in the effort to find a strategy for solving the task and justify why their approach works, as well as why it makes sense to them. This is seen as a high-level task. This example from Huinker and Bill (2017) gives a clear suggestion of how mathematics instruction can be altered to promote problem-solving skills in mathematics and in all aspects of a student's life, as well as a deep conceptual understanding of multiplication. Stein and Smith (1998) observed:

> Tasks that ask students to perform a memorized procedure in a routine manner lead to one type of opportunity for student thinking; tasks that require students to think conceptually and that stimulate students to make connections lead to a different set of opportunities for students thinking. (as cited in Huinker and Bill, 2017, p. 43)

The authors suggested that educators should create a classroom culture where students are able to develop reasoning and problem-solving skills through high-level tasks that allow many pathways and solution strategies for student thinking. Intriguingly, Jones et al. (2015) proclaimed the challenge of promoting problem-solving skills is much more difficult to define and assess for teachers in comparison to assessing rote memorization of facts and procedures.

It is claimed by Fyfe, Decaro, and Rittle-Johnson (2014) that delaying instruction can also be beneficial for students in understanding a deeper meaning of concepts in mathematics. These scholars say an exploration period should be given in order for students to be able to have some time with the problems as well as struggle with them. A research study by Fyfe et al. (2014) found that providing conceptual instruction first resulted in better procedural knowledge and conceptual knowledge of structure than actually delaying instruction. The authors stated that struggling first can help students have a deeper understanding later. Fink (2013) suggested that:

> Real growth happens when people work at the edge of their competence. Students who are not challenged lose out on the sense of confidence that comes from mastering a challenge, and they may come to believe that accomplishment should be effortless. (p. 28)

Many students think struggling means that they are unintelligent and are being judged for their lack of knowledge; they often show signs of being overwhelmed or confused, but that is what is necessary as part of the learning process (Fink, 2013). This research helps inform the professional development sessions that are created in this capstone project by providing a rationale for why problem solving skills are important to consider when teaching early elementary students.

Conclusions

The literature review presented above encourages me to further pursue my research question: *What are the best mathematical teaching practices for early elementary students to ensure they are prepared to transfer problem-solving skills to other areas of mathematics as well as other aspects of their lives?* According to the research summarized above, there are many factors to consider when providing a student with a meaningful mathematical learning experience. First, after reviewing the research, I believe making sure students possess a growth mindset will help with their mathematical endeavors and aid in their effort, persistence, and focus. Second, researchers such as

Hiebert and Lefevre (1986), Huinker and Bill (2017), and Rittle-Johnson and Alibali (1999) believe that having a strong connection between both procedural knowledge and conceptual knowledge will lead into a positive understanding of the underlying concepts and mathematical skills. It is seen throughout this research and explained by many researchers that people do not possess one type of knowledge over the other; usually a child and/or person displays characteristics from both (Hiebert & Lefevre, 1986). Finally, researchers such as Fyfe et al. (2014) and Fink (2013), believe developing strong problem-solving skills that are challenging and allow our students to struggle a bit would be desirable given that such struggles may mirror and support real-world issues and other mathematical situations.

There seems to be a strong need for teachers to be informed about the most current research and studies of the discussions on procedural and conceptual knowledge, which instruction should come first for students in the initial years of schooling, and how these two types of knowledges should be taught. Richland, Stigler, and Holyoak (2012), among others, have said that many teachers are failing to teach their students the deeper conceptual understanding in mathematics. Students in America seem to be lacking the conceptual base for mathematical knowledge more than ever. According to Richland et al. (2012), the number of community college students in the United States who cannot perform adequately on the assessments give insight to the lack of effectiveness of our school system. In an interview with thirty students (fifteen females, fifteen males) who attend community college, Givvin et al. (2011, p. 7) reported that when asked, “What does it mean to be good at mathematics?”, 77% of college students said things such as:

- “Math is just all these steps.”

- “In math, sometimes you have to just accept that that’s the way it is and there no reason behind it.”
- “I don’t think being good at math has anything to do with reasoning. It’s all memorization.”

Research tells us that children begin to develop the basic concepts and procedures in tandem, but once students enter school, the link between the deeper understanding of concepts diminishes and their views are narrowed between how to do mathematics and knowing why they are doing mathematics. Very little emphasis is put on the connections and conceptual understanding as some student’s progress through grade levels, and eventually those students give up on the idea that mathematics is all interconnected and supposed to make sense (Givvin et al., 2011).

