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Increasing Number Sense at the Preschool Level

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INCREASING NUMBER SENSE AT THE PRESCHOOL LEVEL

by

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"High-quality teaching in mathematics is about challenge and joy, not imposition and pressure."

- Douglas H. Clements

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INTRODUCTION

Introduction

It all started with a conversation; a conversation with a colleague regarding one of her students. She described Sophie as a curious, enthusiastic four-year-old girl who enjoys school. "She follows the classroom routines well and is a good listener. Sophie is a good student, eager to participate and motivated to learn, but is struggling with many preschool readiness skills. Her parents are concerned that she is not ready for kindergarten in the fall. I am not sure she is either." It was clear my colleague was concerned. Hearing her concern reminded me of similar experiences that I have had over the years with a handful of students.

That particular conversation sparked an interest in finding answers. In fact, it was the inspiration for pursuing a master's degree and furthermore, the inspiration for this capstone. It is in situations like this that I find myself asking the question, "What do we do when our students are not making the progress we would like them to?" I chose to focus on addressing this issue, but more specifically with preschool mathematics. My research will center around examining the question, "*What strategies can be used to increase number sense at the preschool level*?" When my students are not making the progress I would like, searching for instructional strategies that target their particular educational needs becomes my focus. My hope is that I will discover the best approach to address their lack of progress. This capstone will focus on addressing the needs of

students who, like Sophie, are struggling with preschool readiness skills related to mathematics, particularly addressing the development and progression of number sense.

Early Childhood Education

The focus of early childhood education is to give all children the skills necessary for a successful transition into the world of kindergarten. Early childhood classrooms are brimming with diverse learners with a range of abilities, experiences, and developmental levels. Some students pick up new skills quickly and others need more repetition and practice. In addition, children are coming to school with a wide range of educational experiences, culture, and family traditions. From learning important social emotional skills such as sharing and taking turns, participating in circle time, and working cooperatively with their peers, preschool students are gaining key readiness skills that are essential precursors for elementary school. Although math is not always the center of early childhood education, it has its place in the preschool classroom.

As an early childhood educator, teaching children ages three to five years old, I encounter a wide range of abilities, learning styles, and developmental needs related to mathematics. I expect to have some students who have a slower rate of progress, needing specialized direct instruction and modifications to the curriculum in order to be successful in their regular education classroom. Facing the challenge of teaching a handful of children, like Sophie, who are motivated and eager to learn, but demonstrate skills inconsistently is my passion. It is what I enjoy and am trained to do. With that being said, it is discouraging when a student is not making the progress I would like them to. Like the colleague I mentioned above, I try a variety of approaches, purposefully

capitalizing on my student's interests and real life experiences. I strive to teach to their strengths and learning style. Even so, progress can be slow and inconsistent.

Preschool Mathematics

Students, even at a very young age, are learning math concepts through their interactions with the world around them. They are learning through observation, imitation, trial and error, and most importantly, through play. From scooping and dumping out sand in the sensory table, to counting their crackers at snack time, preschoolers are experiencing math on a daily basis. They are learning early concepts related to geometry (understanding shapes and patterns), measurement (as it relates to size, distance, and amount), math vocabulary (more, less, a few, many), and spatial relations, to name a few. Number sense is only one facet of mathematics, however, it is one of the most fundamental of skills that all math concepts are built upon and it begins at a very early age.

Number sense, in the simplest of terms, is defined as a person's ability to use and understand numbers (Pierce, 2004). A more in depth definition provided by Pierce (2004) states that "number sense is knowing numbers and their relative values, knowing how to use them to make judgments, knowing how to use them in flexible ways, and knowing how to develop useful strategies when counting, measuring or estimating". Preschoolers are interacting with the concept of number sense on a daily basis and across all activities, from the art room, to the playground, to the lunch table. These daily interactions with math contribute to the readiness skills that are necessary for a successful transition into elementary school.

At the elementary and middle school level, math is needed not only for math

courses, but for other courses such as science and social studies (National Association for the Education of Young Children [NAEYC] & The National Council of Teachers of Mathematics [NCTM], 2010). In high school, students need to have a proficiency in math that will help them succeed and prepare for higher education. The joint position statement from the National Association for the Education of Young Children and the National Council of Teachers of Mathematics (2010) states that adults need a certain level of mathematical knowledge in order to make important decisions in their job, in their household, and in their community. Author, Alyse Hachey (2013) asserts that mathematical ability is linked to "employability and can ultimately have a disastrous effect on a country's economic growth" (Hachey, 2013, p. 421). Recent research shows that a child's proficiency at the entrance of elementary school is the most reliable predictor of academic achievement, high school graduation, and college attendance (Szekely, 2014). It is becoming increasingly obvious that by investing in early childhood mathematics education, we are creating pathways that will lead the United States to becoming a stronger and more innovative economy (Szekely, 2014).

Evidence points to the positive outcomes of teaching mathematics at the early childhood level as well as the detrimental effect that can occur when children are not provided with quality math instruction. Research is showing that by fourth grade only forty-two percent of children in the United States are scoring at or above the level of proficient (Szekely, 2014). Even more startling is the significant achievement gap in mathematical knowledge for children from low socioeconomic households. If we do not address the need for high quality mathematics at the early childhood level, these early deficits in foundational math knowledge become more pronounced as a child gets older.

The achievement gap widens and the learning trajectory for children from low socioeconomic households continues to lag in comparison to their peers from middle and high-income households. Inevitably, this achievement gap will "produce negative outcomes across a lifespan and contribute to the continuation of poverty in the U.S. across generations" (Hachey, 2013, p. 426).

When students lack number sense and do not have the most basic of math foundations, there is cause for concern. Not only are they behind their peers academically, but the pattern of avoiding math related activities, math anxiety, and low confidence begins to emerge. These missed opportunities and avoidance of math can be detrimental over time. Recent research suggests that one of the most overlooked contributing factors to difficulties in math is related to a deficit in the area of number sense (Jordan, 2007). Unfortunately most educators focus on interventions such as drill and memorization strategies rather than addressing the issue of a lack of number sense. Without a strong sense of knowing what numbers mean and the quantities they represent, students will continue to struggle with math, each year becoming further and further behind their peers. Jordan (2007) states that math difficulties are apparent as early as kindergarten. I would argue that the root of these math difficulties is apparent much earlier than kindergarten. It is my belief that addressing these difficulties at the preschool level is imperative.

My Background

As an early childhood special education teacher, I work with children ages three to five years old in a variety of settings. These settings can include privately owned daycares where children come full time to part time preschool programs with classes that

are half day, two to four days per week. In addition, I work with students in private preschool programs in local churches, home daycare settings, and individually at their home. My role can vary depending on the needs of the students, ranging from working with a student one to two times per week to team teaching with a regular education teacher in my school district's preschool programs. Within these settings, my role can vary depending on the needs of the students, either working with students individually, in small groups, and/or within the classroom. Most often, I work with students one to two times a week for approximately one hour with my instruction being centered on each student's developmental needs spelled out in their Individualized Education Program. The specific goals and objectives often address delays related to preschool readiness skills. Often times, I find myself working specifically with students who struggle with mathematics.

Preschoolers learn about their world through play. I spend a great deal of time embedding instruction into a classroom's playtime. This gives me the opportunity to follow a child's lead, use natural experiences that they choose and relate those experiences to their learning goals. I use the gift of observation to support them in their learning. These opportunities allow me to tailor future instruction around classroom activities and carryover targeted classroom themes into smaller groups. Time and time again, I find that if a student isn't interested in the activity, doesn't have a personal connection to the activity, or it is something that is challenging, most, if not all, will avoid the activity or stay with it for a very short time. These missed learning opportunities can have a detrimental effect over time. With this research project, it is my intention to find engaging activities that will help tackle the cycle of avoidance of math

activities and teach much needed foundation number sense skills. Addressing this issue will help build confidence in math and help increase each of my students' number sense.

Conclusion

With mathematical competency at the beginning of elementary school being the best predictor of future achievement and a solid understanding of number sense being linked to future math achievement, the need for sound, research-based strategies that are intentional, specialized, and differentiated to a student's developmental level, becomes even more crucial. In chapter two, a thorough review of literature related to my research question, "*What strategies can be used to increase number sense at the preschool level*?" will assist me in evaluating current and past instructional practices that have been researched by theorists in the field of early childhood education. Chapter three will include a summary of the population of students this curriculum capstone is intended for and a review of the framework used to design the curriculum. An overview of the curriculum, including sample lessons and a thorough description of this capstone's curriculum design will be shared in chapter four. The final chapter will offer a reflection of the results of this curriculum capstone, providing the reader with a summary of my the implications, limitations, possible outcomes, and next steps for this curriculum.

Upon completion of this capstone, I hope to increase my capacity to teach basic numeracy skills in a manner that is intentional and engaging, promoting each one of my students to be active learners and future problem solvers in the area of mathematics. In addition, I hope that what I learn through this curriculum development process will be beneficial to my colleagues in regular and special education as well as to the parents of the children I work with.

CHAPTER TWO

LITERATURE REVIEW

Introduction

The purpose of chapter two will be to investigate and summarize the key elements of past research and current trends as they relate to mathematics, particularly examining mathematics at the preschool level with a focus on addressing the question, *"What strategies can be used to increase number sense at the preschool level?"* In order to fully understand the push for mathematics at the preschool level, time must be spent reviewing the history of mathematics in the United States as well as examining the beliefs of leading theorists such as Jean Piaget and Lev Vygotsky. From there, I will move on to discuss the progression of math skills as they relate to number sense and number operations for preschool students. In addition, I will summarize key math standards for preschool students and how those standards relate to early childhood education. Finally, I will highlight important, research based instructional practices related to teaching mathematics as it relates to number sense.

The History of Math Instruction in the United States

Mathematics has been at the forefront of educational reform for decades, with a push for math instruction at the preschool level being a more recent milestone for early childhood education. In the past sixty years, the United States has been faced with the fact that other countries, particularly Asia and Europe, are outperforming the United States in nationwide comparisons, particularly in the areas of mathematics and science. Internationally, the United States has continually been tagged as providing math

education that is “a mile wide and an inch deep”, illustrating a lack of in-depth focus and consensus that plagues our country (National Council of Teachers of Mathematics, 2006 p. 3). The philosophical belief behind how to teach and what to teach in the area of mathematics has continued to change dramatically.

In the 1950s the United States was hit hard by the realization that they were no longer at the cutting edge. Discrepancies in math skills as well as a decline in enrollment in higher level math and science classes was evident, suggesting that the instructional practices of the United States were outdated (Woodward, 2004). With a nationwide focus on atomic energy and the production of nuclear weapons coupled with the USSR’s launch of Sputnik in 1957, the United Stated sprung into action. Feeling ill equipped to compete internationally, the next ten to fifteen years resulted in vast amounts of federal funding being placed on research and training in the area of mathematics in hopes to produce more mathematicians and scientists. This led to what historians refer to as the “New Math Era” in education, embracing the need for abstract learning and theoretical knowledge in math concepts (Schoenfeld, 2004). Less focus was given to basic skills, such as number sense and operations, with an ultimate goal of building every student’s pedagogical knowledge of math. Unfortunately the heavy push for abstract understanding of math concepts had its repercussions.

By the early 1970s, the push for reform was once again at the forefront of math instruction with concern that students lacked the ability to demonstrate basic math skills. The new math era of the 50s and 60s slowly dissipated and was eventually debunked by the early 70s with critics arguing that it was too abstract, teachers were ill equipped to teach the content, and little focus was placed on learning basic math skills. The 1970s

became known as the "Back to Basics" era with a heavy emphasis on basic number computation skills. The results of this push for basic skill proficiency did, in fact, moderately increase many students' ability to complete basic math operations, however, at the expense of a deeper knowledge of math proficiency needed for higher level math (Fiske, 1988).

In the early 1980s, the all to familiar realization that the quality of math and science education in the United States had been deteriorating stirred up controversy and concern among parents, educators, and politicians. Standardized test scores were bottoming out, low enrollment in higher level math classes was continuing to occur, college entrance requirements were forced to lower their standards, and more remedial courses in high school and college were necessary (Klein, 2003). Once again, a push for change was brewing and began the movement towards math content and instruction that embraced high standards, clear expectations, and strong problem solving skills, with public opinion on board (Klein, 2003).

The National Council of Teachers of Mathematics (NCTM), an agency founded in 1920 to support teachers in providing high quality math education, released a position statement in 1980 related to mathematics instruction. This bold and politically driven document, referred to as "An Agenda for Change", highlighted the need for technology, integration of math topics, cooperative learning, the use of manipulatives in math instruction, and a decreased emphasis on paper/pencil calculations. It was also at this time that researchers began to put forth the need for prekindergarten education as a way to build math and literacy skills for the country's youngest learners. Although Head Start was initially created in 1965 to fight in the war of poverty, it went through a

revolutionary revamping in 1981 as a result of the "Agenda for Change" initiative.

In 1989, National Council of Teaching Mathematics (NCTM) released its first set of math standards called the Curriculum and Evaluation Standards for School Mathematics. The NCTM's standards were created with the intention of being "a coherent vision of what it means to be mathematically literate in a rapidly changing world, and to create a set of standards to guide the revision of the school mathematics curriculum" (Schoenfeld, 2004, p. 266). These standards were widely adopted by the most states by the early 90s and had all the intentions of producing change and accountability in education. The NCTM has since revised its math standards, releasing the Principles and Standards for School Mathematics (PSSM) in 2002 and the Curriculum Focal Points in 2006, with statements embracing a more balanced approach between student driven learning and teacher directed instruction. More importantly, these revisions included standards for children at the preschool level. The impact of early education on the future performance of children in elementary, middle, and high school, began to take off as a more plausible solution to some of our countries shortcomings in the area of mathematics.

In the past five to ten years, the United States has begun to embrace the need for high quality early childhood education for all children with initiatives supporting full day kindergarten, four year old kindergarten programs, and Parent Aware. Furthermore, many states have begun to put particular emphasis on math education at the early childhood level with the creation of initiatives and grants related to Science and Math Technology (STEM). This focus on preschool education has continued to inch its way to the forefront of math reform and has proven to be a reality of the 21st century.

Addressing the question *"What strategies can be used to increase number sense at the preschool level?"* through this curriculum capstone is proving to be well timed as the push for high quality mathematics education makes its way into early childhood classrooms across the nation.

Math Standards at the Preschool Level

With the United States beginning to embrace the notion that high quality early childhood education is a key solution to the future success of our students, highly regarded agencies such as National Education Associated for Young Children (NAEYC) and the previously mentioned National Council for Teaching Mathematics (NCTM) have begun to place an emphasis on math skills at the early childhood level. With the National Council of Teachers of Mathematics revising its standards in 2000 and including standards for preschool education for the first time, these agencies sprung into action. With this new push for math at the early childhood level came controversy over whether mathematics should be taught, why it has its place in preschool, and how teachers of young children should approach mathematics instruction; yet another reason why math standards were created. Even so, the push for high quality mathematics at the preschool level has continued to grow in both acceptance and necessity.

The National Council for Teaching Mathematics created five content areas, or standards, that they assert should be taught beginning at the prekindergarten level and progressing through second grade. Author of the book, *Teaching Mathematics in Early Childhood,* Sally Moomaw (2011) summarizes the five content areas as follows (p. 5):

- Number and operations – the development of numbers, number concepts, and quantity with key concepts related to quantifying, comparing, and

combining sets, counting and ordering numbers and understanding one to one correspondence.

- Algebra –understanding patterns and relationships, includes analyzing and modeling mathematical situations. Algebra at the preschool level most often involves sorting and classifying
- Geometry – understanding spatial relationships, positional terms, and properties of two and three-dimensional objects.
- Measurement – understanding that objects have measurable attributes, applying numbers to measurement
- Data Analysis and Probability – interpreting, analyzing and comparing important data in their lives. (i.e. graphing, voting, making predications and inferences)

In addition to these content standards, the NCTM has developed five process standards that highlight ways to acquire and apply knowledge. The five process standards include problem solving, reasoning and proof, communication, connections, and representations. The content and process standards are meant to be the foundational mathematic skills that guide the development of curriculum, assessment, and instructional materials.

The content and process standards are considered equally important, however some researchers argue that Number and Operations is the most fundamental and important content area and at the preschool level. The National Research Council, the National Center for Teaching Mathematics, and the National Agency for Education Young Children suggest that prekindergarten and kindergarten classrooms should place

emphasis on numbers and operations, geometry, and measurement. However, the National Math Advisory Panel (a group of researchers appointed by President Bush in 2008 to advise on how to improve math education) suggests that all standards should be addressed with "the intention of all math instruction leading to the development of algebra concepts" (Moomaw, 2011, p. 9). Understanding numbers and having a solid base of understanding number sense is a necessity in all of the five math content standards. In addition, much of what children learn related to math at the preschool level centers around numeracy. For those reasons, I chose to focus this curriculum capstone on number sense with a focus on the standard related to numbers and operations.

In an effort to link the national early childhood math standards to math curriculum here in Minnesota, the Minnesota Department of Education (MDE) and the Minnesota Department of Human Services (MDHS) developed the *Early Childhood Indicators of Progress: Minnesota's Early Learning Standards* in 2005. The Early of Progress is widely used by early educators in Minnesota as a framework for developmentally appropriate expectations for young children ages three to five years old around six domains of development. Within the Cognitive Domain lie skills related to Mathematical and Logical Thinking with number concepts and operations being one of the subcategories. The Minnesota Early Learning Standards (2005) expect children ages three to five years old to be able to demonstrate the following skills (MDE & MDHS, p. 44):

- Demonstrate increasing interest in and awareness of numbers and counting
- Demonstrate understanding of one-to-one correspondence between objects and numbers

- Demonstrate ability to count in sequence
- Demonstrate ability to state the number that comes next up to 9 or 10
- Demonstrate beginning ability to combine and separate numbers of objects

The standards in the *Minnesota Early Childhood Indicators of Progress* follow the national standards closely. Math standards are a necessary component to any preschool curriculum in that they provide early childhood educators with a framework for what math skills need to be addressed in preschool. With that being said, many still argue that these standards across all grade levels are vague, too broad, and lack depth.