Need for Further Study

After reviewing the research, it is critical to have a solid grasp on how to implement the best teaching strategies for elementary school students that can help benefit their mindset, growth in conceptual understanding, their problem-solving skills, and provide them with the knowledge to transfer those skills.

Teachers at my school would benefit from the new learning I have come across during the development of this capstone project; in particular, how to implement best practices that are aligned with the latest research results. The school in which this project audience is aimed at is starting a new curriculum, as explained in Chapter One. To implement the new curriculum effectively, there is a period of new learning and adjustment for experienced teachers, and a clear need for training new teachers each year. One thing I have noticed through conversations in our school is that there are a lot of questions on the implementation of the curriculum. As part of the leadership team, I have also received inquiries as to how to instill a growth mindset, conceptual knowledge, and transferable problem-solving skills in our students, while following our newly adopted mathematics curriculum. There seems to be a need for more learning to take place in our school, with emphasis on new teachers entering our school system each year. There is a particular need for background knowledge as to why we should be teaching conceptual math and how it is transferable to other areas, as well as how to implement those strategies in our daily instruction using the curriculum.

Taking all these needs into consideration and what I have covered in the literature review above, my capstone project will supply teachers with background knowledge, the best possible teaching strategies to integrate into the new curriculum, and support the teaching of conceptual and procedural knowledge of mathematics in the primary grades. This project will provide a list of strategies and examples that promote positive mathematical mindset, conceptual understanding, and problem-solving skills, which will be proposed to teachers in training based on the information researched in this chapter.

Summary

This chapter reviewed the major themes in the teaching and learning of mathematics: mathematical mindset, teaching strategies that support procedural and conceptual understanding, as well as reasoning and problem-solving skills. Mathematical mindset plays a role in the motivational drive that keeps students engaged and enjoying their mathematical experiences. A learner's mindset can be changed from a fixed mindset to a growth mindset, which can lead to a more positive mathematical outlook for that student. Conceptual and procedural knowledge often go hand in hand, but the absence of conceptual knowledge of mathematical skills is causing students to lack understanding in the "why" questions throughout their learning process. Conceptual knowledge enhances a student's problem-solving skills, helps students in understanding how to work a problem, explain it, and check back to see if it is reasonable. This is in contrast to procedural knowledge which is seen as the "rules" or steps to be followed in order to get a mathematical answer. As seen from the research, being a successful learner of mathematics and problem-solving skills is rooted in the the ability to develop both conceptual and procedural knowledge. Problem-solving skills can be fostered by promoting high-level mathematical tasks that allow for multiple entry points and solutions.

Chapter Three will highlight the professional development presentation plan that I will be presenting to other teachers. It will also describe the desired outcomes of the presentation, as well as detailed components that will make up the professional development. The theoretical framework for both the content and the format will be explained. Given the new mathematics curriculum, Chapter Three also justifies the new learning and provides examples as to what will come. The audience, a timeline for the completion of the project, and the setting for the project will all be clarified.

CHAPTER THREE

Project Overview and Description

Introduction

As an elementary school teacher, I believe it is important to implement the best practices and strategies when teaching mathematics to my students. In support of the newly adopted curriculum by our school, I am going to create professional development sessions to best support our teaching practices. The mission is to provide three main outcomes to support the following research question: *What are the best mathematical teaching practices for early elementary students to ensure they are prepared to transfer problem-solving skills to other areas of mathematics as well as other aspects of their lives?*

Chapter Three describes the professional development plan that will be shared with other teachers in the primary grade level. In this chapter, I will describe the desired outcomes of the presentation, restate my research question, and outline the components of the project. A brief recap of research from chapter two will also be included where appropriate.

The theoretical framework for both the content and the format will also be reviewed in this chapter. The content for the professional development includes teaching strategies that stem from *Taking Action: Implementing Effective Mathematics Teaching Practices in Kindergarten-Grade Five* (Huinker & Bill, 2017). These strategies will be integrated into our new curriculum and supported by examples throughout the project.

The audience for the professional development is two-fold: new teachers entering the district and experienced teachers who have worked in the district. The setting of the professional development will be named, as well as an outlined timeframe for the completion of the project. The effectiveness of the material proposed to teachers and a summary of the project will be discussed to conclude this chapter.