Theories of Learning

The history of mathematics in the United States, the development of math standards, and the push for mathematics at the early childhood level has been addressed in this chapter's review of current research and literature related to preschool mathematics. Equally as important to early childhood education are the works of Lev Vygotsky and Jean Piaget. Vygotsky and Piaget are widely known cognitive theorists that have been instrumental in developing a framework of understanding that characterizes the learning of young children. The works of Lev Vygotsky and Jean Piaget have had a considerable impact on mathematics education and the development of math standards in the United States as well as around the world. Their work plays a significant role in children's learning as well as mathematics at the preschool level and must be addressed in order to fully examine the research question, *"What strategies can be used to increase number sense at the preschool level?"*

Jean Piaget, born in 1896, is known for his constructivist approach to learning, stating that children build knowledge through their own experiences with people and

objects (Moomaw, 2011). Most early childhood educators agree that children are active learners, constructing knowledge through play and exploration in their environments. In fact, many early educators would rate play as the most valuable learning tool that young children have. This is fundamental in Piaget's beliefs, asserting that children learn best when given the opportunities to explore and interact with the world around them. Piaget defined the three content areas of knowledge that occur with children as physical, social, and logical-mathematical knowledge. Physical knowledge reflects learning through our senses and can only be experienced through hands on exploration. This type of learning is characterized by such actions as touching, looking, feeling, tasting, throwing, dropping, or shaking objects and analyzing the effect that those actions have on the object (Moomaw, 2011). Social learning is as it sounds; learning that occurs through interactions within one's culture or family.

According to Piaget, logical- mathematical knowledge is where most mathematical learning occurs. He asserts that many mathematical concepts are intrinsic, however, through interaction with real objects, connections are made and learning and understanding occurs. Using manipulatives in mathematics is rooted in Piaget's belief that children must interact with objects in order to construct fundamental concepts related to numbers and number sense (Moomaw, 2011). Piaget's cognitive learning theory is widely accepted by early educators for a variety of reasons including its focus on child initiated learning in a rich environment with a variety of experiences, learning through process not product, and viewing the teacher as a guide (Smith, 2012). Piaget is most known for his belief that children progress through four stages of learning:

- Sensorimotor stage (0 to 2 years old) - manipulating objects and learning

through one's senses. Development of object permanence.

- Preoperational stage (2 to 7 years old) – representing objects with words; egocentrism; language development. Development of pretend play.
- Concrete operational stage (7 to 11 years) - logical thinking about concrete events emerges; Ability to add and subtract emerges.
- Formal operational stage (12 to adulthood) – Can think abstractly and hypothetically. Development of abstract logic.

The four stages of learning developed by Piaget are an important tool for educators to use in order to truly grasp the progression of mathematical understanding of children. It was once thought that children at the preoperational stage were not equipped for mathematical learning and that they lacked the cognitive skills to be able to engage in math problem solving. Recent research has shown that children are more competent than Piaget initially proposed and are able to handle mathematical concepts at a much early age (Lee & Ginsburg, 2007; Sarama & Clements, 2014). Piaget believed that children must have a strong logic behind mathematical concepts before counting can become meaningful. Clements and Sarama (2014) would argue that this is partially true, however they also assert that children can learn much about counting before they have mastered these ideas. Furthermore, they claim that counting can help young children make sense of the logical ideas in mathematics (Clements & Sarama, 2014)**.**

Vygotsky's cognitive learning theory is much like Piaget in that he places heavy emphasis on play as the most important way for young children to learn (Moomaw, 2011). However, Vygotsky also places an emphasis on how social interactions and cultural aspects contribute to cognitive learning. He talks about the role of "private

speech", a stage of development when children begin talking aloud to themselves, and how this impacts the development of knowledge (Reiber, R. & Carton A., 1987). This kind of speech has more of an intellectual function rather than a social function. The Zone of Proximal Development, another term coined by Vygotsky, refers to the notion that children are able to learn higher level concepts with the help of a teacher or classmate through the use of scaffolding, or support with a "more knowledgeable other" (as cited in Smith, 2012, p.10). Through these interactions and guided instruction, children are able to take their learning to the next level.

Both Piaget and Vygotsky have been instrumental in defining early childhood education and how to engage young learners. Understanding their theories on how children construct knowledge can assist me in examining the research question, *"What strategies can be used to increase number sense at the preschool level?"* Piaget's belief that children learn through interactions with real objects and knowing how children progress through four stages of development is important to developing appropriate instructional practices for teaching number sense at a young age. Vygotsky's zone of proximal development asserts that children are ready for more advanced mathematical learning and can make those connections with the appropriate support from their teacher or peers. Both theories provide a foundation for math instruction that is embedded into the daily interactions and instruction of a preschool classroom.

Progression of Number Sense for Preschoolers

Piaget and Vygotsky, as well as most researchers in the field of early childhood education, agree that children are naturally inquisitive and often spontaneously experience their world through hands on learning and exploration. Many researchers in

the field of early childhood mathematics believe that children also naturally and intuitively see their world through a mathematical lens. At a very young age, they are making judgments regarding quantity, comparing attribute and size, and counting in sequence. Gelman suggests that children "are neurologically wired from birth" for basic number sense (as cited in Hachey, 2013, p. 240) with studies showing that infants as young as six months of age can demonstrate an intuitive sense of numeracy (Clements & Sarama, 2009; Szekeley, 2014). In addition, researchers are finding evidence that supports the belief that children are born with varying levels of number sense (Clements & Sarama, 2009; Riccomini, Witzel, & Riccomini, 2011). If research is showing that children are born with a mathematical sense, examining how children's mathematical skills progress becomes necessary when addressing the issue of number sense at the preschool level.

When teaching number sense to preschoolers, it is important to understand that development occurs in a predictable sequence. However as Piaget point outs out, children's cognitive skills develop gradually and continuously with the age norms and timing being varied depending on the child (as cited in Park, 2013). In addition, we know the age at which a child masters certain math concepts is strongly influenced by experience (Clements & Sarama, 2014). All children are born with an innate sense of numeracy, but even that can vary from child to child. Age ranges are often provided in reference to the development of number sense, however, age ranges are only approximations. Because of this, it is important to recognize that gaining a sense of where a child's number skills are is critical to addressing their educational needs rather than making judgments based on age.

For young children, understanding numbers and what they mean is far more complex than it sounds. As Dacey and Collins (2011) point out, "children must know the correct sequence of number names, count one object for each object they point to (*one to one correspondence*), know that the last number they say when counting a set of items is the total number of objects (*cardinality*), know that the cardinality of a group doesn't change even if you rearrange the objects (*stability*), and to know how many objects are in a set without actually counting the objects (*subitizing*)" ("Counting Routines", para. 1). The concept of number sense can be an abstract concept for young children and goes beyond rote memorization. Children need to understand that counting has a set of rules and procedures and once they know that, they can begin to reason, problem solve, and generalize those skills to other aspects of mathematics.

In the article "Help! They Don't Understand Counting", Faith Sadler (2009) summarizes a six stage model of learning that breaks down how number sense progresses in young children (see Appendix A). Sadler adapted this six stage learning model from Vincente Bermejo's theory about the stages of cardinality written in 1996 and Douglas Clements and Julie Sarama's first edition of the *Learning Trajectories Approach* written in 2009. (Bermejo, 1996; Clements & Sarama, 2009). Bermejo, Clements, and Sarama are widely known researchers in the area of mathematics that have dedicated a considerable amount of time to the field of early childhood mathematics education. Their research has been instrumental in bringing mathematics to the preschool level. This six stage model will support my curriculum design summarized in chapters three and four of this capstone by providing a set of activities that will address students at across those stages of learning.

In the first stage of Sadler's model, children are not able to correctly answer the question of how many. These children are typically around the age of one to two. Referred to as "precounters", these children are at the stage where they are able to give a number name, however, it is often just a guess. They know to answer the question *how many* with a number, however, they do not yet have a sense of counting in correct sequence. Precounters progress to being able to recognize small quantities of one and two before moving to the next stage.

Children at stage II, known as "reciters", are able to respond with a number word sequence, but are not yet using the skill of one to one correspondence (pointing to each item as they count). These two to three year olds are excited to recite number names but often have a very basic and concrete understanding of numbers. They begin to understand the concept of more in the general sense as well as demonstrate an understanding of the quantities of one and two. Gaining an understanding of the quantity of three can be challenging at this stage in that there are far more examples of two for young children than there are of three. They have two eyes, two feet, one head, two arms, two shoes and so forth (Dacey & Collins, 2001, "Numbers", para. 1).

Stage III learners, typically around the age of three, are able to answer the question of how many but have to recount the set of objects. In this model, stage III learners are referred to as "corresponders" because they are mostly able to counting using one to one correspondence (Sadler, 2009). The next stage, stage IV, is characterized by children who are now able to answer the question of how many with the last number they said when counting a set of objects. Children at this stage now see the significance of the last number said when counting however they are still immature counters and may count

objects more than once or skip an object. In Stage V, children are referred to as "rigid rule followers". These children know that the answer to the question "how many?" will always be the largest number in a counting sequence. They are beginning to show an understanding of the rules and patterns of counting. Finally, children at Stage VI, now have the ability to monitor their counting as well as another's counting for accuracy. They can now give the correct answer to the question of how many. You would typically see this skill emerge at the age of four for sets of one to five items and around the age of five for quantities up to ten.

Sadler's summary of the six stages of cardinality, written by Bermejo in 1996 and adapted by Sarama and Clements in 2009, is the foundation for number sense. Sadler used this six stage model of the development of the skill of cardinality (being able to answer the question of how many) to help track a student's number sense ability and provide a variety of strategies for counting that will help children build an understanding of the rules of quantity and numeracy. It is essential for practitioners to understand this progression of skills as tool to better understand where their student's skills are at. This tool can lead to a more specific set of activities geared toward the unique needs of their students especially when students are struggling.

Characteristics of High Quality Mathematics at the Early Childhood Level

With a predictable sequence of the progression of number sense, learning standards established for mathematics at the preschool level, early educators now know *what* to teach, however, *how* to teach mathematics is of much debate. Mathematics at the preschool level is still relatively new. There are still some educators and policy makers who believe that preschool should focus on emotional development, learning to socialize

and be successful in a social environment, and literacy skills. Mathematics is often underrepresented when compared to literacy instruction in the preschool classroom, with time spent on literacy activities being two to three times more (Szekeley, 2014). This discrepancy is concerning with studies showing that a child's mathematical ability measured in kindergarten is often a better predictor of future achievement than literacy skills (Claessens & Engel, 2013; Szekely, 2014).

With a greater emphasis being placed on high quality mathematics education, state leaders are beginning to join in on raising awareness of the impact that a strong math curriculum can have on the future success of our youngest learners. With governors being faced with pressure to improve the quality of education, they have come to realize that action is needed. Governors are coming together to tackle issues affecting the quality of education across the nation through a variety of initiates and agencies. One such agency, called the National Governor Association (NGA), is an organization that allows governors to join forces in hopes to share best practices, develop solutions to improve state government, and work collectively to tackle issues of public policy and reform. The NGA recently came out with a position statement that focuses on what the research is telling us about mathematics instruction and summarizes these research based key characteristics of high quality early mathematics education (Szekeley, 2014, p 6):

- It follows an intentional sequence of developing math skills in which children master one skill and then another that builds on the preceding skills.
- It is taught through a mix of teacher-led direct instruction and student-centered exploration and practice.
- It focuses on building an understanding of mathematics concepts and skills.

- It includes engaging play-based activities with teachable moments about mathematics
- It promotes family engagement and helps parents support children's mathematics learning
- It offers assessment and differentiated support for children who have learning disabilities in math.

The key characteristics provided by the NGA match what research is showing us about high quality mathematics instruction at the early childhood level. Essentially, both are saying that best practice and effective teaching of mathematics at the preschool level involves a variety of teaching strategies that are both student centered and teacher directed. Within those activities, teachers should act as facilitators, guiding children's learning through encouraging them to problem solve, discuss their ideas, and connect with what they know (Huber & Lenhoff, 2006; Linder, Powers-Costello, & Stegelin 2011). Both Clements (2001) and Notari-Syverson & Sadler (2008) assert that a more balanced approach with both child initiated play and teacher directed experiences, intentional in nature, provide children with a rich experience that will help build a strong foundation in number sense. In the next section of this literature review, I will review a variety of strategies that include teaching mathematical concepts through games, music and movement, and literature as well as through play and natural discovery, intentional teaching opportunities in a child's everyday activities and routines, and parent involvement.

Instructional Strategies For Teaching Number Sense

As Piaget points out, children learn best when given opportunities to explore and interact with the world around them. Vygotsky takes this notion a step further, asserting that a child's social interactions with peers and adults also play a key role in one's cognitive learning. With that being said, it isn't a surprise that many leading researchers are pointing out play as one of the most influential ways for preschoolers to experience math. This hands-on approach to learning offers young children the opportunity to experiment with toys and materials within the social context of a classroom where math concepts find their way into each child's conversations and play.

Young children naturally compare, observe, and problem solve mathematically in their learning environment. A child's play is the source of their first mathematical experiences (Clements, 2001). Opportunity for play allows children to learn through trial and error exploration as well as through peer interactions. Children are more engaged and motivated when learning is self-directed and self-initiated with plenty of opportunities to connect these experiences with activities that are of interest. Young children should be exposed to mathematical concepts in daily routines, natural contexts, and in real life activities connected across all areas of learning (Linder, Powers-Costello, & Stegelin, 2011). As Clements (2001) suggests, " High quality teaching in mathematics is about challenge and joy, not imposition and pressure" and quality education in math goes beyond drills and practice in counting and adding (p. 270).

In addition to providing opportunities to learn number sense through play and exploration in a child's natural environment, early educators need to further their student's abilities through intentional teaching. Intentional teaching involves organizing

experiences for children that lend themselves to mathematical learning. Intentional teaching is not accidental, but involves purposeful planning and setting up the environment in order to promote learning experiences that are goal oriented and informed, with a specific set of skills in mind (Clements, 2001; Notari-Syverson & Sadler 2008; Epstein, 2007). Teachers that are intentional make informed decisions about the activities and experiences they provide in the classroom based on individual abilities and interests. Emphasis is placed on moving from concrete to abstract learning where children are challenged through open-ended questions and scaffolding (Notari-Syverson & Sadler, 2008;Witzel, Ferguson, & Mink, 2012). Knowing that children see their world through a mathematical lens, setting up play opportunities that lend themselves to mathematical exploration and learning is the premise for intentional teaching. Furthermore, being available by asking questions, targeting specific skills by embedding math instruction into a child's play, and facilitating peer to peer exploration and problem solving will support a student's learning in a way that helps build on the skills they have, encourage learning from others, and maintain focus and interest.

With much emphasis being placed on child initiated discovery and natural learning opportunities as most influential in a child's mathematical understanding, teacher directed activities are also of importance in the preschool classroom. Using a variety of games, including board games, card games, or teacher created games to teach mathematical concepts can be a valuable instructional tool for preschoolers (Kamii in Moomaw, p. 27; Whyte & Bull, 2008). Whyte and Bull (2008) assert that board games offer "multiple cues" through repetition to the meanings of numbers (p. 589). Games played within a small group of peers allows children to maintain focus as well as

minimizes the amount of time they have to wait for their turn. Engaging in math related games offers children the opportunity to engage in discussion with each other around mathematical concepts where direct feedback and problem solving can occur. In addition, many board games are self-leveling, in that they can be used with children at various stages of development, adjusting the game to meet the learning needs of their students. This allows children of varying developmental levels to work together and learn from each other in a context that builds social connections and self-confidence.

A variety of games can be used to teach math skills in a preschool setting including board games, movement games, dice games, card games, and games with spinners. Park (2013) cautions that using "commercially made games such as Chutes and Ladders and Uno have their benefits", however, often have to be adapted to the age level of the students involved (p. 94). Games that involve manipulatives can be used to help children make connections between informal learning and abstract ideas in math (Park, 2013). Moomaw (2011) asserts that card games, path games, and board games can provide preschoolers with the opportunity to build such skills as cardinality and subitizing as well as opportunities to practice counting and comparing quantities with their peers in a fun and engaging way.

Teaching math concepts through large muscle movement activities is especially beneficial for preschoolers who often need opportunities with hands on learning and large muscle activities. These kinesthetic learners need to have opportunities to move. Rae Pica, a known education consultant specializing in children's physical activity, asserts that the more senses involved in an activity, the more likely a student will retain the information (Pica, 2004). Furthermore, she states that physical movement is key in the

creation of nerve cell networks that are critical for learning. Physical movements specific to cross lateral movements or crossing the midline activate all four lobes of the brain. Such activities include any exercise or movement where your arm or leg crosses to the other side of your body. Marching, crawling, dancing, windmill exercises, and touching your toes with the hand on the opposite side of your body are all examples of cross lateral exercises. This in turn can increase a child's cognitive functioning with the notion that children may, in fact, retain more information if an activity is combined with physical movement (Pica, 2004).

For young children, mathematical learning is grounded in concrete, everyday learning experiences that involve exploring toys and materials in a variety of ways. Physically experiencing the cognitive concepts through actions such as sorting, stacking, and comparing as well as through sensory table play, bath time, mealtime, physical exercise and pretend play can activate more parts of the brain thus increasing a child's ability to make connections in their learning. Math is full of quantitative concepts such as big/little, more, few, tall/short. By allowing children to experience theses concepts physically through movement, exercise, whole body imitation, and through activities that involve crossing the midline, we are helping building children attach meaning to them in a concrete way (Pica, 2004; Sadler, 2009).

Whole body path games using carpet squares and a large die can combine mathematical learning with movement, a combination necessary for kinesthetic learners. When using their own body, children are more aware of the spaces they have already counted and make less mistakes with one to one correspondence counting (Moomaw, 2011). Sadler would argue that children who are at stage two, referred to as the

"reciters", need number concepts/words paired with large motions in order to help them *truly* begin to understand the skill of counting with one to one correspondence (Sadler, 2009). Once children have mastered counting small quantities using their whole body or large motions, teachers can then progress to smaller motions such as pushing objects to the side as they count and then onto counting by pointing to objects (Sadler, 2009).

Using rhythm and beat through music is proven to be another important strategy that can increase a student's mathematical knowledge, competency, and retention. Music and movement go hand in hand and build on the same premise that involving the whole body activates more parts of the brain, which often results in children building stronger connections to the concepts they are learning. More public attention was placed on integrating math and music instruction in the early 1990s after a University of California researcher named Gordon Shaw concluded that listening to music increased SAT scores (Burack, 2005). This finding, known as the "Mozart Effect", permanently linked math and music instruction in the eyes of the public, however not in the way Shaw would have hoped. Further research into the "Mozart Effect" showed that there was indeed an impact, however that impact was extremely short lived, lasting only 10 to 15 minutes (Kells, n.d.).

Although the "Mozart Effect" was found to be much less impacting as initially thought, it did spark a wave of research into the effects of music on one's cognitive abilities. More recent brain development research has found positive links between math instruction and music, specifically related to music instruction and actively engaging in making music. Using music instruction was found to be the perfect "entryway" into building stronger connections along the neural pathways (Kells, n.d.). These neural

pathways are located in the same part of the brain that is responsible for mathematical reasoning (An, Tillman, Shaheen, & Boren, 2014). Furthermore, the earlier a child starts playing music and the longer they play, the stronger the connections are. Dr. Francis Rauscher, a well-known University of Wisconsin researcher studying the impact that of music instruction has on cognition, concluded the following (as cited in Gupta, 2009):

- there are far more benefits to actively playing music than just listening to music
- young children perform better on spatial temporal tasks, eye hand coordination, and arithmetic when provided with music instruction
- children who learn their academics through music and dance have better retention than when provided with just verbal instruction
- rhythm and rhyme in the form of songs, chants, poems, or raps increase recall skills and the memory of content facts and details.

In addition to the brain research that has been done related to music and math instruction, further research has been done on the effects that music can have on one's emotions. One's emotional state plays a crucial role on their learning and music can have a profoundly positive impact on a student's emotions. Positive emotions lead to higher levels of motivation, which in turn, facilitates learning. In addition, music is relaxing and motivating for children and if integrated into the curriculum in a positive way, it can cause less anxiety and more motivation to participate in mathematics (An, Tillman, Shaheen, & Boren, 2014).

The use of children's literature is yet another strategy that early childhood educators can use to teach mathematics in the classroom. Picture books have the potential to be engaging, interesting, and are often a useful tool to teach concepts related

to number sense, quantity, and problem solving for preschoolers. For young children, math concepts can be both abstract and irrelevant, often times due to lack of experience and the concrete nature of their learning. Children's books can provide both the hook and the context needed to help children visualize the when, where, why, and how a math concept relates to their day-to-day experiences (Golden, 2012). Furthermore, literature can help introduce math vocabulary through the use of pictures and text as well as uses words instead of numbers to teach math concepts (Golden, 2012; Flevares & Schiff, 2014).

The National Council of Teaching Mathematics asserts that using children's literature to teach mathematics aligns with the five process standards (problem solving, reasoning and proof, communication, connections, and representations) for how children can acquire and apply the math concepts they are learning. Children's literature's use of pictures and storylines will help children work through math problems visually as well as allows teachers to model new skills through another mode of learning. In addition, teachers are able to use pictures to discuss multiple solutions and encourage critical thinking skills. Using picture books to teach a math concept helps children understand that math is more than just memorizing numbers, quantities, and formulas. Rather, children will see that math can be applied to everyday life and not just in the math classroom.

Teaching math through children's literatures has the potential to align with Vygotsky's sociocultural perspective of how young children learn about their world. The social and emotional connections that are built when teachers, caregivers, and parents read to their children provides yet another positive outcome that teaching mathematics

through literature can have. The sharing of ideas, the solving of problems, and the discourse that can occur when children are actively engaged and challenged can have a dramatic impact on their learning. Furthermore, the emotional connection that books can bring to the classroom provides a "springboard" to further math related learning (Anderson, Anderson, Shapiro, 2004, p. 29). If a child can connect to the story on a personal and emotional level, they are more likely to internalize the content. Their curiosity is sparked and further learning is more likely to occur, motivation spikes, and stronger connections are made. In addition, the more positive a child's disposition is towards math, the less math anxiety they feel and the end result is deeper learning (Flevares & Schiff, 2014).

Becoming increasingly well known is the role that parent involvement can play on a child's success in mathematics. Research points to the significant effect that parent involvement can have on math success however, many programs are still lacking in both parent initiated involvement and in the amount of school initiated opportunities to involve parents. Clements and Sarama (2014) suggest that the lack of parent initiated involvement stems from a variety of reasons. The level of a parent's education and factors such as socioeconomic status, a parent's own educational experiences related to mathematics, and language/cultural differences are all factors that can have an impact on a child's success in school. School initiated involvement is often impacted by dwindling resources, limited parent involvement, lack of appropriate school to home math activities, and teaching staff that is already stretched. Parents often believe that the school plays a more important role in teaching mathematics and as a result, provide fewer math experiences and provide less support with homework in the home (Clements & Sarama,

2014). Furthermore, parents tend to have a greater understanding about what literacy skills need to be taught, have less experience with higher level math curriculum, and feel less confident in supporting their child's learning in the area of mathematics (Clements & Sarama, 2014).

Clements and Sarama's book, *Learning and Teaching Math: The Learning Trajectories Approach* (2014), lists several factors that point to the growing importance and positive effects that a parent's involvement can have in their child's understanding of math concepts. Simply including conversation around numbers in a child's day-to-day routines can have a substantial impact on mathematical knowledge. Parents need to talk about "numbers both frequently and within a child's daily experience from the time they are toddlers" (Clements & Sarama, p. 34). Creating opportunities to bring numeracy into routines is both engaging and effective for children.

Another important factor that has a positive and lasting effect on a child's mathematical learning is a strong home to school connection. This not only allows teachers to capitalize on a child's unique experiences and the math curriculum they are experiencing, but can also give parents the opportunities to be involved and support their child's learning. Programs shown to be the most successful included joint and separate sessions for parents and children, a structured numeracy curriculum, and bridging activities for parents to develop their child's number skills (Clements & Sarama, 2014). When teachers and parents work together to link a child's own unique experiences to what math concepts they are learning, greater retention and generalization of concepts to other settings and experiences is more likely to occur. Parents are more likely to follow through and be involved in their child's learning if schools provide them with hints,

guidance, and training opportunities on how they can best support their children's learning. Unfortunately, this is often viewed as a luxury as it takes additional time and resources for both parties involved.

Conclusion

A historical trend in mathematics education in the United States has shown a need for change and reform with a relatively recent emphasis placed on math instruction at the preschool level in hopes to better prepare students for K – 12 education. With instruction around key developmental standards in the area of preschool mathematics becoming a widely accepted and necessary component of early childhood education, evaluating instructional practices at the preschool level become essential. Addressing key learning theories by the well-known Lev Vygotsky and Jean Piaget provides the foundation for high quality instruction for our youngest of learners. Current research related to best practices in mathematics education points to providing preschoolers with opportunities to engage in math related learning through natural play opportunities, intentional teaching, embedding math concepts into daily routines, and structured teacher led math activities such as games, whole body movement, and literature. In addition, promoting family engagement where parents can help support their child's learning and differentiated instruction for children who are struggling will help build a strong foundation of math knowledge for preschoolers as they move into elementary school.

This chapter provided a summary of the history of mathematics education in the United States, theories related to how young children learn, and the push for high quality mathematics at the early childhood level. In addition, current research related to high quality mathematics education at the preschool level including instructional strategies and

standards at the early childhood level was reviewed. Chapter three will further address the research question "*What strategies can be used to increase number sense at the preschool level?"* by summarizing the population of students this curriculum capstone is intended for as well as a review of the framework used to design the curriculum.

CHAPTER THREE

METHODOLOGY

Introduction

The previous chapter provided a summary of current research and literature related to mathematics in the preschool environment. Through the literature review, a common theme emerged stating that mathematics at the preschool level goes beyond providing opportunities to practice rote counting and number recognition. It involves a delicate balance between setting the stage for natural exploration and play, intentional teaching opportunities, and providing structured learning activities for students through games, movement, literature, and parent involvement to further a child's understanding of number sense. Chapter three further addresses the research question "*What strategies can be used to increase number sense at the preschool level?"* by describing the setting, the participants, the curriculum design, and the major goals and rationale that are driving the development of this capstone curriculum. A summary of the learning outcomes, assessment procedures, and data collection methods will also be provided in this chapter.

Participants and Classroom Setting

This curriculum was designed for children who attend a preschool program located within a first tier suburb of a large metropolitan city in the Midwest and are run by the school district's community education department. These preschool programs are inclusive programs that support children with diagnosed disabilities and developmental delays alongside their peers who are typically developing. Classes meet two to four days per week for two hours and thirty minutes per class day. One third of the students have

been placed in the program as part of their Individualized Education Program (IEP) to address their developmental delays and special education needs. For these students, their tuition is paid for by the district and special education support is provided in that setting. For the remaining two thirds of the students, their parents have chosen the program for their child and pay the tuition associated with the program.

Classrooms consist of fourteen children, one regular education teacher, one regular education assistant, and one special education paraprofessional for the entire class period. The students range in age from three to five years old and come from a variety of racial, ethnic, and linguistic backgrounds. Approximately twenty five percent are income eligible for free or reduced lunch. For some students, this will be their first classroom experience. For the students who receive special education, their support is provided through an itinerant model by an early childhood special education teacher, speech language pathologist, and paraprofessional. The amount of time that these professionals are in the classroom is driven by the student's Individualized Education Program (IEP) and is dependent on student need.

Curriculum Design and Framework

The goal of this curriculum capstone will be to provide research based learning activities related to number sense in an inclusive classroom setting where students from a variety of developmental levels and learning styles can participate. The activities that will be provided through this curriculum capstone are meant to supplement the school's numbers and math portion of the *Get Set For School* curriculum that has recently been adopted by the special education classrooms in this particular district (Olsen & Knapton, 2011). This curriculum capstone and the *Get Set For School* curriculum offers a

multisensory approach to learning through a variety of hands on learning activities. Although the Numbers and Math portion of the *Get Set for School* curriculum provides activities related to a broader selection of math concepts, this capstone will focus primarily on providing activities around quantity, number sense, and counting.

The activities designed in this capstone will be implemented by any of the professionals in the classroom during a variety of activities including small group learning centers, circle time, one to one instruction, transitions, free choice, and through parent - child activities that can be carried out in the home. In addition, these activities are meant to be used repeatedly and may need to be adapted to align with the current theme, student interest, and classroom focus. This repetition is, in part, due to the age of the students and the need for multiple opportunities to learn and practice skills that both typically developing preschool children and children with developmental delays often require. The use and timeline for these activities may change from class to class depending on a variety of factors including student progress, student interest, and learning style. As a result, the use of anecdotal data, ongoing assessments, parent/teacher report, and student affect will need to be closely monitored and documented.

The framework of this curriculum will follow Grant McTighe and Jay Wiggins' Understanding By Design (UbD) model (2011) for curriculum planning. The Understanding by Design model is an educational resource for curriculum planning where the major goal is to teach in a way that students not only make personal connections to the learning, but transfer their learning to a variety of contexts. McTighe and Wiggins' Understanding by Design (2011) takes the stance that you cannot plan an effective curriculum if you don't have clear outcomes established. Through the

Backwards Design model, educators move through three stages of planning. The first stage involves clearly defining the learning outcomes of the unit and establishing "desired results" (McTighe & Wiggins, 2011). In this stage, educators are formulating essential questions of what the student will understand once the unit is completed. The second stage moves into defining what assessment procedures are needed in order for educators to know if their students are making progress and if the targeted outcomes are achieved. Lastly, the third stage of the Backwards Design Model will define the learning plan including what lessons will be taught, the sequence of those lessons, and other resources that will be used to help students achieve mastery. You can find this capstone's completed copy of the Understanding by Design Unit Planning Design Template in Appendix B.

McTighe and Wiggins' Understanding by Design curriculum framework will allow me to carefully and thoughtfully sequence unit activities using a variety of research-based strategies with clearly defined learning outcomes and goals. Within the Understanding by Design framework, I plan to develop and use lessons and activities that address early childhood students' number sense at various stages of development. These lessons and activities will be utilized for students across six ability levels, starting with pre-counters and moving towards being proficient at counting to ten. In addition, extension activities will be provided to encourage parents to engage in their child's learning out in the community and in the home. Through this capstone, I will be able to further address the research question "*What strategies can be used to increase number sense at the preschool level* ?".

Learning Outcomes

The learning outcomes of this curriculum capstone will align with the *Minnesota Indicators of Progress* related to number concepts and operations for preschool students. The following standards listed below are found on page 44 of the *Minnesota Indicators of Progress* booklet and focus on cognitive skills related to mathematics and logical thinking (MDE & MDHS, 2005).

- Demonstrate increasing interest in and awareness of numbers and counting
- Demonstrate understanding of one-to-one correspondence between objects and number
- Demonstrate ability to count in sequence
- Demonstrate ability to state the number that comes next up to 9 or 10
- Demonstrate beginning ability to combine and separate numbers of objects

These number skills typically occur at the three to five year old age range, however, some of the activities and lessons in this capstone will address precursor math skills for children who are demonstrating skills at the eighteen to thirty-six month level due to their developmental level. It is important to note that the standards listed in the table below show skills that children develop between the ages of three to five years with the skills listed below developing around the age of four. Because of this, they are intentionally broad.

Data Collection Methods and Assessment Procedures

A variety of qualitative and quantitative data collection procedures will be used in this curriculum capstone in order to measure progress and assess if the targeted outcomes were achieved. Quantitative data is comprised of information that can be measured, deals

with quantity, and can be written down as a number (i.e. test score, percentage). Qualitative data measures deal with descriptions, involve data that has been observed and not measured, and involves quality of skills. Because of the age and developmental level of the students that this curriculum is designed for, including both quantitative and qualitative measures becomes essential.

Quantitative data will be collected through the administration of the Individual Growth and Development Indicators of Early Numeracy [IGDIs-EN] (Hojnoski & Floyd, 2004) . The IGDIs – EN is a comprehensive assessment of early numeracy skills used for monitoring young children's mathematical knowledge, growth, and development. This assessment tool looks at a student's early mathematics and number skill acquisition by assessing the following skills; Oral Counting, Number Naming, Quantity Comparison, and One-to-One Correspondence. This assessment procedure will be done individually three times per year, once in the fall (Sept - Oct), winter (Jan), and once in the late spring (May).

Qualitative measures will include completing the *Get Set for School* Numbers and Math Observation Checklist three times per year (Olsen & Knapton, 2011). The numbers and math observation checklist looks at numeracy skills related verbal counting in sequence, one to one correspondence, making a set of objects, matching numbers to quantities, writing numbers, and using mathematical strategies to share (i.e. one for you and one for me). This checklist also looks at other facets of mathematics including sorting and comparing by attribute, building with blocks, completing puzzles, and use of position and sequence words. The Numbers and Math Observation Checklist uses the following criteria to assess the skills listed above: early emerging, growing, and meets

expectation and is meant to be used as an observation tool rather than administered in a one on one setting.

The Numbers and Math Observation Checklist will use anecdotal data related to a student's counting and number sense skills that is observed naturally throughout the day. It will also include targeted anecdotal data related to a student's that is elicited during classroom routines, play, and group activities. The observational and elicited data gathered will reflect each student's level of engagement, participation, and performance in structured math games and activities. In addition, examining play choices, generalization of mathematical concepts, spontaneous use and integration of math concepts into play, opportunities for peers interactions and peer coaching related to number sense, and response to intentional teaching opportunities during free play will be included in the anecdotal and observational data as part of this research plan.

I believe that both qualitative and quantitative data have their place in the preschool classroom. Both have merit in assessing the mathematical knowledge of preschoolers and will afford me the opportunity to better interpret and understand what my students are able to do both formally through one to one assessments and informal ways through observation and anecdotal data collected throughout daily routines. An analysis of qualitative and quantitative data will allow me to have a more comprehensive and thorough investigation of my student's response to the lessons and activities that have been created for this capstone curriculum.

Conclusion

This chapter provided an overview of the curriculum designed to address the need for high quality, developmentally appropriate mathematics at the preschool level. A

description of the setting, participants, curriculum framework, data collection methods, and assessment procedures was described as well as what the targeted outcomes are for this curriculum capstone. Chapter four will provide an in-depth description of the three Understanding by Design stages of curriculum planning as it relates to this capstone's research question "*What strategies can be used to increase number sense at the preschool level?"*. The latter portion of chapter four will summarize the learning plan including how these lessons and activities will be used across developmental levels. In addition, chapter four will discuss any connections to the literature reviewed related to the instructional strategies that will be used in this study as well as how the Understanding by Design supports this capstone's curriculum development.

CHAPTER FOUR

RESULTS

Introduction

The previous chapter gave an overview of the setting and participants, methods and assessment procedures, and framework used to develop this curriculum capstone. Chapter four will continue this capstone's journey by providing an explanation of the curriculum designed to support children's understanding of numeracy at the preschool level and further address the research question "*What strategies can be used to increase number sense at the preschool level*?". Lessons and activities summarized in this chapter are supported by the notion that young children are naturally inquisitive and learn best when given a variety of hands on activities that allow them to explore and learn through experiences in their daily routines.

This capstone is a synthesis of learning activities that are based on instructional strategies supported by chapter two's literature review and organized in a framework using McTighe & Wiggins' three stage Understanding By Design model for curriculum design created by introduced in chapter three (2011). The activities are meant to supplement my school's current curriculum and focus primarily on embedding numeracy into regular classroom routines. Building stronger numeracy skills is not something that can be done in a six-week unit. It takes time, practice, and regular opportunities in a child's daily routines in order to support children's understanding of numbers and how numbers can be meaningful to them. As a result, these activities are designed to be used repeatedly as well as can be adapted and expanded based on student need and

developmental level throughout the school year.

In chapter three, I gave a brief overview of the Understanding by Design framework and how it focuses on the need for having a clear outcome or goal and then working backwards to map out a sequence of lessons and activities to achieve that outcome. This curriculum planning tool coupled with clearly defined developmental levels is a good fit for the curriculum planning that occurred as the result of the capstone. Because I work in the field of special education, analyzing student needs and present levels of performance as well as determining progress made is an individualized and in depth process. This process often takes specific skills that students are struggling with and breaks those skills into smaller outcomes or benchmarks. Activities and lessons that are set up to address those specific outcomes need to have a clear end result. Knowing that numeracy skills develop in a predictable sequence, mapping out the skills needed to work towards a goal becomes just as important as the starting point of those skills. Because of this, I chose to embed the six stage model of cardinality (the ability to answer how many) within the Understanding by Design framework by organizing activities based on a student's developmental level related to being able to answer the question of "How many?"

This chapter will be broken down into the three Understanding by Design stages. I will begin with a summary of the first stage, describing the desired results, outcomes, and learning goals of this curriculum. From there, I will describe the second stage where the focus will be on explaining how progress will be assessed and measured. Lastly, I will summarize the third and final stage of the Understanding by Design curriculum design with lesson and activity ideas that will be used to increase numeracy at the

preschool level. It is in this final stage that I will show how the six-stage model of cardinality can be used to organize lessons and activities within this curriculum. As I summarize each stage of the Understanding by Design's framework, I will also discuss how using this tool supports my exploration of the research question "*What strategies can be used to increase number sense at the preschool level*?".