Outcomes

The first desired outcome of the professional development session is for teachers to gain background knowledge of the themes in the teaching and learning of mathematics based on the literature review from chapter two. The second desired outcome is for new teachers and experienced teachers to understand the effective strategies that can be implemented in making a positive change in the way mathematics is taught. The third desired outcome for this professional development is for teachers to then implement the effective strategies within the new curriculum to ensure students gain transferable conceptual math knowledge, problem-solving skills, and a growth mathematical mindset.

Project Description

Professional development supports new learning throughout a teachers' career stages. This is necessary due to this rapidly changing world which significantly impacts the learning and teaching we do each day. This will ensure teachers have the knowledge, skills, and competencies to provide up to date best teaching strategies to their students (Rakwichitkul, 2017). The materials created for this capstone project will be presented through two professional development sessions. The components of this presentation will first instill background knowledge of the research and explain why this is important to understand in our work we do each day. Reflection on our learning and sharing in small groups will follow. As the first session closes, teachers will be asked to commit to a goal they wish for themselves and their students. The second session will then go into detail of the eight mathematical teaching strategies that support student learning. A one-page handout with each important teaching strategy will be provided in supporting teachers to implement with their students in mathematics as they work through the new curriculum. The purpose of the visual aid handout is for teachers to keep it in their classrooms as a clear reminder of these meaningful practices. Video representation of teachers and students in the classroom following the learning will also be shown to explain how these effective teaching strategies can be utilized within the new curriculum. Following the learning of the second session, teachers will be asked to put themselves in the learner's perspective and show a variety of different ways to show their thinking in a real life example that would be given to our students. Next, teachers will be given time in small groups of four or five to reflect on the information received and come up with any questions they may have moving forward. To ensure accountability, teachers will be asked to come up with an action step that they will take in their own classroom based on the new learning from this presentation. This action step will be a way for me, as the speaker, to determine the effectiveness of the learning.

The professional development will include eight highly-effective teaching practices for teachers to use that will balance both procedural and conceptual knowledge, as well as promote problem-solving skills and a positive mathematical mindset in their students. These strategies intend to support the learning of teachers to help meet the complexities of teaching a set of skills that promote lifelong learners and competent mathematicians in their classroom.

As mentioned in Chapter Two, many researchers such Hiebert and Lefevre (1986), Vazquez (2008), and Huinker and Bill (2017), all stated that procedural and conceptual knowledge are important for young learners, and should be woven together during instruction. Many students graduate from K–12 mathematics programs without flexible, conceptual mathematics knowledge, which impacts their ability to transfer knowledge into the real world (Richland et al., 2012). Teachers often use their professional knowledge and past experiences when making decisions about the best practices for their students. It is clear that there is a real need for professional development to assist teachers, especially those new to the district, in providing targeted instructional strategies which will result in transferable conceptual math knowledge in our students.

Theoretical framework

The skills taught in this professional development stem from the eight effective teaching practices for mathematics discussed by Huinker and Bill (2017). These eight teaching practices represent “a core set of high-leverage practices and essential teaching skills necessary to promote deep learning of mathematics” (NCTM 2014, p. 9). See Figure 4 for specifications of each strategy:

Establish mathematics goals to focus learning. Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and use the goals to guide instructional decisions.
Implement tasks that promote reasoning and problem solving. Effective teaching of mathematics engages students in solving and discussing task that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.
Use and connect mathematical representations. Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.
Facilitate meaningful mathematical discourse. Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.
Pose Purposeful questions. Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships.
Build procedural fluency from conceptual understanding. Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve conceptual and mathematical problems.
Support productive struggle in learning mathematics. Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas of relationships.
Elicit and use evidence of student thinking. Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.

Figure 4. Eight effective teaching practices for mathematics. (Adapted from Huinker & Bill 2017, p. 5)

Using the new curriculum, we can implement these eight principles, which have deemed to be effective. For example, in a story problem, teachers can allow multiple entry points, ask the students to make a picture or diagram, write an equation, suggest that students ask a question about the story problem, pose a new story problem, or share their thoughts with a neighbor. Sentence stems can also be helpful in creating mathematical discourse among the class. As another real-life example, Huinker and Bill (2017) pose question stems for engaging students in mathematical discourse such as, “That seems really important, who can say that again?” or “Do you agree or disagree with ___? Why?” (p.105). In the new curriculum, these sentence stems can be utilized in almost any lesson to pose purposeful questions.