Understanding by Design's Stage One - Desired Results

The desired results of this capstone curriculum will align with the "Number Concepts and Operations" benchmarks established in the *Minnesota Indicators of Progress Manual* (MDE & MDHS, 2005, p. 44). *The Minnesota Indicators of Progress* includes outcomes related to skills and procedures as well as outcomes related to interest and motivation. These outcomes involve helping students understand rules, procedures, and skills related to numeracy as well as building stronger connections to numbers and increasing interest in math related activities. Through the implementation of this supplemental curriculum, it is my intention that my students will increase their interest in and awareness of numbers and counting, increase their understanding of one to one correspondence between objects and numbers when counting, demonstrate an increase in their ability to count in sequence, demonstrate an ability to state the number that comes next up to 9 or 10, and demonstrate a beginning ability to combine and separate numbers of objects. In addition, activities will focus on demonstrating an emerging understanding of the following skills related to numbers and operations:

- There is a predictable sequence that doesn't change when counting
- There is a number word and a matching symbol that tell how many items are in a set
- One to one correspondence - count one object for each object they point to

- Cardinality - know that the last number they say when counting a set of items is the total number of objects
- Stability - know that the number in a set of objects doesn't change even if you rearrange the objects
- Subitizing - know how many objects are in a set without actually having to count the objects

The Understanding by Design curriculum design tool supports having outcomes related to skills and procedures however also focuses heavily on "big ideas" and building connections between the content and the student (McTighe & Wiggins, 2011, p.3). The indicators listed above are important and foundational skills that preschoolers need to understand and learn in order to be ready for K – 12 mathematics, however, there is more to mathematics than numbers and rules. Initially, when using the Understanding by Design tool, I found it difficult to identify anything other than a discreet set of skills as my desired outcomes. This tool challenged me to go beyond a set of skills and benchmarks as the end result to include activities that will focus on helping students find joy in mathematics. My goal moved to also include increasing my student's interest, confidence, and deeper understanding of number concepts rather than the obvious skills that we gravitate towards when we think about mathematics. It was through this curriculum planning that I came to realize the importance of helping children move past rote counting and memorization to a place where they bring math into their play, learning, and discovery throughout all parts of the day.

Understanding by Design's Stage Two – Assessment Evidence

The Understanding by Design model describes stage two as the stage where you

gather evidence that your students have met the established goal. It is in this stage that McTighe and Wiggins (2011) suggest that you "think like assessors" when deciding if your students have successfully met the outcomes defined in stage one (p. 48). They caution educators that you must go beyond assessing a discreet set of skills and move towards looking at a student's ability to explain what conclusions they have drawn as well as if they are able to apply their learning to new situations. In stage two, educators must take extra steps to assure that they are assessing for understanding versus assessing for content acquisition through defining key criteria, performance tasks, and gathering other evidence (Wiggins & McTighe, 2011).

In order to assure that my students are progressing towards increasing their understanding and use of number concepts, quantitative and qualitative data collection methods will be used. As mentioned in chapter three, I will complete the Individual Growth and Development Indicators of Early Numeracy (IGDIs-EN) three times per year with each student (Hojnoski & Floyd, 2004). The IGDIs – EN will allow me to assess my student's rote counting, counting using one to one correspondence, ability to identify numbers, and comparing quantities. This assessment takes approximately fifteen minutes per student and is done individually. The IGDIs provides me with a systematic way to monitor progress on a regular basis.

The data gathered via the IGDI's will give me objective, skill oriented information although it only demonstrates one facet of my student's learning. The qualitative measures that I will be using will also give me valuable information on the depth of my students understanding of numeracy and whether my students are able to transfer their learning to new situations. This in depth understanding tends to be more

difficult to document and will likely involve some time and preparation to ensure that all teaching staff in a classroom are aware of the data collection methods, key criteria, and concepts that are being assessed. In order to bring my teaching team together to address this need, at least one of our team's weekly staff meetings in the beginning of the year will be dedicated to reviewing this. Qualitative data is a valuable tool at this age because most learning at the preschool level centers around process not product.

Qualitative data will be taken through the completion of a variety of data collection methods. First, the *Get Set for School* "Numbers and Math Observation Checklist" will be completed at least three times per year (Olsen & Knapton, 2011). This checklist looks at verbal counting in sequence, one to one correspondence, making a set of objects, matching numbers to quantities, writing numbers, and using mathematical strategies to share (i.e. one for you and one for me). This checklist also looks at other facets of mathematics including sorting and comparing by attribute, building with blocks, completing puzzles, and use of position and sequence words. The information needed through the Numbers and Math Observation Checklist will be gathered as observational anecdotal data throughout the classroom's daily routines.

This spontaneous and targeted anecdotal data will be supported through the completion of an ongoing data sheet completed and reviewed monthly (see Appendix C). Spontaneous anecdotal data will allow me to take skills that are observed and documented as well as are observed naturally in a child's play and exploration in the classroom. Targeted anecdotal data will allow me to take data that is elicited through questioning, modeling, or coaching during classroom activities. This data sheet is a simple tool that I have used for data collection in the past and have found it successful in

monitoring who I have taken data on and what skills have been documented or need to be documented. All teaching staff will have access to this data collection tool and will be able to document skills they have observed/assessed throughout the class day. Data of particular interest to me will involve looking at a student's level of engagement in math related activities and response to intentional teaching opportunities during free play as well as examining their play choices and how they use and integrate math concepts into play.

Understanding by Design's Stage Three – Overview

Stage three of McTighe and Wiggins' Understanding by Design model brings me to the final leg of this capstone's journey of curriculum planning and design. It is at this point in the process that I can discuss the lesson plans and activities designed to address my research question, "*What strategies can be used to increase number sense at the preschool level*?". The literature review in chapter two of this capstone equipped me with knowledge of how young children learn, how math skills progress and grow, and what strategies can be used to maximize my student's learning potential. It is here that I can take that knowledge and apply it to mapping out the learning plan, organizing the activities based on the developmental progression of number sense, and aligning the activities with the desired results of this capstone's curriculum.

McTighe and Wiggins suggest that stage three needs to move beyond activity oriented lesson planning, focusing primarily on whether or not the activity is fun and engaging (2011). They also caution against lesson planning that is "heavy on content coverage where the focus becomes covering all of the content at the expense of in depth learning" (McTighe and Wiggins, 2011, p. 9). The backwards design helped me to steer

away from content and activity focused planning and move towards developing learning plans that align with the assessment evidence from stage two and the desired results that were initially defined in stage one. Again, McTighe and Wiggins (2011) push teachers in this stage of curriculum planning to measure success and achievement based on whether their students have "transfer, meaning, and acquisition of the content learned" (p. 17). For me, transfer, meaning, and acquisition will take the form of my student's being able to generalize their learning to a variety of activities in a variety of contexts. I will be looking for this type of learning in the spontaneous and targeted anecdotal data that will be taken. I anticipate that this data will require more time, planning, and ongoing investigation as it isn't always easily elicited and can be difficult to observe due to the amount of activity going on in the classroom.

Sequence of Activities Across Developmental Levels

The learning plan that will be used for this capstone curriculum is organized across developmental levels and includes a sequence of activities using the following instructional strategies summarized in chapter two's literature review: rhythm, music and movement, using games to teach math concepts, introducing and reinforcing math concepts through literature/picture books, parent involvement, intentional teaching and play, and embedding math concepts into daily routines. These lessons and activities are arranged across developmental levels of how children grow to understand the concept of cardinality. The skill of being able to answer the question of how many follows a predictable sequence of development and is fundamental to the development of number sense. Introduced in chapter two of this capstone was the article "Help! They Still Don't Understand Counting!" written by Faith Sadler. This article includes a table, description,

and suggested activities that focus on how children gain an understanding of cardinality through six clearly defined stages (See Appendix A). I chose to use her description of the stages of cardinality summarized in the article for three important reasons: cardinality is fundamental skill as it relates to number sense, cardinality develops in a predictable and clearly defined sequence, and this predictable sequence of skill development allows me to pinpoint exactly where my student's skills are at. This six-stage model provides a clear progression of number sense that will guide the lesson planning process.

The remainder of chapter four will be dedicated to describing the focus of my lesson plans and activities across the six developmental levels of cardinality. Sadler has named these six levels as follows: precounters, reciters, corresponders, immature counters, rigid rule followers, and counters (2009). Each developmental level will include a brief description of what the abilities are for a child at that level as well as the types of lessons that would be appropriate for children at that level. Many of the activities and instructional strategies that will be used in this capstone's learning plan are appropriate at multiple levels and when appropriate, a description will be included as to how the activity will be expanded or adapted to meet the needs of a wider range of skill levels. Because the skills for each of the six stages of cardinality often overlap, I chose to reference the appropriate lessons found in the appendix of this capstone by combining activities for precounters and reciters, for corresponders and immature counters, and for rigid rule followers and counters.

In-depth descriptions of each of the lesson plans and home connection activities are found in Appendix D and Appendix E of this capstone. These lesson plans include a description of the math concepts and objectives of the activity, an explanation of how to

carry out the activity, key points to remember, ways to extend the activity, ways to involve parents, and picture books that can be incorporated into the lesson. The "Math at Home" parent connection activities that accompany many of the lessons in this capstone include a brief description of how to carry out the parent- child activity at home, internet resources that support the objective of the activity, ways parents can extend the activity, and materials needed. A list of internet resources and a list of number related picture books for preschoolers can be found in Appendix F and Appendix G. In addition, the completed Understanding by Design template in Appendix B has the recommended lesson plans and parent connection suggestions separated by the appropriate developmental stages.

Stage I - Activities for Precounters

Children at this stage are unable to correctly answer the question of how many. These children are typically around the age of one to two. Referred to as "precounters", these children are at the stage where they are able to give a number name, however, it is often just a guess. They know to answer the question "how many?" with a number, however, they do not yet have a sense of counting in correct sequence. Pre-counters need to be able to recognize small quantities of one and two before moving to the next stage.

Important activities for young children at this stage of learning should focus on helping them learn to associate number words to quantities and begin the skill of verbal counting in sequence. Sadler (2009) suggests that activities should include rote counting through songs and chants using rhythm and movement as well as beginning matching and sorting games involving quantities up to three (Clements & Sarama, 2014; Sadler, 2009). In addition, Sadler suggests that working on helping children understand the concept of

"each" through activities such as having a student give each person one cup at the snack table or each baby a bottle in the dramatic play area. Both Sadler (2009) and Clements and Sarama (2014) suggest that teachers should set up opportunities for practicing subitizing (i.e. tell how many objects are in a set without actually counting the objects) for quantities up to three as well as providing non-examples of quantities up to three. It becomes important, primarily due to the developmental level of children at this stage, for educators to provide experiences in multiple contexts and through rich, sensory experiences embedded into children's daily routines (Clements & Sarama, 2014).

Stage II - Reciters

Children at stage II, known as "reciters", are able to respond with a number word sequence, but are not yet using the skill of one to one correspondence (pointing to each item as they count). These two to three year olds are excited to recite number names but often have a very basic and concrete understanding of numbers. They begin to understand the concept of more in the general sense as well as demonstrate an understanding of the quantities of one and two. Gaining an understanding of the quantity of three can be challenging at this stage in that there are far more examples of two for young children than there are of three. They have two eyes, two feet, one head, two arms, two shoes and so forth (Dacey & Collins, 2011).

Like Stage I, activities at this stage should focus on the helping them learn to associate number words to quantities and begin the skill of verbal counting in sequence. Clements and Sarama (2014) suggest "using number words (one through five) and demonstrating how many using motions or holding up fingers in every opportunity that makes sense" (p 13). Verbal counting activities in sequence should involve tagging the

number word with an action, using large motions at first (i.e. stomping feet, clapping hands, tapping head) and then move to smaller motions (i.e. sliding or pushing objects aside as you count). Eventually you can move to just pointing to each object as you count (Sadler, 2009).

Lessons one through six (Bear Hunt, Count and Move, Crocodile Down by the Lake, Rhythm Stick Follow the Leader, Animal Picnic, and Using Songs, Fingerplays, and Chants) found in Appendix D of this capstone are most appropriate for children who are precounters and reciters. The accompanying "Math at Home" parent connection activities listed with each of the lesson plans, the parent connection letters named, "Math Talk" and "Count and Move", and the list of "Internet Resources" from Appendix F are appropriate for children who are at the precounting and reciting stages. These resources can be found In Appendix E and F.

Stage III - Corresponders

Stage III learners, typically around the age of three, are able to answer the question of how many for smaller quantities but have to recount the set of objects. In this model, stage III learners are referred to as "corresponders" because they are more apt to count using one to one correspondence. They are now verbally counting to ten and tend to double count or skip numbers when counting using one to one correspondence for higher quantities.

Activities that are important at this stage of learning should focus on more practice with the concept of cardinality. This can be accomplished through modeling and using the phrase "how many" frequently. Sadler (2009) suggests that teachers should continue to offer "many opportunities to model counting and when counting a set of

items, to repeat the last number said and pair it with a motion to emphasize that the last number said *is* the answer to the question how many altogether" (p. 7). Because children are more verbal at this age, they are ready for their teachers to use questions and comments that encourage problem solving and critical thinking skills. Clements and Sarama (2014) suggest activities such as having a student practice making sets of three and four through games that encourage visual matching and subitizing. It is also important to continue to verbally count to ten using physical movement/actions whenever possible.

Stage IV - Immature Counters

The next stage, stage IV, is characterized by children who are now able to answer the question of how many with the last number they said when counting a set of objects. Children at this stage now see the significance of the last number said when counting however they are still immature counters and may count objects more than once or skip an object. Children at this stage will benefit from teachers reminding them of strategies they can use to count accurately. Such strategies and prompting should include reminders to "start over", "start at number one", and "count slowly" as well as suggestions that will encourage accuracy such as using a common starting point they will remember when counting, lining up the objects before counting, or pushing them aside as they count (Sadler, 2009, p. 7). In addition, using a puppet to count a set of objects where the children have to decide if the puppet has counted the correct amount can be a fun and engaging activity for young children as well as can help students observe counting and explain what the puppet did wrong (Sadler, 2009).

Lessons one through six (Bear Hunt, Count and Move, Crocodile Down by the Lake, Rhythm Stick Follow the Leader, Animal Picnic, and Using Songs, Fingerplays, and Chants) continue to be important for corresponders and immature counters however including lessons seven through twelve (Let's Race, How Many?, Racing Cars, Create Your Own Classroom Counting/Number Book, Estimation Jar, Let's Make a Pizza, Let's Make a Collection) will also be effective. The lesson plans can be found in Appendix D and the accompanying "Math at Home" parent connection activities listed with each of the lesson plans can be found in Appendix E.

Stage V - Rigid Rule Followers

In Stage V, children are referred to as "rigid rule followers". These children know that the answer to the question "how many?" will always be the largest number in a counting sequence. They are beginning to show an understanding of the rules and patterns of counting. It is important to continue using the instructional strategies at the previous stages. However, as mentioned in the last stage, it is important to keep building in opportunities where the teachers are continuing to promote critical thinking, reasoning, and problem solving through questioning. This can help guide children to come to the correct solution or explain what they did wrong in their own words. At this stage of development, you can begin to introduce simple dice games, board games, and motor games as these young children are beginning to understand turn taking, rules in games, and can participate in group activities for short periods of time.

Stage VI - Counters

Children at Stage VI, are at a point in their development where they have the ability to monitor their counting as well as another's counting for accuracy. They can

now give the correct answer to the question of how many. You would typically see this skill emerge at the age of four for sets of one to five items and around the age of five for quantities up to ten. Although useful at previous stages, the use of dice games, board games, and motor games become even more important at this stage. Children are now at a point where they are more capable of taking turns with their peers, can sustain attention for the duration of a shorter board game, can understand and follow basic rules in a game, and are able to work cooperatively in a small group of peers. In addition, they are beginning to support each other's learning. Children at a higher level can model skills for children who are at the beginning stages, and they can work together to solve simple math problems rather than relying on support from the teacher.

Lessons one through six (Bear Hunt, Count and Move, Crocodile Down by the Lake, Rhythm Stick Follow the Leader, Animal Picnic, and Using Songs, Fingerplays, and Chants) continue to be important for rigid rule followers and counters however including lessons seven through twelve (Let's Race, How Many?, Racing Cars, Create Your Own Classroom Counting/Number Book, Estimation Jar, Let's Make a Pizza, Let's Make a Collection) will also be effective. The lesson plans can be found in Appendix D and the accompanying "Math at Home" parent connection activities listed with each of the lesson plans can be found in Appendix E.

Many of the previously listed lessons are appropriate and necessary for rigid rule followers and counters, but the focus will need to shift to working with higher quantities, smaller movements, and more cooperative play opportunities with peers using math concepts. In addition to the previous lessons, it's important to work on math concepts using turn taking games such as the games listed in lessons fourteen and fifteen. Lessons

fourteen and fifteen can be found in Appendix D and the accompanying "Math at Home" activities can be found in Appendix E.

Conclusion

This chapter provided a summary of the curriculum designed to support children's understanding of numeracy at the preschool level. The Understanding by Design three stage model of curriculum design provided the framework for describing the major outcomes, assessment procedures, and learning activities used in this capstone to address the research question "*What strategies can be used to increase number sense at the preschool level*?". Through this capstone, I have developed a deeper understanding of the curriculum planning and design process as it relates mathematics and early childhood education. Although I have not implemented this curriculum in its entirety, I am optimistic that it will have positive outcomes. I also expect that with any curriculum, it will need to be added to, adapted, and revised as the needs of my students change and my learning and experience as a teacher grows.

Chapter five, the final chapter of this capstone, will afford me the opportunity to reflect on the entire process of writing this capstone. From coming up with my topic to doing extensive and in-depth research on the current literature related to preschool mathematics to writing a supplemental curriculum meant to address my research question, I will reflect on the learning that I gained throughout this process as well as possible next steps that can be taken to implement and expand this curriculum. Furthermore, I will discuss the possible implications, limits and next steps of this curriculum including how this curriculum can benefit my students, other teaching staff, and the parents of the children I work with.

CHAPTER FIVE

CONCLUSIONS

Introduction

Through the entire process of this capstone curriculum, I have dedicated myself to answering the question "*What strategies can be used to increase number sense at the preschool level*?". From explaining how a young student by the name of Sophie had motivated me to find answers to why some children struggle with number sense to taking what the research is saying and putting it into a cohesive curriculum, this experience has been a journey to say the least. Because of this capstone, I have grown to understand how the history of mathematics instruction in the United States has evolved to include teaching mathematics at the preschool level as a viable option for increasing student achievement in later grades. I have learned about curriculum design and how having a strong framework is the first and most important step in creating a curriculum. In the final chapter of this capstone, I end my journey by summarizing my personal growth as a result of this process and possible implications and limits of this study as well as future research and next steps that can be done.

Personal Growth

As I mentioned in the paragraph above, this experience has been a journey, both professionally and personally. There were roadblocks along the way that prolonged this process and forced me to change my focus from an action research to a curriculum capstone. In the end, this turned out to be beneficial for me in that I was able to learn more about the Understanding by Design (UbD) framework and how it relates to

curriculum design and planning. Through this design process, I have moved from being an activity oriented planner to looking more at big ideas and long term goals first and then mapping out the lessons and activities that will follow in order to help my students achieve those long term goals. I realize that this is still something I need to work on and it will take time and experience using the UbD framework to make that shift happen in a more natural and streamlined manner.

The literature review that occurred as the result of this capstone alone has given me so much more to work with then I could have hoped. My learning curve through this process has been high however some of my fundamental beliefs about the development of young children have been supported several times over in the review of research that I did for this capstone. I have always placed a heavy emphasis on play, experiential learning, and intentional teaching as most influential in helping young children grow and learn and it is reassuring to see research supporting this. Every part of a young child's day is a teachable moment and this notion supports the research that mathematics should be built into a child's daily routines in order for them to build stronger connections. At this age, children are learning through exploration, repetition, and play. As Albert Einstein says, "Play is the highest form of research" and it is through play that we can tap into what a child understands and where they are struggling (Einstein in Kostelnik & Grady, 2009). I realize that careful planning related to the big ideas and desired outcomes of this capstone's curriculum can help promote optimal play and learning through the activities I create and can ultimately guide the exploration of my students. This line of thinking takes the notion of free choice as it relates to play to a level where my students do have a choice in what they play with, however I can still be in control of

what those choices are.

The literature review supported the use of play and intentional teaching as important and necessary avenues for learning however it also emphasized certain strategies that can be used to encourage and foster learning on a deeper level. The literature review taught me that it is important and necessary to use instructional strategies within math activities involving rhythm, music and movement as well as using literature/picture books to introduce and reinforce math concepts can have a significant impact on the connections that children make. In addition to the instructional strategies mentioned above, parent involvement will also play an important role. For our youngest learners, number sense is heavily influenced by experience. This fact alone is reason enough to build in more time and opportunities that promote parent involvement as it can also have an impact on my student's understanding of number concepts.

The literature review also showed me that numeracy develops in a predictable sequence. The six stages of cardinality that I referenced in chapter four has provided me with a clear scope and sequence of how children gain a beginning sense of numeracy. These stages can easily be incorporated into the assessment of my student's abilities, giving a clear point of reference as I track their growth and development. Such clarity provides a well-defined path that can aid in the use and effectiveness of this curriculum. Additionally, these stages can be extremely beneficial for writing IEP goals and objectives for some of my students with special education needs who struggle with basic number sense.

One of the most startling revelations for me as a result of this literature review was the fact that mathematic ability at the preschool level is one of the best predictors of

future academic performance (Szekely, 2014). This alone justifies the need for high quality mathematics at the preschool level. I presume that many early childhood educators don't realize the impact that high quality math instruction can have on their student's future school success. Mathematics continues to be underrepresented when compared to literacy instruction in the preschool classroom, with time spent on literacy activities being two to three times more (Szekeley, 2014). Knowing this will definitely impact the frequency, quality, and depth of the math instruction I provide. Furthermore, this will keep numeracy at the forefront of my mind when I am working with parents and teaming with other staff in the classroom.

Limits, Implications, and Next Steps

As with any research project, there are positive outcomes and possible limitations that can affect its overall effectiveness. I can say, without a doubt, that the knowledge gained as a result of this research capstone is already having a positive effect on how I teach. These positive changes are something that can't be written down in a lesson plan or unit, but rather show through in how I teach, what I teach, and how I involve parents in the curriculum. I place more value on deeper learning and transferring skills across settings, working hard to tie lessons together in a more meaningful way.

As with any curriculum, adaptations will need to be made based on student need, interest, and ability and I anticipate that I will encounter some obstacles along the way. One of the biggest obstacles I foresee in this curriculum is related to the fact that at the early childhood level, mathematical knowledge is heavily related to experience. With a child's mathematical ability correlating to the amount of time they are exposed to mathematics throughout their day, parent involvement becomes crucial. This is a

struggle that all educators face regardless of grade level or discipline. This curriculum attempts to involve parents, however, there are roadblocks that can make that difficult. Sending my students home with activities that they can do with their parents can be impacted by factors that are somewhat out of my control. Families are increasingly busy and many may not have the time to complete these types of activities with their children. Other things to consider are whether or not the parent's educational level will allow them to understand the activity and have the ability to extend their child's learning to meet the objective of the activity. Furthermore, these home activities are written in English. For families that do not speak or read English, home activities written only in English are not effective unless I can pair these activities around open house/parent nights, home visits, and conferences where a brief explanation or demonstration can be given. In addition, there may be other cultural implications related to the lesson itself and the materials used that I may not be aware of. Ideally, I would hope to incorporate at least one numeracy activity during the monthly hour long "stay and play". These stay and play activities provide a great opportunity to introduce parents to a range of math activities that they can implement at home.

Another obstacle that I ran into when creating this curriculum was finding effective lessons that meet the needs of students at a variety of skill levels. This is not a new challenge to me and I would venture to say that most educators, regardless of grade level, encounter this with every new group of students they have. Working in the area of special education lends itself to planning for children who have a wide range of needs. Additionally, I am an itinerant special education teacher who supports students in their regular education environment. Creating lessons for a group of students in a classroom

where I am not the lead teacher has its own set of challenges. I found that I had to prioritize activities based on feasibility and accessibility thus limiting the scope of the lessons planned.

I also had to come to terms with the fact that number sense is not the only skill area that I work on. When I am in a classroom for a limited amount of time, it can't always be my priority. This leads me to another obstacle that has the potential to lead to possible next steps with this curriculum. Because I am supporting groups of students in a two to three different classrooms and home visits, my instructional time is limited. Of course I address other areas of need, but often times my focus needs to be related to IEP goals and objectives. Over the years, I have come to value the time I get to plan and collaborate with my teams. Planning time with the regular education teacher, assistant teacher, and support staff, although limited, can provide a wonderful opportunity to share this curriculum with other educators who work with the same students I work with. I have already shared strategies and resources gained as a result of the research I did for this capstone. I see so much potential in sharing what I have gained with others through the teaming process as it relates to the students that we share.

Beyond my immediate classroom instructional teams, I hope to share the strategies and resources with my colleagues and related service counterparts within my district. There are resources cited in this capstone that I feel would be of particular interest to other early childhood special education teachers, early childhood family education teachers, and community preschool teachers. Resources such as the "Stages of Cardinality" from Faith Sadler's article "Help! They Still Don't Understand Counting" provides a scope and sequence of the progression of number sense. This article also

offers simple and concrete counting strategies that can be used to support children who are struggling with basic numeracy skills (Sadler, 2009). *The Learning Trajectories Approach* written by Douglas Clements and Julie Sarama is another resource that I plan to share as it offers a variety of lesson plan activities and the research that backs those activities up (Clements & Sarama, 2014). The sharing of these resources would best be done through our district late starts, faculty meetings, or staff development training where I can touch on key points from this capstone. In addition, having a printed copy of this capstone available may also be of benefit to other instructional teams as there are many resources cited and lesson plans that are pertinent to a variety of children. Being able to provide my colleagues with the knowledge I have gained through this capstone can have a positive impact on mathematics instruction at the early childhood level in my district.

Future Research

As the push for high quality mathematics continues to filter down into early childhood education, more research will be done and new instructional strategies will surface. One area of particular interest to me that I hope to explore in the future relates to what, if any, cultural factors can have an impact on a child's mathematical development. I find myself wishing I had more time to discuss each family's beliefs and experiences related to education as well as the traditions and daily routines that might impact their child's learning. Julie Sarama and Douglas Clements have included some research related to implications and the teaching of mathematics in their book *Early Childhood Mathematics Education Research: Learning Trajectories for Young Children* (2009) however they recognize that more research is needed. Because I work in a school that has at least 20% of its population being culturally diverse and English Language

Learners, exploring cultural factors and family beliefs as it relates to the students I work with becomes increasingly important. I strive to provide instruction that supports a child's culture however I always feel like there is so much more to learn. Spending time discussing with parents ways they incorporate math and other areas of development into their daily routines will be valuable information as it relates to my students. Additionally, exploring specific research about math instructional practices around the world can provide further insight into other country's best practices in education.

Conclusion

As I wrap up this capstone process, I can't help but think back to a paragraph in chapter one where I wrote, "I hope to increase my capacity to teach basic numeracy skills in a manner that is intentional, engaging, promoting each one of my students to be active learners and future problem solvers in the area of mathematics." I can honestly say that although this may have been a lofty goal, I have, at the very least, increased my capacity to teach basic number sense. It became apparent quickly in the research process that mathematics at the preschool level goes beyond providing opportunities to practice rote counting and number recognition. When I chose the research question, *"what strategies can be used to increase number sense at the preschool level?"*, I didn't expect to experience the growth that I have. As I mentioned before, my learning curve has been high and I feel I have pushed myself to become a more insightful writer, researcher, and most importantly, educator. It is my hope that I can add to this curriculum as I continue to explore its effectiveness with the students I work with as well as share what I have learned with other teaching staff in my district.

REFERENCES

Aber, L. (2002). *Grandma's button box*. Kane Press: New York, NY.

An, S. A., Tillman, D., Shaheen, A., & Boren, R. (2014). Preservice teachers' perceptions about teaching mathematics through music. *Interdisciplinary Journal of Teaching and Learning*, 150

Anderson, A., Anderson, J., & Shapiro, J. (2004). Mathematical discourse in shared storybook reading. *Journal for Research in Mathematics Education*, 5-33.

Bermejo, V. (1996). Cardinality development and counting. *Developmental Psychology, 32*(2), 263.

Burack, J. (2005, August 1). Uniting mind and music: Shaw's vision continues. *American Music Teacher,* 55 (1): 84 – 87.

Calitri, S. (2003). *There were ten in the bed.* Scholastic Incorporated: New York, NY.

Carle, E. (1997). *From head to toe.* Harper Collins Publishers Incorporated: New York, NY.

Carter, D. (2006). How many bugs in a box. Little Simon: New York, NY.

Charles, F. (2012). *The selfish crocodile book of numbers.* Bloomsbury Publishing: London, UK.

Claessens, A. & Engel, M. (2013). How important is where you start? Early mathematics knowledge and later school success. *Teachers College Record* 115(6), 1-29.

Clements, D. H. (2001). Mathematics in the preschool. *Teaching Children Mathematics*, *7*(5), 270-75.

Clements, D. H., & Sarama, J. (2014). *Learning and teaching early math: The learning trajectories approach.* (2nd ed). Routledge: New York, NY.

Crews, D. (1995). *Ten black dots*. Greenwillow Books: New York, NY.

Dacey, L., & Collins, A. (2011). *Zeroing in on number and operations, pre-K-K: Key ideas and common misconceptions.* Portland, ME: Stenhouse Publishers.

Dowdy, P. (2008). Estimation. Crabtree Publishing: Ontario, Canada.

Epstein, A. S., (2007, Feb 19). Intentional teacher. Retrieved from

http://www.highscope.org/Content.asp?ContentId=279.

Fiske, E. (1988). Schools' back-to-basics drive found to be working in math. *The New York Times.*

Flevares, L. M., & Schiff, J. R. (2014). Learning mathematics in two dimensions: a review and look ahead at teaching and learning early childhood mathematics with children's literature. *Frontiers in Psychology*, *5*, 459. http://doi.org/10.3389/fpsyg.2014.00459

Giganti, P. (1994). *How many snails a counting book*. Greenwillow Books: New York, NY.

Golden, L. (2012, Apr 12). Children's literature in mathematics instruction. *Library Media Connection*; Retrieved from http://smkms.pkgbatupahat.com/journals/jurnal%20matematik/Jurnal%20Mathematic/CHILDREN'S%20LITERATURE%20IN%20MATHEMATICS%20INSTRUCTION.pdf

Greenberg, J. (n.d.). Support math readiness through math talk. Retrieved from http://families.naeyc.org/learning-and-development/music-math-more/math-talk-infants-and-toddlers

Gupta, A. (2009). The interesting connection between math and music. The Vancouver Sun.com. Retrieved from http://www.vancouversun.com/Entertainment/interesting+connection+between+math+music/1473881/story.html

Hachey, A. C. (2013). The early childhood mathematics education revolution. *Early Education & Development*, *24*(4), 419-430.

Hill, E. (2003). Spot can count with blocks. Warne Publishing: London, UK.

Hines, A. (2008). *1 2 buckle my shoe.* Houghton Mifflin Harcourt: Boston, MA.

Holub, J. (2001). *The pizza that we made.* Penguin Publishing: New York, NY.

Hojnoski, R. & Floyd, R. (2004). *Individual growth and development indicators of early numeracy (IGDIs-EN).* Early Learning Labs, Inc: St. Paul, MN.

Huber, L. L., & Lenhoff, R. S. (2006). Mathematical concepts come alive in pre-k and kindergarten classrooms. *Teaching Children Mathematics*, *13*(4), 226.

Jordan, N. C. (2007). The need for number sense. *Educational Leadership*, *65*(2), 63.

Kells, D. (n.d.). The impact of music on mathematics. Retrieved from

http://media.kindermusik.com/docs/PDF/Kindermusik_Benefits_Music_and_Math_3_to_5_FullResearch.pdf

Klein, D. (2003). A brief history of american K-12 mathematics education in the 20th century. *Mathematical Cognition,* 175-225.

Kostelnik, M. & Grady, M. (2009). *Getting it right from the start. A principle's guide to early childhood education.* Corwin Publishers: Newbury Park, CA.

Kramer, J. (n.d.). Alligator or crocodile circle time fun. Retrieved from http://www.makinglearningfun.com/themepages/CrocodileCircleTimeFun.htm

Krebs, L. (2004). *We all went on safari.* Barefoot Books: Cambridge, MA.

Lee, J. S., & Ginsburg, H. P. (2007). What is appropriate mathematics education for four-year-olds? Pre-kindergarten teachers' beliefs. *Journal of Early Childhood Research*, *5*(1), 2-31.

Leslie, D., Audrain, A., Bell, J., Bell, M., & Brownell, J. (2008). *Everyday mathematics teacher's guide to activities pre-k.* Wright Group/McGraw Hill: Chicago, IL.

Leslie, D., Audrain, A., Bell, J., Bell, M., & Brownell, J. (2008). *Everyday mathematics math masters pre-k.* Wright Group/McGraw Hill: Chicago, IL.

Linder, S., Powers-Costello, B., & Stegelin, D. (2011). Mathematics in early childhood: research-based rationale and practical strategies. *Early Childhood Education Journal*, *39*(1), 29-37. doi:10.1007/s10643-010-0437-6

Lodge, J. (2010). *1, 2, 3, Snap a mr croc book about numbers*. Hodder Children's Books: London, UK.

Maccarone, G. (1994). *Pizza party*. Cartwheel Books: New York, NY.

McDonald, A. (2013) 31 Counting books for kids. Retrieved from http://www.notimeforflashcards.com/2013/06/31-counting-books-for-kids.html

McGrath, B. (2012). *Teddy bear teddy bear school day math*. Charlesbridge Publishing Inc: Maryland.

Metzger, S. (2008). *We are going on a bear hunt.* Cartwheel Books: New York, NY.

MDE & MDHS, (2005). The early childhood indictors of progress: minnesota's early learning standards. Retrieved from http://education.state.mn.us/MDE/StuSuc/EarlyLearn/

Moomaw, S. (2011). *Teaching mathematics in early childhood*. Brookes

Publishing Company: Baltimore, MD.

NAEYC. (2002) Early Childhood Mathematics: Promoting Good Beginnings. A joint position statement of the National Association for the Education of Young Children (NAEYC) and the National Council of Teachers of Mathematics (NCTM). *Washington, DC: NAEYC/NCTM.* Retrieved from http://www.naeyc.org/tyc/links/math

NAEYC. (n.d.). Math related children's books. Retrieved from https://www.naeyc.org/files/tyc/file/MathbookslistSchickedanzexcerpt.pdf

NAEYC. (n.d.). Math related children's books, songs, and finger plays for preschoolers. Retrieved from http://www.naeyc.org/files/tyc/file/BooksSongsandFingerPlays.pdf

National Council of Teachers of Mathematics. (2006). Curriculum focal points for prekindergarten through grade 8 mathematics: A quest for coherence. National.

Notari-Syverson, A., & Sadler, F. H. (2008). Math is for everyone: Strategies for supporting early mathematical competencies in young children. *Young Exceptional Children*, *11*(3), 2-16.

Olsen, J., & Knapton, E., (2011). *Get set for school. Numbers and math. Pre-k teacher's guide*. Cabin John, MD.

Park, Y. J. (2013). The relative effectiveness of teacher-made games for preschoolers' understanding number concepts. *Asia-Pacific Journal of Research in Early Childhood Education*, *7*(1), 93-119.

Pica, R., (2004). *Experiences in movement: birth to age eight.* Delmar Learning: Albany, NY.

Pierce, R. (2014, Nov 4). Definition of number sense. Math is fun. Retrieved 28 Nov 2015 from http://www.mathsisfun.com/definitions/number-sense.html

Potter, A. (2014). *Counting blocks numbers 1 – 20*. CreateSpace Independent Publishing Platform: Charleston, SC.

Protopopescu, O. (2007). *Two sticks.* Farrar, Straus and Giroux: New York, NY.

Pruitt, J. & Pruitt, S. (1999). *Twelve little race cars*. World Weaver Books Incorporated: Star, ID.

Reiber, R. W., & Carton, A. S. (1987). *The collected works of LS Vygotsky volume 1: Problems of general psychology*. Plenum Press: New York, NY.