The strategies that will be shared in the professional development are based on research presented in Chapter Two and are modeled after those provided by Huinker and Bill (2017). These strategies are meant to provide teachers with the opportunity to engage their students in valuable learning. I am using a well-established set of principles proposed by Huinker and Bill (2017). In addition, to ensure accuracy and validity, the strategies and examples to be included in the professional development rely on information covered in the literature reviewed in Chapter Two, which includes both quantitative and qualitative studies. I have adopted an approach based on triangulation, in that, the information comes from more than one type of data source, which adds to validity (Creswell & Creswell, 2018).

I am also using a well-known set of adult learning principles based off of Knowles (1992) professional development framework. Knowles’ (1992) principle of adult learning aids in making a presentation that will provide opportunities for adult learners to be active participants and build on their own personal experiences to better help their students. The author provides a special theory foundation that allows quality interaction among adults in a large meeting. There are three areas that Knowles (1992) lists in which collaboration can be influenced: the platform, the audience, and the relationship between the platform and audience. The first area is the platform. Setting the stage for a productive meeting can be increased by using some sort of visual aid. The second area is the audience. Making sure the audience is actively involved can be promoted by asking small groups or teams to meet together. This will allow small groups to expand their thinking with others, gather more ideas, and talk about how they will apply their learning to benefit their students. Knowles (1992) suggested to gather teachers in groups of four or five to converse ideas. This can be followed by allowing one member of the group an opportunity to provide a summary of their group discussion to the whole group. Groups should also be given the chance to then go back to their small groups to discuss how they plan to implement one or more of these strategies learned.

In this presentation, small groups will be sharing their reflections and questions with one another, then come up with a commitment and share it via Flipgrid, individually. Flipgrid will provide teachers a chance to circle back to the variety of commitments and ideas of others, with the possibility of gaining more ideas from colleagues.

Audience

There is a two-fold audience aim for this training; the first being the new teachers entering our district each year and the second is the experienced teachers within the school district. The first audience this training will focus on will be the new teachers entering the district. This training will be important to consider each year, due to new teachers entering the system. This training will source teachers with background knowledge, the best possible strategies to integrate into the new curriculum, and support the teaching of conceptual and procedural knowledge of mathematics in their classroom. It is important to underscore this point because we need to ensure new teachers are on the same page as the rest of the school.

The second audience will be the experienced teachers who teach kindergarten through fourth grade. In the past, many of these teachers have been teaching math through the curriculum, *Math Expressions* (Fuson, K. C., 2011) and/or have taught mathematics to their students through strategies and activities they have developed from their own toolbox. As of fall 2018, these teachers are now expected to teach through a new curriculum called *Bridges in Mathematics* (Deerwater et al., 2007). Conversations with my colleagues have led to many questions regarding the implementation of the new curriculum while providing conceptual and procedural based knowledge.

Setting

The learning that takes place during these professional development sessions will directly affect students with whom the teachers will be interacting with. These students range from kindergarten to fourth grade. According to the Minnesota Department of Education's 2017 report, 55% of these students are eligible for free or reduced lunch. The school's diversity score of 68% is more than the state average of 33%.

The school setting is located in a low-income community with approximately 730 students. The school has been recently expanded to service preschool through fourth grade students. Each classroom has a single teacher for mathematics and two academic specialists that support students in various ways in mathematics instruction.

Timeline

In order for the project to be readily available for new teachers, the project content will be worked on throughout the fall of 2018 and completed by the end of December 2018. New teachers entering the system, as well as experienced teachers will then be able to attend the professional development to gain more knowledge, ideas, strategies, and examples that provide the most current and successful mathematical teaching practices that coincide with our new curriculum. The learning time for the adult learners will be broken into two sessions, the first session lasting about an hour, and the second session lasting about an hour and a half. Likely, a follow up session will proceed thereafter once it is known what else is needed in order for the teachers to move forward with success.

Assessing Effectiveness

The effectiveness of the material proposed to teachers will be assessed through the impact it makes on students' thinking, problem-solving skills, and conceptual knowledge of mathematical skills. Teachers will be expected to examine students' thinking and responses through tasks, observe the details in student work, build on students' mathematical ideas, as well as elicit student thinking through writing. Huinker and Bill (2017) categorized assessment as not only a summative test, but a way to assess a student's progress through their thinking process while instruction is being given. This way of assessing also aligns with our new curriculum. The authors stated that the effectiveness of these teaching practices is measured by perceived changes/improvements in student thinking, reasoning, and understanding (or misunderstanding). This evidence will inform the teachers' actions during instruction. A visual aid as real life examples will be given to teachers to help in understanding how to utilize this learning in their own classrooms.