Riccomini, P. J., Witzel, B. S., & Riccomini, A. E. (2011). Maximize development in early childhood math programs by optimizing the instructional sequence. *Mathematics for All: Instructional Strategies to Assist Students with Learning Challenges,* 131-138.

Rosen, M., & Oxenbury, H. (1989). *We are going on a bear hunt.* Aladdin Paperbacks: New York, NY.

Sadler, F. H. (2009). Help! They still don't understand counting. *Teaching Exceptional Children Plus, 6*(1). Retrieved from http://files.eric.ed.gov/fulltext/EJ875422.pdf

Sarama, J., & Clements, D. (2009). *Early childhood mathematics education research: Learning trajectories for young children.* Routledge: New York, NY.

Sarnecka, B. & Carey, S. (2008). How counting represents number: What children must learn and when they learn it. *Cognition,* 108(3), 662-674. doi:10.1016/j.cognition.2008.05.007

Schoenfeld, A. H. (2004). The math wars. *Educational policy*, *18*(1), 253-286.

Silverman, E. (2000). *Follow the leader.* Farrar, Straus and Giroux: New York, NY.

Sleeper, D. (2013). *Ten little gator eggs*. Bear Hug Publishing: Charleston, SC.

Smith, S. S. (2012). *Early childhood mathematics*. New York, NY: Pearson Higher Ed.

Szekely, A. (2014, Oct. 28). Unlocking young children's potential: governors' role in strengthening early mathematics learning". *Washington, D.C.: National governors association center for best practices.* Retrieved from http://www.nga.org/files/live/sites/NGA/files/pdf/2014/1410UnlockingYoungChildrensPotential.pdf

Tafuri, N. (2009) *Big storm a very soggy counting book.* Simon & Schuster Books: New York, NY.

Thomas, I. (2014). *Number fun 123 making numbers with your body.* Heinneman: Portsmouth, NH.

Thomson, K. (2009). *Ten little racing cars*. Tide Mill Press: Suffolk, UK.

Wiggins, G. P., & McTighe, J. (2011). *The understanding by design guide to creating high-quality units*. Boston, MA: Allyn & Bacon.

Witzel, B., Ferguson, C., & Mink, D. (2012). Strategies for helping preschool through grade 3 children develop math skills. *YC: Young Children*, *67*(3), 89-94.

Whyte, J., & Bull, R. (2008). Number games, magnitude representation, and basic number skills in preschoolers. *Developmental Psychology*, *44*(2), 588-596. doi:10.1037/0012-1649.44.2.588

Woodward, J. (2004). Mathematics education in the united states. *Journal of Learning Disabilities*, 37(1), 16-31.

Appendix A
Stages of Cardinality Chart

Stages	Description
Stage 1: Precounters	• Children do not understand the question how many so they provide random answers. These children are typically 1-2 years of age.
Stage II: Reciters	• Children respond with a number-word sequence, but without tagging each item.
Stage III: Corresponders	• Children respond to the question by completely recounting the set usually demonstrating one to one correspondence. Children at this stage are typically around 3 years of age.
Stage IV: Immature counters	• Children answer with the last number-tag used even if inaccurate. These children are not mature enough yet to monitor their counting to ensure its accuracy.
Stage V: Rigid Rule Followers	• Children answer with the largest number-tag included in the count but it may not have been the last tag used. These children are beginning to sleuth out the rules and patterns of how counting works but continue to make errors.
Stage VI: Counters	• Children are able to monitor their own or someone else's counting for accuracy and provide the correct response to the how many question. Children reach this stage for the

	smaller quantities (1-5) around the age of four and for the larger quantities (6-10) around the age of five.

(Sadler, F.H., 2009)

Appendix B
Understanding by Design Template

<table>
<tr><th colspan="2">STAGE 1 – DESIRED RESULTS</th></tr>
<tr><td colspan="2">Unit Title: Increasing Number Sense - Number Concepts and Operations

Established Goals: Minnesota Indicators of Progress - Mathematical and logical thinking in the area of Number Concepts and Operation

• Demonstrate increasing interest in and awareness of numbers and counting

• Demonstrate understanding of one to one correspondence between objects and number

• Demonstrate an ability to count in sequence

• Demonstrate ability to state the number that comes next up to 9 or 10

• Demonstrate beginning ability to combine and separate numbers of objects</td></tr>
<tr><td>Understandings: Students will understand that…

• There is a predictable sequence that doesn’t change when counting

• There is a number word and a matching symbol that tell how many items are in a set

• One to one correspondence - count one object for each object they point to

• Cardinality - know that the last number they say when counting a set of items is the total number of objects

• Stability - know that the number in a set of objects doesn’t change even if you rearrange the objects

• Subitizing - know how many objects are in a set without actually having to count the objects</td><td>Essential Questions:

• How they can use manipulatives, verbal skills, or my body to show quantity?

• What are the different ways/materials that can be used to show the same answer?

• What are numbers and why do we have them/need them?

• What are the rules and procedures in math? (i.e. always start with number one when counting, there is a predictable sequence)</td></tr>
<tr><td>Students will know:
• Math concepts, rules/procedures, and strategies - They can show their understanding of math concepts using a variety of strategies and</td><td>Students will be able to:
• Verbally count in sequence without error
• Count using 1 to 1 correspondence or through subitizing to answer the</td></tr>
</table>

materials to answer the question "how many" through prompting, questioning, cues, and eventually independently without errors. • They can show what they know verbally, through the use of manipulatives, and through the use of movement.	question "How many?" • Use a variety of tools to demonstrate their math knowledge • Identify numbers and begin to put them in order

STAGE 2 – ASSESSMENT EVIDENCE	
Performance Tasks: I will need evidence that my students are able to verbally count in sequence, count using one to one correspondence, use math in a variety of activities throughout the day. I will be looking for this knowledge in their participation in the lessons spelled out in stage 3's learning plan, participation in classroom activities where number activities are offered, generalization of math concepts into their play, focus during math related activities, and response to intentional teaching activities meant to elicit math knowledge. Data I will be looking for: • Specific data related to verbal counting, counting using one to one correspondence, matching quantities to numbers, how long do they participate in math activities, what ways can they show their knowledge, can they represent quantities in different ways (i.e. make a set, hold up # of fingers, clap that many times)	**Other Evidence:** • Individual Growth & Development Indicators of Early Numeracy (IGDIs) - completed 3 times a year • Get Set for School Numbers and Math Observation Checklist - completed 3 times per year • Anecdotal Data taken during classroom activities, transitions, and center activities.
Key Criteria: • Establish what stage they are in using the Sadler's Six Stage Model of Cardinality • Within the stage they are in, determine whether they are at the beginning, emerging, or proficient level • What are their errors? How high can they count to? In what activities/daily routines are they most successful with math activities? Can they solve simple math problems using math concepts? What prompts (i.e. questions, cues, modeling) do I need to give in order for my student to be successful?	

STAGE 3 – LEARNING PLAN
Summary of Learning Activities: Transfer and meaning will occur through repeated opportunities to incorporate counting into their daily routines such as transitions, snack times, play time, motor activities, centers, and free choice. The aim is for students to bring math into their play and conversations spontaneously or through intentional teaching opportunities. Student's prior knowledge will be pre-assessed through elicited opportunities during daily routines, pre-data IGDI's to determine where they fall on the 6 stages of cardinality and a starting point for their skill level. The lesson plan activities 1 – 15 will be implemented and adapted depending on student need and skill level. **Precounters and Reciters** – instruction will focus on beginning verbal counting skills and understanding smaller quantities 1 to 3. Activities and examples will be provided in everyday routines such as snack, understanding and using the word "more" and "each", counting while walking up the steps, multiple examples of quantities of 1 to 3 will be provided as they relate to the child. Read books that involve numbers and counting. Instruction will focus on sensory motor activities, daily routines where counting makes sense (i.e. counting while going up the stairs, singing counting songs paired with movements/actions). Counting paired with movement will be incorporated into daily routines and play with larger movements at first (jumping, clapping, stomping). The following lessons are most appropriate at this age and should be repeated frequently: Lesson 1 - Bear Hunt Lesson 2 - Count and Move Lesson 3 - Crocodile Down by the Lake Lesson 4 - Rhythm Stick Follow the Leader Lesson 5 - Animal Picnic Lesson 6 - Using Songs, Fingerplays, and Chants Send home Math at Home parent connection activity related to "Math Talk" and "Count and Move". Share "Internet Resources" from resource list. After the class is familiar with "Bear Hunt", "Animal Picnic" and " "Crocodile Down by the Lake", send home parent connection math at home activities. **Corresponders and Immature counters** – Continue repeating and using the same activities mentioned with Precounters and Reciters. Continue to build in opportunities to count and learn quantities in everyday routines, verbal counting to 10. Read books that involve numbers and counting. Count providing multiple sensory motor activities where counting can be incorporated as well as using songs/chants paired with movement whenever possible. Begin to add in some smaller movements with counting such as (clapping, patting knees, tapping fingers). When counting a set of items, emphasize the last number said. Continue using counting activities listed for precounters and reciters focusing more on verbal counting to 10, and understanding quantities to 3, using a die or

spinner with games that goes to 2 or 3 however add the following activities and repeat frequently:

Lesson 7 – Let's Race
Lesson 8 – How Many?
Lesson 9 – Create Your Own Classroom Counting/Number Book
Lesson 10 – Estimation Jar
Lesson 11 – Let's Make a Pizza
Lesson 12 – Let's Make a Collection

Send home Math at Home parent connection activity related to "Let's Play a Game". After the class is familiar with "Let's Race", "How Many?", "Let's Make a Pizza", "Let's Make a Collection". Continue adding pages to Classroom Math Book and send home parent connection math at home activities.

Rigid Rule Followers and Counters – Continue repeating and using the same activities mentioned with Precounters, Reciters, Corresponders, and Immature counters. Continue to build in opportunities to count and learn quantities in everyday routines, begin verbal counting past 10. Read books that involve numbers and counting. Count providing multiple sensory motor activities where counting can be incorporated as well as using songs/chants paired with movement whenever possible. Continue to add in some smaller movements with counting such as (clapping, patting knees, tapping fingers) and be sure to incorporate crossing the midline. Introduce counting and movement activities that begin to involved working with a peer or small group. Continue using counting activities listed for the above stages focusing more on verbal counting beyond 10, and understanding quantities to 5, using a die or spinner with games that goes to 3 to 5 however add the following activities and repeat frequently:

After the class is familiar with "Racing Cars", "Cover it Up!", and "Dot Pattern Card Games", send home the corresponding Math at Home parent connection letters.

Many of the previously listed activities are appropriate and necessary at this age, but the focus will shift to working with higher quantities, smaller movements, more cooperative play opportunities with peers. Add in more turn taking games such as:

Lesson 13 – Racing Cars
Lesson 14 – Cover it Up
Lesson 15 – Dot Pattern Card Games

Appendix C
Anecdotal Data Collection Sheet

Number Sense Data Collection

Verbal count in sequence to _____.					
Matches quantities					
When shown a number card, counts out that many objects.					
Can tell how many w/o counting out loud					
Participates in math games/math centers.					
Understands concept of “each”					
Identify numbers					

Notes:

Appendix D
Lesson Plans 1 – 15

1. Bear Hunt

Objective: verbal counting in sequence, associate number words to quantities

Math concepts:
pre-counters, reciters, and corresponders - focus on counting 1 to 5, follow directions related to number concepts, match sets of items to number, begin to use 5 frames.

immature counters, rigid rule followers, and counters - focus on counting to 10, follow directions related to number concepts, match sets of items to number, begin to use 10 frames.

- ✓ This activity is meant to be used repeatedly. You can use this during circle time, centers during free play, and small group.

Circle Time, Small Group, Centers:
Before circle time, hide bears (bear counters, bear stuffed animals, bear cut outs, flannel bears) around the room. Read the book or sing "We're Going on a Bear Hunt". Give each child a bag or basket and have them search for bears in the room/hallway/on the way to the gym…etc. Once you have found the bears, regroup and count out how many bears were found. You can extend this activity in a variety of ways (i.e. how many red/yellow bears did you find, how many big/little bears did you find). You may want to regroup the kids before all the bears have been found so that you can count out what you have using the five or ten frame strip and decide how many more you need to find.

Remember…
- ✓ *emphasize how many they have altogether using a gesture or visual prompt and repeat the phrase "we have ___ altogether" as this will help reinforce the concept that the last word said is the correct amount.*
- ✓ *miscount the bears so students can have the opportunity to point out what you did wrong*
- ✓ *Do this activity regularly changing up what kind of animal or toy you hide depending on the theme/unit/interest of the students.*

Extended Activities/Adaptations:
Hide bears in sand or beans in the sensory table. Have cups with numbers 1 to 5 on them and dots or bear pictures showing the quantity so they can count out sets of bears. Add five or ten frames strips.

Give each child a cup of teddy grahams and laminated five frame card. Model putting

one bear in each square counting each bear as you go. As they eat, take the opportunity to point out how many empty spaces they have left on their card. Emphasize how many they have altogether.

Act out the song *"There Were 5 in the bed…."* with stuffed bears during circle time. Pick a child to take one a way when they are supposed to fall out.

Book Connection:
We Are Going on a Bear Hunt by Michael Rosen and Helen Oxenbury
There Were Ten in the Bed by Susan Chapman Calitri
Teddy Bear Teddy Bear School Day Math by Barbara Barbieri McGrath

Family Connection:
Send home a copy of the parent handout "Math at Home – Bear Hunt" after you have played this game in class. Include a copy of some bears to cut out and a fine or ten frame grid.

* This activity is adapted from the activity "Searching for Bears" in the Everyday Mathematics Pre – K Teacher's Guide to Activities. (Leslie, Audrain, Bell, J., Bell, M., & Brownell, 2008, p. 48)

2. Count and Move

Objective: verbal counting in sequence, one to one correspondence

Math concepts:
pre-counters, reciters, and corresponders - focus on counting 1 to 5, follow directions related to number concepts, match sets of items to numbers, begin to use 5 frames.

immature counters, rigid rule followers, and counters - focus on counting to 10, follow directions related to number concepts, match sets of items to number, begin to use 10 frames.

- ✓ *This activity is meant to be used repeatedly. You can use this during circle time, centers during free play, and small group.*

Circle Time, Small Group, Centers:
Pick a set of movements that you can do while verbally counting out loud. This activity can be implemented during a variety of activities throughout the day such as circle time or during transitions. For precounters, reciters, and corresponders, pick larger movements such as jumping, clapping hands, patting floor. For immature counters, rigid rule followers, and counters, you can also include smaller movements such as tapping fingers, tapping their nose…etc.

Remember…
- ✓ *Do movements that cross the midline (i.e. touching right hand to left foot)*
- ✓ *Use larger movements for younger children. Include large movements with older children, but also include smaller movements as well.*
- ✓ *Try pairing up the students in groups of two and doing the movements with a partner facing each other. Try movements that they have to do with each other such as giving a double high five.*

Extended Activities/Adaptations:
Record the class doing this activity and watch it on the electronic whiteboard later. This is a great opportunity to have them see themselves counting in a fun and motivating way.

Make print outs of yoga cards/movement cards. Have one child roll a larger die. Do the movement or hold the pose for the amount rolled on the die. Have the children count out loud as they are holding the pose or doing the movements.

Family Connection:
Send home a copy of the parent handout "Math at Home – Count and Move" after you have played this game in class.

Book Connection:
Teddy Bear Teddy Bear School Day Math by Barbara Barbieri McGrath
From Head to Toe by Eric Carle

* This activity is adapted from the activity "Rhythmic Counting" in the Everyday Mathematics Pre – K Teacher's Guide to Activities. (Leslie, Audrain, Bell, J., Bell, M., & Brownell, 2008, p. 38)

3. Crocodile Down by the Lake

Objective: number identification, matching/sorting numbers

Math concepts:
pre-counters, reciters, and corresponders - focus on numbers identifying numbers 1 to 3, matching number sets 1 to 3,

immature counters, rigid rule followers, and counters - focus on 1 to 5 and higher depending on the group

- ✓ *This activity is meant to be used repeatedly. You can use this during circle time, centers during free play, and small group.*

Circle Time, Small Group, Centers:
Cover an empty Cascade dishwashing packet container with green construction paper to make a crocodile. Add eyes and a mouth. Put magnetic numbers into the container. Sing the chant/poem…

"Crocodile Crocodile Down by the Lake
I'm going to reach right in
and see what number you ate!"

Have the children pull out a number from the crocodile, show it to the class, and name what it is. Start with simply pulling the number out and matching it or naming it to pulling a number out and then counting out that many objects or doing a set of movements that many times.

Remember…
- ✓ *Include non-examples of numbers. Throw in a letter or a shape and see what the children do when they pull out something that is not a number.*

Extended Activities/Adaptations:
Leave the Crocodile and numbers as a center in the room during playtime. Have the children work on matching and sorting the numbers. Extend this activity by include a magnetic dry erase board with a graph with columns with different quantities of dots. Children have to work together to pull out a number and put it in the column with the correct number of dots.

Instead of numbers in the crocodile, put cards with dots and have the children count how many they have on the card.

Book Connection:
Ten Little Gator Eggs by Denise Sleeper
1, 2, 3 Snap a Mr Croc Book About Numbers by Jo Lodge
The Selfish Crocodile Book of Numbers by Faustin Charles

Family Connection: Send home a copy of the parent handout "Math at Home – Crocodile Game!" after you have played this game in class. Include materials to make the crocodile and a copy of the number cards 1 - 10.

(Kramer, J., n.d.)
*Retrieved from
http://www.makinglearningfun.com/themepages/CrocodileCircleTimeFun.htm

4. Rhythm Stick Follow the Leader

Objective: verbal counting in sequence, imitating movements, one to one correspondence

Math concepts:
Precounters, reciters and corresponders - focus on quantities up to 5

immature counters, rigid rule followers, and counters - focus on quantities up to 10

- ✓ *This activity is meant to be used repeatedly. You can use this during circle time and small group*.

Circle Time, Small Group, Centers:
Give each child a pair of rhythm sticks. Explain that you are playing a game called follow the leader and you are the leader. They need to copy what you are doing with the rhythm sticks. Pick a movement and do the movement 5 times, counting out loud and tagging a number with each movement. Repeat with a variety of movements.

Remember…

- ✓ *Try a variety of movements that engage the whole body and cross the midline. Use smaller or more complex movements (crossing arms and tapping the floor) for rigid rule followers and counters. Stick with simple movements (tapping the floor, tapping knees) and smaller quantities for precounters and reciters.*

Extended Activities/Adaptations:
Try having students take turns being the leader. If you have the *Get Set for School* block set, use the wood pieces (big stick, little stick, big curve, little curve) as your rhythm sticks (Olsen, J., & Knapton, E., 2011). Extend the activity by making numbers out of the wood pieces and having them copy the number you or their peer made.

Book Connection:
Two Sticks by Orel Protopopescu
Follow the Leader by Erica Silverman

5. Animal Picnic

Objective: verbal counting, one to one correspondence, understand the concept of "each"

Math concepts:
pre-counters, reciters- focus on quantities 1 to 3 and working towards 5.

Corresponders, immature counters, rigid rule followers, and counters - focus on counting beyond

- ✓ *This activity is meant to be used repeatedly. You can change this activity based on theme, focus, or student interest.*

Free Choice:
Gather 3 to 5 stuffed animals and the same amount of food items, utensils, cups, plates, napkins ahead of time. Tell your students that you are going to have a Teddy Bear Picnic (or Puppy Picnic…etc). Either lay a blanket on the floor or have the dramatic play area table if available. Pick a child to put a stuffed animal in each chair or at each side of the blanket. Have the next child give each stuffed animal a plate. Continue until all of the items are on the table. Pretend to have a picnic making the animals eat!

Remember…
- ✓ *Include extra items in the box or leave out an item and see what happens when a child realizes they have too many plates or not enough plates.*

Extended Activities/Adaptations:
Turn this into a turn taking game for small group - Make a set of cards each with a picture of the supplies needed to do the teddy bear picnic. You may want to include a number with a linear dot pattern next to it to the children know how many items they need to next to each spot at the table. Children can take turns choosing a card and putting the correct number of that item at the table.

Snack – Have one or two snack or lunch helpers who can work on setting the table, giving each student the correct amount. You can extend this to larger quantities such as giving each friend 2 crackers or 3 orange slices.

Book Connection:
We All Went on Safari by Laurie Krebs
Big Storm A Very Soggy Counting Book by Nancy Tafuri

Family Connection: Send home a copy of the parent handout "Math at Home –Let's Have a Picnic!" after you have done this activity at school.

* This activity is adapted from the activity called "Table's Ready" in the *Get Set for School's Numbers & Math Pre – K Teacher's Guide.* (Olsen & Knapton, 2011, p. 44)

6. Using Songs, Fingerplays, and Chants

Objective: verbal counting, one to one correspondence, matching quantities to numbers, subitizing quantities

Math concepts:
This can be used at any age however it is especially important for precounters and reciters. For pre-counters, reciters, and corresponders - focus on quantities 1 to 5

immature counters, rigid rule followers, and counters - focus on songs that count to 10

- ✓ *This activity is meant to be used repeatedly. You can change this activity based on theme, focus, or student interest.*

Circle, Transitions, Small Group:
There are many songs, fingerplays, and chants that help children increase their number sense. Using music offers many opportunities for pairing movements with counting as well as opportunity for children to use their fingers for counting and representing quantities. Some great songs that can be used repeatedly are: 5 Little Ducks, 5 Little Monkeys, 5 Green and Speckled Frogs, 1 2 Buckle My Shoe, One Elephant.

Remember…
Many counting songs on CDs or through ITunes are great, but they often move at a fast pace. Find ones that are at a slow enough pace that children are able to count/move at the pace of the song. Track number 9 "Counting, Counting" on the Get Set for School Sing, Sounds, & Count CD is a great example of a simple movement and counting song that moves at a slow enough pace (Olsen, J., & Knapton, E., 2011).

- ✓ *Many familiar songs have books that go with them offering visual images for children to cue into.*
- ✓ *Use large movements at first and work towards smaller movements (i.e. start with jumping, then clapping, then tapping fingers as you are counting).*
- ✓ *Include movements that cross the midline*
- ✓ *Try songs and chants that count backwards.*
- ✓ *Use props, such as finger puppets, flannel board pieces, or stuffed animals, to represent quantities.*
- ✓ *Repeat these songs frequently. Include versions of familiar songs where they have to show quantities with just their fingers/hands and don't use any props.*

Extended Activities/Adaptations:
Create activities on the electronic whiteboard that can be used with certain songs. For example, for the Elephant Song, make a board with an empty spiders web and a set of 5 elephants. Have one child be the song helper. As you sing the song, have the child drag an elephant into the web. Pause after each verse and encourage the students to either tell you how many elephants are on the web without counting them or count the elephants verbally and saying how many they have altogether.
Record the children making their own video where they are acting out a song. Replay the video at group time using the electronic whiteboard. Occasionally leave out the props to songs in the dramatic play or in the circle area where the children can work together to act out the songs during free choice.

Family Connection: Once the children are familiar enough with a song you have introduced, send home a copy of the lyrics to the song, a lunch sized paper bag, and supplies (glue stick, popsicle sticks, copies of the animals in the song) to make the props to the song that they can have at home. Share internet resource called "Math-Related Children's Books, Songs, and Finger Plays for Preschoolers" (NAEYC).

7. Let's Race

Objective: verbal counting in sequence, one to one correspondence

Math concepts:
pre-counters, reciters, and corresponders - focus on counting 1 to 5, verbally and using one to one correspondence

immature counters, rigid rule followers, and counters - focus on counting to 10 verbally and using one to one correspondence

- ✓ *This activity is meant to be used repeatedly. You can use this during transitions, circle time, small group, and motor times*.

Small Group/Motor activity in the gym or on the playground:
Create a track using 5 to 10 rubber floor mats or carpet squares. Have children roll a large die or pick a number card and move that number of spots on the track. Be sure to have them count out loud marking each spot/movement with a number name. When they get to the end, have them ring a bell/give a high five. Have them try different movements such as jumping, hopping, jumping sideways, tiptoeing.

Remember…
- ✓ *Have children verbally count out loud as they move from space to space. If done in a small group, have the entire group count out loud to as they child moves across the board.*

Extended Activities/Adaptations:
Record the class doing this activity and watch it on the electronic whiteboard later. This is a great opportunity to have them see themselves counting in a fun and motivating way.

Instead of making this a race game, have them simply go across the track doing different movements, tagging a number each time they move to a new shape/square. Be sure to have them count out loud as they go. Once you have done this a few times, have the children pick their own way to move across the track. Crawling on hands and knees and wheelbarrow walking are great movements that promote good proprioceptive movement.

Book Connection:
Ten Little Racing Cars by Kate Thomson
Twelve Little Race Cars by Judy and Scott Pruitt

Family Connection: Send home a copy of the parent handout "Math at Home – Let's play a Game - Let's Race!" after you have played this game in class.

* This activity is adapted from the activity called "Kid Race" in the Everyday Mathematics Pre – K Teacher's Guide to Activities. (Leslie, Audrain, Bell, J., Bell, M., & Brownell, 2008, p. 60)

8. How Many?

Objective: subitizing (being able to tell how many without counting), stability (quantity doesn't change even if you move objects around), verbal counting in sequence, one to one correspondence

Math concepts:
Precounters, reciters and corresponders - focus on quantities up to 3

immature counters, rigid rule followers, and counters - focus on quantities up to 5

- ✓ *This activity is meant to be used repeatedly. You can use this during circle time and small group.*

Circle Time, Small Group, Centers:
Gather a set of blocks/small counters that are all the same (i.e. color, size, shape) and a box that can be used to cover the set of items. Set out the items so all the kids can see them and tell the group how many you have. Then, cover up the items with your box for a few seconds. Lift the box top and ask the group how many you have. Repeat this activity a few times (in a session and throughout the week) without changing the number of items. You may need to just play this game without changing the amount of items over the course of a few weeks or so. Once you feel they have a sense of the game, then try taking one of the items away or adding an item before you lift the box up.

Remember…

- ✓ *Use small quantities at first. This activity is meant to be used repeatedly and can be adapted as the children get used to the game and can subitize small quantities. Once they are proficient at small quantities (up to 3), add more items. Teach this game at the beginning of the school year and use it as circle time game as they become familiar with it.*

- ✓ *For rigid rule followers and counters, when they give an answer of how many items are there without verbally counting out loud, ask them how they know without having to count.*

Extended Activities/Adaptations:
Once the children are familiar with the game, you can leave this out as a center or small group activity where they work can work in pairs (for rigid rule followers and counters). Try recording a pair working through this game and show it to the whole class during circle time. Ask questions like, "How do you think _____ knew there were only 3 blocks? I didn't see him count them!".

Try moving the items into a different arrangement before lifting the box rather than taking one away or adding one. This will help teach the concept that even if you move them around, the quantity still stays the same.

Book Connection:
How Many Bugs in a Box by David. A. Carter
How Many Snails A Counting Book by Paul Giganti Jr.
Counting Blocks Numbers 1 – 20 by Anita Potter
Spot Can Count with Blocks by Eric Hill

Family Connection:
Send home a copy of the parent handout "Math at Home – How Many?" after you have played this game in class.

* This activity is adapted from the activity called "Hide & Peek" in the *Get Set for School's Numbers & Math Pre – K Teacher's Guide.* (Olsen & Knapton, 2011, p. 44)

9. Create Your Own Classroom Counting/Number Picture Books

Objective: Ongoing classroom project that will encourage different ways the student's use and observe numbers in the classroom.

Math concepts: number identification, one to one correspondence, verbally counting in sequence

- ✓ *This activity is meant to be ongoing. New pages will be added throughout the school year.*

Circle Time/Free Choice:
Take pictures of your students in math related activities where they are working with numbers such as playing games, sorting and counting, holding up fingers to show how old they are, and laying on the floor to make a number. Compile the pictures in a book that you can read to the class showing the different ways you use numbers throughout the day. Leave the book on the bookshelf for children to look at.

Remember…

- ✓ *Continue to add pictures throughout the year. Revisit the book frequently! Surprise them with new pages. Send it home and encourage family's to read it with their child at home and even leave suggestions/pages that they can add to.*

- ✓ *Use pictures of different activities, stations, environments (i.e. on the playground playing hopscotch, setting the table for snack, playing a math game during free choice, stacking blocks and counting the blocks during free choice, counting out crackers during snack…etc)*

Extended Activities/Adaptations: Put this book on the electronic whiteboard and watch it as a group. Pick a page/activity throughout the year and recreate that activity! Look for changes in skill level, accuracy, cooperation…etc

Book Connection:
Number Fun 1 2 3 Making Numbers with Your Body by Isabel Thomas

Family Connection: Send the book home with each child. Encourage parents to take a picture of how they use numbers at home. Add the page to the book and show the class.

10. Estimation Jar

Objective: verbal counting, one to one correspondence, subitizing, beginning understanding of estimating.

Math concepts:
pre-counters, reciters, and corresponders - focus on quantities 1 to 5

immature counters, rigid rule followers, and counters - focus on counting to 10

- ✓ *This activity is meant to be used repeatedly. You can build this into your circle time routines on a daily or weekly basis.*

Circle Time: On a weekly basis , fill up a clear, plastic container with a set of identical smaller objects. Try using quantities 1 to 5 for precounters and reciters and quantities to 10 (or more) for corresponders, immature counters, rigid rule followers, and counters. Have the children guess how many items are in the jar. Write their name and their guess on the dry erase board. Dump out the objects and count them. Compare what you counted with the student's guesses.

Remember…
- ✓ *emphasize how many they have altogether using a gesture or visual prompt and repeat the phrase "we have ___ altogether" as this will help reinforce the concept that the last word said is the correct amount (stability).*
- ✓ *Have the children verbally count the items out loud with you.*

Extended Activities/Adaptations:
Use a puppet to count the items. Tell the class that the puppet often makes mistakes and we need to make sure that he counts the right amount. Have the puppet miscount and encourage the class to explain what he did wrong.

Use different size objects - After doing this activity for a few months, try putting small items in and other times putting bigger items in. Occasionally, use two jars with the same amount in each but different sized objects. Compare the two sets and point out that both have the same amount of items.

Five frame/ten frame - You could add 5 and 10 frame boards and put the items on the board as you count them.

After the class understands the activity and has done it as a large group several times,

leave a few smaller plastic jars, trays, and different items as a free choice/centers activity and encourage children to play the game in pairs. One can put items in the jar and the other can guess.

Family Connection: Send home a copy of the parent handout "Math at Home – Let's Estimate!" after you have played this game in class a few times.

Book Connection:
Estimation by Penny Dowdy

11. Let's Make a Pizza

Objective: verbal counting, one to one correspondence, turn taking game

Math concepts:
pre-counters, reciters, and corresponders - focus on quantities 1 to 3

immature counters, rigid rule followers, and counters - focus on counting to 10

- ✓ *This activity is meant to be used repeatedly. You can change this activity based on theme, focus, or student interest.*

Circle Time/Free Choice/Small Group:
Gather the game pieces for Mr. Poppers Pizza or create your own pizza and toppings using felt or thick paper. Prepare a die or spinner with numbers 1 and 2 for younger students and 1 through 5 for older students. Separate the pieces into bowls. Have children take turns picking what topping they want to put on the pizza and rolling the die or spinning the spinner to find out how many of that topping they need to put on. For younger students who are not ready to use a die or spinner, have them choose what topping they want to put on and give them two of that topping. Count the toppings at they put it on the pizza.

Remember…
- ✓ *Use small quantities for younger students.*
- ✓ *Have the children verbally count the items out loud with you.*

Extended Activities/Adaptations:
Leave the materials out as a center activity during free choice. Children can play individually or with a partner

Pizza Party in dramatic play – leave out pretend pizza crusts (metal pizza pans with crust/sauce made of felt and toppings in the dramatic play area). Create recipe cards that have a list of ingredients with the amount they need for each kind of pizza. Encourage the children to work together to create the different kinds of pizzas.

Make a pizza for snack – create the activity using real items to make a pizza. Make a recipe card and have the students take turns adding each item.

Book Connection:
The Pizza That We Made by Joan Holub
Pizza Party by Grace Maccarone

Family Connection: Send home a copy of the parent handout "Math at Home –Let's Cook!"

12. Let's Make a Collection

Objective: verbal counting, one to one correspondence, matching sets to numbers, sibitizing

Math concepts:
pre-counters, reciters, and corresponders – focus on quantities to 5

immature counters, rigid rule followers, and counters - focus on quantities up to 10 and beyond

- ✓ *This activity is meant to be used repeatedly. You can change this activity based on theme, focus, or student interest.*

Circle Time/Small Group/Free Choice:
Prepare a few examples of collections in a jar, bowl, or box (i.e. a collection of leaves during the fall, a collection of favorite cars, a collection of rocks) and a set of cards with numbers 1 – 10 and corresponding dot patterns). Explain to the class what a collection is and count the items in the jars trying to match the correct number to the right quantity. As a free choice activity, create a set of jars with numbers 1 - 10 and bowls of different items (i.e. rocks, buttons, jewels, dry noodles, erasers, beads) and encourage the children to fill up their jars with the corresponding amount. Leave a few extra jars with no number/dot pattern on them. Have the children pick the number of items they want or fill up the jar and count out how many they have. Write that number on the jar.

Remember
- ✓ *Use larger items (non chokables) for younger children.*
- ✓ *Use smaller quantities (1 – 5) for younger children.*
- ✓ *Encourage subitizing when appropriate.*
- ✓ *Emphasize how many they have altogether using a gesture or visual prompt and repeat the phrase "we have ___ altogether" as this will help reinforce the concept that the last word said is the correct amount (stability).*
- ✓ *Have the children verbally count the items out loud with you.*

Extended Activities/Adaptations:
Neighborhood/School Walk – gather a set of boxes or plastic jars with a lid. Write a number (1 – 5 for precounters, reciters, and corresponders and 1 – 10 for immature counters, rigid rule followers and counters) on each jar. Go on a nature walk and gather different amounts of items depending on the quantity you need and fill up your jars one

by one. Instead of going for a walk outside, stay inside school and go to different classrooms gathering sets of items from other rooms.
Make a collections book - Take pictures of the different collections that the children make and create a "collections" book. Laminate the book and leave it in the book area.

Book Connection:
Grandma's Button Box by Linda Williams Aber
We are Going on Leaf Hunt by Steve Metzger
1 2 Buckle My Shoe by Anna Grossnickle Hines

Family Connection: Send home the collections book you made, a plastic jar, and a set of instructions with a different child each week. Encourage each family to read the book together and gather a collection of items from their home that can be brought to school. When each child's collection comes back to school, take a picture of that child with their collection and add a page to the book.

13. Racing Cars

Objective: verbal counting in sequence, one to one correspondence, taking turns, using a die/spinner, number identification

Math concepts:
reciters and corresponders - focus on counting 1 to 5, verbally and using one to one correspondence

immature counters, rigid rule followers, and counters - focus on counting to 10 verbally and using one to one correspondence

- ✓ This activity is meant to be used repeatedly. You can use this during circle time, centers during free play, and small group.

Circle Time, Small Group, Centers:
Create a game board with a track and numbers 1 through 5 (or up to 10 depending on level). Have a matchbox car or car counter as a marker for each person playing. This game can be done individually or in pairs. Have each child take turns rolling a die and moving the correct number of spaces on the track until they get to the end of the track. Use a die or spinner with only numbers 1 to 3. Repeat game a few times.

Remember…
- ✓ *Have children verbally count out loud as they move from space to space. If done in a small group, have the entire group count out loud to as they child moves across the board.*

Extended Activities/Adaptations:
This game can be adapted in various ways depending on the theme. Instead of cars, use other kinds of game pieces such as a bear getting to his cave or a dog getting to his bone.

Make this game on the electronic whiteboard and have children take turns rolling a die and moving the car the correct amount of spaces.

For children at the "counters" level, try having them count from where they left off on their last turn. If they had their car on the number 3 and they spin or roll a 2, they move forward calling out the numbers "4, 5".

Family Connection:
Send home a copy of the parent handout "Math at Home – Let's Play a Game - Let's Race" after you have played this game in class. Include a copy of the race track and a

spinner or die.