Two to four months after the professional development presentation, data of the effectiveness of this learning will be collected upon my classroom observations, student surveys, and staff surveys. Collecting this data will determine how and if teachers are using the strategies learned. Staff surveys will give teachers the opportunity to speak about their experiences using these mathematical strategies and provide a chance for them to give feedback on what they need, as well as ask any lingering questions. Often times, it is hard to know what you need when you haven't implemented the strategies, so allowing a few months to become comfortable with using these strategies will allow an adequate amount of implementation and reflection time. Student surveys will give insight on how well students are adapting to this new way of learning, as well as their overall mindset in the area of mathematics.

Summary

This chapter described the professional development plan that I will be presenting to other teachers in the primary grade levels based on my research question: *What are the best mathematical teaching practices for early elementary students to ensure they are prepared to transfer problem-solving skills to other areas of mathematics as well as other aspects of their lives?* In this chapter, I have described the desired outcomes of the presentation, as well as detailed components that will make up the professional development for teachers. The theoretical framework for both the content and the format have also been explained. Additionally, given the new mathematics curriculum, this chapter also highlights the justification for new learning and provides examples as for what will be included in the professional development.

The intended audience for this professional development includes two groups: new teachers entering the district and experienced teachers. A timeline of completion for the project, the setting of the professional development, and the effectiveness of the material proposed to teachers have been discussed in this chapter as well.

Chapter Four will provide a reflection of the project and highlight what was learned through the process. The literature review will be revisited along with a list of implications and limitations of the project. I will reflect on the growth moving forward though this capstone process and provide a conclusion to my project.

CHAPTER FOUR

Conclusions

Introduction

As an educator, and passionate about student learning, I want all teachers to be provided background knowledge as well as the tools needed to teach their students with the best possible strategies available, specifically an emphasis in the area of mathematics, which is the purpose of this capstone. This purpose led me to my research question: *What are the best mathematical teaching practices for early elementary students to ensure they are prepared to transfer problem-solving skills to other areas of mathematics as well as other aspects of their lives?*

In this chapter, I reflect on the development of this capstone project, as well as what I have learned as a researcher, writer, and learner. I will make connections to Chapter Two's literature review and my project outcomes. I address the implications as well as limitations I encountered while creating this capstone project. I also speak to the plans for furthering knowledge on how to carry out these strategies in a classroom. As I conclude, I share my recommendations for next steps of professional development growth.

Insights

Through the exploration of this capstone project, I learned many different things, but two major points become apparent. First, I reflected a lot about myself as a learner. I often put myself in the shoes of the student as I was reading about what the research said and how to implement the best teaching practices in the area of mathematics for young children. It was an eye-opening learning experience for me as I realized how much deep conceptual understanding I missed out on in my own educational experience. I found hope in the way students can learn and comprehend the interconnectedness of skills in mathematics. My mindset has shifted from a fixed mindset to a growth mindset in the way I think about the learning of mathematics, and as I shift into our school's new curriculum, *Bridges in Mathematics*. This curriculum supports many of the highly effective teaching strategies mentioned in Chapter Three. The importance of a positive mathematical mindset and understanding underlying concepts has been solidified as I reflect on the course of this work.

The second point that was clear from my learning and reflecting was that the teaching practices and strategies as stated in Chapter Three takes much practice, time, and effort. Teachers are not perfect, we do not always have all the answers, but with time, practice, and the support of other teachers, we as educators can make an incredible difference in the way mathematics is understood, taught, and thought about not only within ourselves, but most importantly in our students. I feel so compelled to share my learning with other teachers because of the positive effect it has had on me and my students the past few months of school.

My capstone project has taken about six months to complete. I started my project in the summer of 2018, and while researching and learning background knowledge, teaching practices, and the history of mindset in students in mathematics, I could not wait to get into the classroom myself to implement the best practices as presented in this capstone project. The work of my capstone project has helped me understand the importance of me as a learner myself, the power of a positive mathematical mindset, and teaching skills that represent high-leverage practices. When you have done your best to reflect on all three of these, as an educator, you're taking steps in a positive direction for bettering your students and yourself.