Book Connection:
Ten Little Racing Cars by Kate Thomson
Twelve Little Race Cars by Judy and Scott Pruitt

* This activity is adapted from the activity "Racing Cars" in the Everyday Mathematics Pre – K Teacher's Guide to Activities. (Leslie, Audrain, Bell, J., Bell, M., & Brownell, 2008, p. 62)

14. Cover It Up

Objective: verbal counting in sequence, one to one correspondence, taking turns, matching dots to number of items on board

Math concepts:
Precounters - reciters and corresponders – focus on counting 1 to 5, verbally and using one to one correspondence

immature counters, rigid rule followers, and counters - focus on counting to 10 verbally and using one to one correspondence

- ✓ *This activity is meant to be used repeatedly. You can use this during circle time, centers during free play, and small group.*

Circle Time, Small Group, Centers:
During circle time, draw a game board on the dry erase board or create one with a larger piece of roll paper. Have children take turns rolling a dot die and adding the corresponding number of items (stickers, cut outs, magnets) to the board. Continue until the board is filled. If done in small groups, provide each child with a game board and a small bowl of identical items (blocks, shapes, washers, counters). Have each child take turns rolling a dot die and putting the corresponding number of items on the board. Continue game until the board is full. Repeat game if appropriate. Leave this activity out as a center off and on throughout the year. Children can do this individually or in pairs. Use counters, bottle caps, rocks, jewels…ect as counters.

Remember…
- ✓ *Use a game board with quantities based on developmental level (6 to 9 boxes for precounters/reciters and 12 to 16 boxes for corresponders, immature counters, rigid rule followers, and counters).*
- ✓ *Be sure to use a dot die with 1 to 3 dots per side, especially for precounters, reciters, and corresponders.*

Extended Activities/Adaptations: Try playing this activity on the electronic whiteboard. Create a board ahead of time (same as listed above). There are various ways you can do this such as dragging one item into each box depending on the amount they roll on the dot die. You could also put a small shape in each square of the game board. The child can then roll the die and tap on corresponding number of shapes revealing a picture. After their turn, verbally count the number of items altogether.

Family Connection: send home "Math at Home – Cover It Up" with a copy of the

"Cover it Up" game board, a spinner, and/or die cut out.

* This activity is adapted from the activity "Cover All" in the Everyday Mathematics Pre – K Teacher's Guide to Activities. (Leslie, Audrain, Bell, J., Bell, M., & Brownell, 2008, p. 52)

15. Dot Pattern Card Games

Objective: Subitize quantities, matching quantities to numbers,

Math concepts:
reciters, and corresponders - focus on quantities 1 to 3

immature counters, rigid rule followers, and counters - focus on counting to 5 to 10

- ✓ *This activity is meant to be used repeatedly. You can change this activity based on theme, focus, or student interest.*

Circle Time, Free Choice, Small Group:
Make two sets of cards with dot arrangements on them. Pass out a card to each child. Encourage your students to look at the dot pattern and either name the amount without counting or count how many dots they have on their card using one to one correspondence. Mix up the remaining cards either in a box or upside down on the floor. Pull out a card and show it to the class. Whoever has the matching card should raise their hand. Hold the two cards together and see if they match. Continue until you have gone through all of the cards. There are *many* different games that can be used with dot cards. See the extended activities below for more ideas.

Remember…

- ✓ *Start with dot cards with 1 – 3 dots on them younger students. This game may not be appropriate for precounters.*
- ✓ *Start with dot pattern arrangements that are in a straight line and evenly spaced, then a rectangular pattern, and then dice arrangements. Eventually you may be able to present the dots in scrambled arrangements (Clements & Sarama, p. 13).*
- ✓ *Use patterns that are circles or squares and not animal pictures at first. Initially, do not embed the dots or squares in a picture (i.e. circles that represent apples on a tree or squares that represent windows in a house). This will encourage children to count using one to one correspondence rather than subitizing.*
- ✓ *Make sure patterns are regular (i.e. symmetrical and linear)*

Extended Activities/Adaptations:
Memory Game – For small group, make a set of cards (start 2 sets of dot pattern cards 1 – 5). Have children take turns turning over two cards, looking for a match. Remove the two cards when they have found a match. Use identical cards at first. Depending on skill level, you can move towards having a number on one card and dot patterns on the other set. Students can take turns turning over two cards, looking to match the number with the corresponding set of dots. Next, make a set of cards that has different variations of dot

patterns of the same quantity and students have to turn over two cards looking for the matching quantities.

File Folder Matching Game – Make different file folder games (depending on developmental level) using the same sets used for the memory games. Children can do this activity individually.

Beat the Teacher – Try holding up a card and the class has to shout out the quantity before the teacher does.

Matching Quantities – In a small group, give each child a bowl of counters, blocks, washers, pennies…etc, and a blank card. Lay out a card (dot pattern card, number) on the table and have the child create the same amount on their card. For larger quantities, try showing them the same number again, but arrange their counters in a different pattern to make the same quantity.

Book Connection:
Ten Black Dots by Donald Crews

Family Connection: Send home a copy of the parent handout "Math at Home – Card Games" after you have played this game in class. Include a copy of the dot cards for parents/child to cut out. Give instructions for different games that can be played with cards.

(Clements & Sarama, 2014, p. 13)

Appendix E
Math at Home Parent Letters

Math at Home
Let's Play a Game – "Let's Race!"

Games are a great way to work on counting in a fun and engaging way. Board games, card games, or simple made up games can offer many opportunities for your child to learn and practice counting while practicing turn taking and social interaction. For younger children, use games that have a die or spinner with quantities up to 2. Gradually move up to using a regular die or a spinner with numbers 1 – 6 as your child's counting skills grow. You may want to make your own dot die putting one and two dots on each side of the die.

"Let's Race!"

Before starting the game, have your child pick a small car, toy, or object as their game piece. Using the "racing cars" track, take turns rolling a die or spinning the spinner and moving the correct number of spaces on the track. Continue taking turns until you get to the end of the track. Once you both get to the end of the track, start a new game. Repeat the game a few more times.

Remember…

- ✓ *Have your child verbally count out loud as they move from space to space.*
- ✓ *If you want, write the numbers 1 through 10 on each box. Try starting at 10 and going backwards.*

Math at Home
"Math Talk!"

One of the most effective ways you can work on counting with your child is simply by talking about counting, numbers, and math concepts within your daily routines. Use every opportunity you can to bring math into your conversation. Count the stairs as you are going up and down, count how many dogs you see at the park, count the number of cups you need to set the table, count how many boats they have in the bathtub. Talk about the numbers you see in your house, at the park, in your neighborhood, or at the grocery story. Games like "I Spy" can be a great opportunity to talk about quantity in a fun and engaging way (i.e. "I spy 3 geese flying in the sky").

Here are a few resources on the internet related to idea of Math Talk:

- ✓ "Support Math Readiness through Math Talk" – by Eugene Geist http://families.naeyc.org/learning-and-development/music-math-more/support-math-readiness-through-math-talk
- ✓ "Math Talk with Infants and Toddlers" – by Jan Greenberg http://families.naeyc.org/learning-and-development/music-math-more/math-talk-infants-and-toddlers

Math at Home
"Bear Hunt"

Have your child color (and cut out if able) the bears on the attached sheet. Hide the bears (bear around your house. Give your child a bag or basket and have them search for bears. Once you have found the bears and count out how many bears were found. You can extend this activity in a variety of ways (i.e. how many red/yellow bears did you find, how many big/little bears did you find, use words like "in", "on", ect.).

Remember…

- ✓ *Start by hiding the bears in just one room rather than around the house.*
- ✓ *Once you have found all the bears, count how many you have altogether. Try miscounting the bears and see if your child can point out what you did wrong*
- ✓ *Use words like in, on, under, behind as you find them (i.e. "You found the bear under the couch!"*
- ✓ *If you are using the paper bears, have your child glue each bear on the five or ten frame grid as they find it. Check is as you are going along and count how many you have found and home many more you need.*
- ✓ *Try this activity with stuffed animals, cars, or other fun toys!*

Math at Home
"Count and Move!"

Remember to use any opportunity you can to bring counting into your daily routines. Combine counting with movements, exercise, or active activities will allow your child to develop their counting skills in a meaningful way. Research shows that pairing movement with counting helps children build stronger connects to numbers (Pica, 2004). Try such activities as counting the stairs as you go up and down, count how many times they can hop in a row, try counting how many steps it takes to go from the car to the front door…etc.

Remember…

- ✓ *Use both whole body movements (jumping, crawling) and smaller movements (clapping, tapping fingers).*
- ✓ *Draw a hopscotch board on the sidewalk and encourage your child to count aloud as they jump. Have them move from square to square in different ways (tip toe, stomping. crawling).*
- ✓ *Try partner movement where you and your child face each other. Do movements such as giving a double high five and counting while you are doing it.*

(Pica, R., 2004)

Math at Home
"Crocodile Down By the Lake"

Cut out the crocodile and glue it to the paper bag. Put the number cards inside the paper bag. Repeat the following chant…

"Crocodile Crocodile
Down by the lake
I'm going to reach right in
And see what number you ate"

Take turns pulling out a number. Name what number you have and pass the bag to the next person. Keep playing until all the numbers have been taken out.

Other ways you can play…

- ✓ Have a basket of small toys/objects near by. Each time you pull out a number, count out that many items.
- ✓ Have your child show you the same amount with their fingers
- ✓ Try including two or three sets of the same numbers. Each time you pull out another number, sort them into piles with the same number.

(Kramer, J., n.d.)
*Retrieved from
http://www.makinglearningfun.com/themepages/CrocodileCircleTimeFun.htm

Math at Home – How Many?

Being able to recognize how many objects are in a group without having to count them is a good skill for your child to know. Young preschoolers often times can tell you how many you have without counting if the number is 3. This skill shows that your child is beginning to understand that numbers represent a group of items.

Gather a set of blocks/small objects that are all the same (i.e. color, size, shape) and a box that can be used to cover the set of items. Have your child sit facing you. Set out the items so your child can see them and tell how many you have. Then, cover up the items with your box for a few seconds. Lift the box top and ask your child how many you have. Encourage them to try at first without actually counting the items. Repeat this activity without changing the number of items. When you feel your child understands the game, try taking one of the items away or adding an item when you lift the box up.

Remember…

- ✓ *Use small quantities at first. Once they are proficient at small quantities (up to 3), add more items.*
- ✓ *If your child is able to give an answer of how many items are there without verbally counting out loud, ask them how they know that without having to count.*
- ✓ *When you are waiting in line at the grocery store or the clinic, try this activity by holding up fingers instead of using objects. Have your child hold up their fingers and you tell them how many!*

Math at Home – "Let's Play a Game - Cover It Up!"

Games are a great way to work on counting in a fun and engaging way. Board games, card games, or simple made up games can offer many opportunities for your child to learn and practice counting while practicing turn taking and social interaction. For younger children, use games that have a die or spinner with quantities up to 2. Gradually move up to using a regular die or a spinner with numbers 1 – 6 as your child's counting skills grow. You may want to make your own dot die, putting one and two dots on each side of the die.

"Cover It Up!"

Before starting the game, gather 20 or more small items (pennies, rocks, bottle caps, stickers or if use bingo stampers/stamps for younger children). Using the "Cover it Up" game board (either the 9 square grid or the 12 square grid), take turns rolling a die or spinning the spinner and adding that many items to their board. Continue until the board is filled. Repeat the game a few more times.

Remember…

- ✓ Use stickers or a bingo stamper if you are concerned that your child will put items in their mouth.
- ✓ Once you have filled up the board, try rolling the die or spinning the spinner and taking that many items off the board. Continue until the board is empty.

(Leslie, Audrain, Bell, J., Bell, M., & Brownell, 2008, p. 52)

Math at Home
"Let's Make a Collection!"

Use a box with a lid, Tupperware container, or bag. Talk to your child about what a collection is. Show examples if you have any. Tell your child that you are going to make a collection. Go on a nature walk and collect rocks or leaves or look around your house for collections of buttons or balls, or toy dinosaurs. Gather a few different sets of items in a bag/box/basket/jar. When you are finished gathering the items, dump them out and count how many you have. Give your child a few bags or bowls and encourage them to look around the house or the yard for things they can use to make a collection of their own. Remember to build in conversation about the collections using concepts of quantity. Send in the collection you made to school. Your child can show the class and talk about what he/she found.

Remember

- ✓ *Use larger items (non chokables) for younger children.*
- ✓ *Use smaller quantities (1 – 5) for younger children.*
- ✓ *Have your child verbally count the items out loud with you.*
- ✓ *Encourage them to make a "guess" of how many items they found.*
- ✓ *Save your collections and add to them as you find more items.*

Math at Home
"Let's Estimate!"

Find a clear jar or Tupperware container. Make this your "Estimation Jar". On a weekly basis , fill up a clear, plastic container with a set of identical smaller objects or toys from your home. Have your children and other family member's guess how many items are in the jar. Write each person's guess on a piece of paper. Dump out the objects and count them. Compare how many you counted with the guesses made. Repeat this activity weekly!

Remember…

- ✓ *emphasize how many you have altogether*
- ✓ *Have your child verbally count the items out loud with you.*
- ✓ *Try using a puppet or a stuffed animal pretend to count the items. Have the puppet miscount and encourage your child to explain what s/he did wrong.*
- ✓ *Use different size objects – Try putting small items in and other times putting bigger items in. Occasionally, use two jars with the same amount in each but different sized objects. Compare the two sets and point out that both have the same amount of items.*

Math at Home
"Let's Have a Picnic!"

Gather 3 to 5 stuffed animals and the same amount of food items, utensils, cups, plates, napkins ahead of time. Tell your child that you are going to have a Teddy Bear Picnic (or Puppy Picnic…etc). Either lay a blanket on the floor or use a small table if available. Have your child put a stuffed animal in each chair or at each side of the blanket. Next, have your child give each stuffed animal a plate, then cup, then silverware, then food…etc. Continue until all of the items are on the table. Pretend to have a picnic making the animals eat!

Remember…

- ✓ *Try to include extra items in the box or leave out an item and see what happens when your child realizes they have too many plates or not enough plates.*
- ✓ *Have your child help set the table, giving each family member the correct amount. You can extend this to larger quantities such as giving each person 2 crackers or 3 orange slices.*

* This parent letter was adapted from the "Solving Problems at Home" family connection master from the *Everyday Mathematics Math Masters - Pre-kindergarteners* book. (Leslie, Audrain, Bell, J., Bell, M., & Brownell, 2008, p. 78)

Math at Home
"Let's Cook!"

Cooking is a great opportunity to bring math, counting, quantity, and number concepts into your conversation. You can create simple recipe cards for snacks such as a fruit salad or trail mix. Use smaller quantities and have your child count out the number of each item you want (i.e. make a fruit salad where your child has to count out 4 strawberries, 6 pieces of cantaloupe, 4 apple slices, and 10 blueberries). Encourage them to make their own recipe card, picking how much of an item they want to put in.

- ✓ *Try making a home made pizza. Your child can count out the different number of topping that they want on their pizza.*
- ✓ *Use measuring spoons, thermometers, timers, and measuring cups, pointing out the number of cups you might need for a recipe or the time it needs to cook.*

***** This parent letter was adapted from the "Cooking at Home" family connection master from the *Everyday Mathematics Math Masters - Pre-kindergarteners* book. (Leslie, Audrain, Bell, J., Bell, M., & Brownell, 2008, p. 83)

Math at Home
"Let's Play a Game – Card Games!"

Games are a great way to work on counting in a fun and engaging way. Board games, card games, or simple made up games can offer many opportunities for your child to learn and practice counting while practicing turn taking and social interaction. For younger children, use games that have a die or spinner with quantities up to 2. Gradually move up to using a regular die or a spinner with numbers 1 – 6 as your child's counting skills grow. You may want to make your own dot die putting one and two dots on each side of the die.

Dot patterns and playing games with dice are a great way to work on number concepts related to counting and quantity. There are many different games you can play with the attached dot pattern cards.

Cut out the cards and separate into two identical piles. Try any of the games listed below.

Memory Game – Gather six identical pairs of dot cards and place the cards, evenly spaced, upside down on the floor or the table. You and your child can take turns turning over two cards, looking for a match. Once you have found a match, remove those two cards and set aside. Use identical cards at first. Depending on your child's skill level, you can try using a set of dot pattern cards and a set of cards with the corresponding numeral on it. You and your child can take turns turning over two cards, looking to match the number with the corresponding set of dots.

Matching Game – Have your child go through the cards and make piles of the dot patterns that are the same.

Beat your Mom/Dad– Try holding up a card and see who can shout out the correct quantity first.

Matching Quantities –Give your child a bowl of small items such as blocks, washers, pennies…etc, and a blank card. Lay out a card with a dot pattern card or number on it and have your child match the same amount on the blank card.

Appendix F
Internet Resources

"31 Counting Books For Kids" (McDonald, 2013)
http://www.notimeforflashcards.com/2013/06/31-counting-books-for-kids.html

"Math Related Children's Books" (NAEYC, n.d.)
https://www.naeyc.org/files/tyc/file/MathbookslistSchickedanzexcerpt.pdf

"Support Math Readiness Through Math Talk" (NAEYC, n.d.)
http://families.naeyc.org/learning-and-development/music-math-more/support-math-readiness-through-math-talk

"Math Talk with Infants and Toddlers" (NAEYC, n.d.) – by Jan Greenberg
http://families.naeyc.org/learning-and-development/music-math-more/math-talk-infants-a

"Math-Related Children's Books, Songs, and Finger Plays for Preschoolers" (NAEYC, n.d.). http://www.naeyc.org/files/tyc/file/BooksSongsandFingerPlays.pdf

Appendix G
List of Children's Books

We Are Going on a Bear Hunt by Michael Rosen and Helen Oxenbury

There Were Ten in the Bed by Susan Chapman Calitri

Teddy Bear Teddy Bear School Day Math by Barbara Barbieri McGrath

From Head to Toe by Eric Carle

Ten Little Gator Eggs by Denise Sleeper

1, 2, 3 Snap a Mr Croc Book About Numbers by Jo Lodge

The Selfish Crocodile Book of Numbers by Faustin Charles

Two Sticks by Orel Protopopescu

Follow the Leader by Erica Silverman

We All Went on Safari by Laurie Krebs

Big Storm A Very Soggy Counting Book by Nancy Tafuri

Ten Little Racing Cars by Kate Thomson

Twelve Little Race Cars by Judy and Scott Pruitt

How Many Bugs in a Box by David. A. Carter

How Many Snails A Counting Book by Paul Giganti Jr.

Counting Blocks Numbers 1 – 20 by Anita Potter

Spot Can Count with Blocks by Eric Hill

Number Fun 1 2 3 Making Numbers with Your Body by Isabel Thomas

Estimation by Penny Dowdy

The Pizza That We Made by Joan Holub

Pizza Party by Grace Maccarone

Grandma's Button Box by Linda Williams Aber

We are Going on Leaf Hunt by Steve Metzger

1 2 Buckle My Shoe by Anna Grossnickle Hines

Ten Black Dots by Donald Crews