Revisiting the Literature

The literature from Chapter Two provided many important elements that influenced my work. There are many factors to consider when providing a student with a meaningful mathematical learning experience. First, after reviewing the research, I believe making sure students possess a growth mindset will help with their mathematical endeavors and aid in their effort, persistence, and focus. Second, researchers such as Hiebert and Lefevre (1986), Huinker and Bill (2017), and Rittle-Johnson and Alibali (1999) believe that having a strong connection between both procedural knowledge and conceptual knowledge will lead into a positive understanding of the underlying concepts and mathematical skills. It is seen throughout this research and explained by many researchers that people do not possess one type of knowledge over the other; usually a child and/or person displays characteristics from both (Hiebert & Lefevre, 1986). Finally, researchers such as Fyfe et al. (2014) and Fink (2013), believe developing strong problem-solving skills that are challenging and allow our students to struggle a bit would be desirable given that such struggles may mirror and support real-world issues and other mathematical situations.

Researchers such as Cotton (2004), has suggested that many students throughout the years of school make a dramatic shift in mathematical mindset from a positive attitude towards mathematics as they enter school to a negative attitude towards mathematics as they progress through grades (as cited in Westenskow, Moyer-Packenham, & Child, 2017, p. 2). Clayton et al. (1998) stated that students with a negative outlook on math have much anxiety and doubt about their own abilities which may cause habits of avoidance and negative feelings to develop (as cited in Westenskow, Moyer-Packenham, & Child, 2017, p. 2). Van De Walle (2004) also believed that these feeling hinder mathematics development and students become locked into the cycle of failure (as cited in Westenskow, Moyer-Packenham, & Child, 2017, p. 2). This research was always in the back of my mind while working on my capstone project presentation for educators. One of the most important components in my work was promoting a growth mindset and ensuring that we not only have a growth mindset in mathematics ourselves as teacher, but that we can teach our children in a way that may change their mindset in a positive way as well.

The research of Huinker and Bill (2017) was my main focus and had the most significant influence on the development of the professional development sessions created in my capstone project. The information presented in their book, Taking Action: Implementing Effective Mathematics Teaching Practices, profoundly shaped the development of this project. The skills used in this professional development presentation stem from the eight highly-effective teaching practices for mathematics discussed by Huinker and Bill (2017) in Chapter Two. They are as followed:

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.

7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking.

Huinker and Bill (2017) argued that implementing tasks that promote reasoning and problem-solving gives opportunity for students to engage in high-level tasks. These authors concluded that a high-level task is a task that promotes mathematical reasoning and allows multiple entry points and a variety of strategies to solve problems.

The research from the literature review helped me reflect on my own teaching practices. It has made a positive impact on how I approach teaching mathematics with my classroom of learners, and should be shared with other educators who teach mathematics. The research, the process of creating the professional development sessions, and reflecting on my work have all helped me address the best mathematical teaching practices for early elementary students to ensure they are prepared to transfer problem-solving skills to other areas of mathematics as well as other aspects of their lives.

Implications

The most significant implication of this project is its use throughout our school for teachers to use in support of our new curriculum. The research behind the reasoning of the highly effective strategies, stated in this chapter, support the implication of why we are using these strategies and how to use them in everyday mathematical practices. Teachers will benefit from this project by gaining the tools and knowledge needed to best serve their students in the area of mathematics as well in other aspects of their lives.

If the implementation of this project is proven effective within one elementary school, the leads in our mathematics department could then use this project in all the other elementary schools within our district. The leads of our mathematics department at the district level would also need to get involved as part of the planning and implementation process throughout the district. With the many positive implications of this project, there does come some limitations, which are discussed next.

Limitations

As I began to use these highly-effective strategies with my own students in mathematics, I began to realize that they are going to take some time getting use to in a classroom, because of how different I had been teaching in the past. This may be the same for many other teachers as well. The previous mathematics block, as well as student engagement, looked much different in previous years. Students will take time warming up to these new teaching practices. For example, the strategy of facilitating meaningful mathematical discourse is a practice that takes time to learn for both students and teachers. It will be challenging, especially when the teacher and students are unfamiliar. It has been inspiring getting my students to talk about their thinking every step of the way, and will be well worth it, but knowing that it will not happen overnight is important to consider. I plan to address these challenges as I talk through some of the real life examples throughout the professional development presentation.

Supporting productive struggle has been another skill that has brought its fair amount of challenges as well. I was not quite prepared to have such a difficult time with allowing students to struggle. As a teacher, I want to see my students succeed of course, I want them to understand the concept taught, I want to see them do well. When you are supporting a productive struggle within your students you must allow them the time and room to make mistakes without stepping in to help right away. Recognizing and making mistakes has been a challenge because of old habits, so making that shift has created a limitation.

I became aware that this new way of thinking will and has impacted my students' mindsets in a positive way. I see a profound difference in this specific group of students I have in my classroom currently, when compared to the last three years of students I have had in my classroom.

What is Next

Overall, creating this project has brought new, positive energy in the way I think about teaching mathematics. I plan to carry out this professional development presentation to experienced teachers as well as new teachers that enter our district in the future. I am inspired to bring researched background knowledge and reasons why we should be implementing these strategies in our classrooms. I am hopeful that those who attend the professional development sessions are enlightened and empowered to take the knowledge and use it to better their practices with their students. In the end, we all want what is best for students.

The impact of this professional learning will be felt in experienced teachers as well as new teachers entering the profession. With the proper knowledge and training from this professional development project, the impact student learning will hopefully be the most profound. Each session created was aimed to educate, as well as prepare teachers, on how to best serve their students in the area of mathematics. With the strategies and examples given through this professional development, teachers will be able to take their learning and apply it to their everyday lessons within our new curriculum.

In the future, I hope to see a shift in mathematical mindset of our teachers and students. A possible study of mathematical mindset and problem-solving skills could be investigated to gather more information on the impact of this professional development. This data can initially be taken qualitatively. As for the next couple of years, I hope to observe students in our building to notice any changes, both big and small. I will be observing teaching practices taking place in regards to mathematical mindset and problem-solving skills in the area of mathematics and throughout everyday life skills. In the future, quantitative data can be drawn from state testing to also see how these highly-effective strategies are making a difference in our students' overall proficiency.

No educator has all the answers, and we know change takes time, but this project brings a few fundamental stepping stones to help ensure our students are prepared to transfer problem-solving skills to other areas of mathematics as well as other aspects of their lives. As the world of education changes and as our student's change, educators will always continue to research best practices. From here, we should keep furthering our education in understanding what is best for kids and continue reflecting on how our teaching is affecting our students' mindset about mathematics.

To further our knowledge of best teaching practices in the area of mathematics, I would suggest to all educators attending my professional development presentation to read the book, Taking Action: Implementing Effective Mathematics Teaching Practices. This text goes into substantial detail about each strategy and how it can be implemented in the primary classrooms in a variety of ways.

Within the next two to four months of the professional development presentation, data of the effectiveness of this learning will be collected upon my classroom observations, student surveys, and staff surveys. These observations will then continue into the next couple of years. Collecting this data will determine how and if teachers are using the strategies learned. Staff surveys will give teachers the opportunity to speak about their experiences using these mathematical strategies and provide a chance for them to give feedback on what they need, as well as ask any lingering questions. Often times, it is hard to know what you need when you have not implemented the strategies yet, so allowing a few months to become comfortable with using these strategies will allow an adequate amount of implementation and reflection time. Student surveys and observations will give insight on how well students are adapting to this new way of learning, as well as their overall mindset in the area of mathematics.

Summary

The responsibilities of a teacher are expanding each year, the decision making that we do day to day can sometimes be overwhelming, and as I created this project for myself and other teachers, I realized that these are actually opportunities that we get to do, not something we have to do. We are the ones that can make a change and be the change.

After extensive research, the answers to how we will prepare early elementary students to transfer problem-solving skills to other areas of mathematics and gain a growth mindset now has stepping stones to guide us in teaching mathematics in a way that will better support our students. We now know, with my own professional opinions, that this kind of learning will take time. A shift in mathematical mindset and developing problem-solving skills that transfer into other areas of mathematical skills and in other areas of life are not going to happen overnight, this will take time. I believe that it is okay to fail, but it is not okay to give up on something you have just begun. I am hoping to bring this message as I share my findings and strategies in my capstone project.

These professional development sessions are planned and prepared to be accessible to all teachers, and next actions steps are put into place. As we begin this journey together, my hope for all educators taking on this new way of learning and teaching is for them to find success. How do we know when we have succeeded? When you have found your students loving mathematics, seeing and hearing different pathways when solving problems, making mistakes and learning from them, and when your students are willing and able to teach others.

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