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The role of language in early childhood mathematics

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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

THE ROLE OF LANGUAGE
IN EARLY CHILDHOOD MATHEMATICS

A dissertation submitted in partial fulfillment of the
requirements for the degree of
DOCTOR OF EDUCATION

in

CURRICULUM AND INSTRUCTION

by

Raquel Munarriz Diaz

2008

To: Dean Luis Mirón
College of Education

This dissertation, written by Raquel Munarriz Diaz, and entitled The Role of Language in Early Childhood Mathematics, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

Charles Bleiker

Mohammed Farouk

Louis Manfra

Lisbeth Krauss, Co-Major Professor

Tonette Rocco, Co-Major Professor

Date of Defense: April 1, 2008

The dissertation of Raquel Munarriz Diaz is approved.

Dean Luis Mirón
College of Education

Dean George Walker
University Graduate School

Florida International University, 2008

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DEDICATION

I dedicate this dissertation to my mother, Raquel Martin Munarriz, for her inspiration, strength and support. Her dream of becoming an educator was cut short as a young woman in a Communist country... her dream lives in me.

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I would also like to thank all of my friends and family who have encouraged me throughout this journey. I especially would like to thank my mom and dad. They set the foundational skills needed to become a life long learner and through their example shown me the work habits necessary to succeed in life. Their biggest gift to me has been their unconditional love.

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ABSTRACT OF THE DISSERTATION

THE ROLE OF LANGUAGE IN EARLY CHILDHOOD MATHEMATICS

by

Raquel Munarriz Diaz

Florida International University, 2008

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Math literacy is imperative to succeed in society. Experience is key for acquiring math literacy. A preschooler's world is full of mathematical experiences. Children are continually counting, sorting and comparing as they play. As children are engaged in these activities they are using language as a tool to express their mathematical thinking. If teachers are aware of these teachable moments and help children bridge their daily experiences to mathematical concepts, math literacy may be enhanced.

This study described the interactions between teachers and preschoolers, determining the extent to which teachers scaffold children's everyday language into expressions of mathematical concepts. Of primary concern were the teachers' responsive interactions to children's expressions of an implicit mathematical utterance made while engaged in block play.

The parallel mixed methods research design consisted of two strands. Strand 1 of the study focused on preschoolers' use of everyday language and the teachers' responses after a child made a mathematical utterance. Twelve teachers and 60 students were

observed and videotaped while engaged in block play. Each teacher worked with five children for 20 minutes, yielding 240 minutes of observation. Interaction analysis was used to deductively analyze the recorded observations and field notes. Using a priori codes for the five mathematical concepts, it was found children produced 2,831 mathematical utterances. Teachers ignored 60% of these utterances and responded to, but did not mediate 30% of them. Only 10% of the mathematical utterances were mediated to a mathematical concept.

Strand 2 focused on the teacher's view of the role of language in early childhood mathematics. The 12 teachers who had been observed as part of the first strand of the study were interviewed. Based on a thematic analysis of these interviews three themes emerged: (a) the importance of a child's environment, (b) the importance of an education in society, and (c) the role of math in early childhood. Finally, based on a meta-inference of both strands, three themes emerged: (a) teacher conception of math, (b) teacher practice, and (c) teacher sensitivity. Implications based on the findings involve policy, curriculum, and professional development.

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CHAPTER I

INTRODUCTION

This parallel mixed methods study explored preschoolers' use of everyday language to express mathematical concepts and how teachers interact with children following a mathematical utterance. Adults and children use everyday language in typical conversations in their daily lives. In contrast, mathematical concepts are usually expressed as the scientific terms for concepts mastered through instruction (Moseley & Bleiker, 2003).

This section presents the background of the study, problem statement, purpose of the study, and research questions that will be investigated. The conceptual framework, significance of study, assumptions, delimitations, and definition of terms will also be addressed. The chapter concludes with a summary and brief description of the organization of the following chapters.

Background of the Study

A Nation at Risk (1983) warned that “the educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people” (p. 1). These words generated many debates between those who wanted reform and those who felt the report was full of myths and a “manufactured crisis” (Berliner & Biddle, 1995). Two decades later we are still a nation concerned with improving our educational standards and producing reports in attempts to reform the educational system, including mathematical reform.

In response to the call to improve the quality of math education, The National Council of Teachers of Mathematics (NCTM, 1989) produced content and process

standards for mathematics. Content standards encompass the five big ideas of math (a) number and operations, (b) algebra, (c) geometry, (d) measurement, and (e) data analysis and probability. Process standards delineate the procedures used to master the content standards. They include (a) communication, (b) problem solving, (c) connections, (d) reasoning, and (e) representation (NCTM, 2000). The NCTM standards have been revised several times from their conception in 1989 and were expanded in 2000 to include pre-kindergarten instruction for the first time.

In *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*, the National Research Council (NRC) examined the necessity of having quality mathematic programs. They concluded that everyone should have access to worthy mathematical programs, since “mathematics is the key to opportunity” (NRC, 1989, p. 3). Quality math programs in early childhood yield higher acquisition of math concepts when students are provided with hands-on experiences. Hands-on experiences help children construct mathematical understandings. “Research in learning shows that students actually construct their own understanding based on new experiences that enlarge the intellectual framework in which ideas can be created” (NRC, 1989, p. 6).

In 2001, the NRC, once again, examined the math curriculum in *Adding it up: Helping Children Learn Mathematics*. Findings supported the need for students to become mathematically literate. Math literacy was defined as being able to perform basic mathematical problem solving tasks needed to function competently in society. “For people to participate fully in society, they must know basic mathematics” (NRC, 2001, p. 1). Research-based instructional practices focused on mathematical literacy should guide curriculum and play a central role in deciding what is taught and how it is taught.

In 2002, the National Association for the Education of Young Children (NAEYC) and the National Council of Teachers of Mathematics (NCTM) created a joint position paper providing recommendations for high-quality, early childhood math instruction. An emphasis was placed on providing instructional opportunities that stem from the student's interests. This paper retained the claim the NRC (1989) that early childhood instruction should be filled with hands-on opportunities for learning that nurture the inquiring mind. Hands-on, engaging experiences allow the young learner to build the foundation needed to bridge their concrete understandings to more abstract concepts (NAEYC & NCTM, 2002).

With the plethora of reports addressing the importance of quality mathematical instruction, legislation is not focusing on high quality early childhood mathematics. In 2002 President Bush signed the *No Child Left Behind* (NCLB) act with strong support from both political parties. Although the law guarantees that all children in the United States will receive a high-quality education and the existing achievement gap will be narrowed, the emphasis was on reading instruction. NCLB has designated over \$1 billion dollars to the Reading First program to improve the literacy curriculum (U.S. Department of Education, 2006) with little to no money designated to math programs. While reading is crucial to success in school, the acquisition of early mathematical concepts is equally as crucial (Geist, 2004; Macnamera, 1972; Minton, 2007; Whittin & Whittin, 2000). The need for quality math in early childhood is necessary for future success in math (NRC, 2005).

Problem Statement

From birth, a newborn's environment is surrounded with mathematical opportunities (Geist, 2004; Macnamera, 1972). As infants become toddlers and enter school, they are engaged in free play where they sort, count, classify, add, and subtract. Math is everywhere and integrated into the child's daily context. Whether children are standing in line (ordinal numbers) or buying lunch (counting money), they are continually surrounded by mathematical opportunities. Reports to date have supported that curriculum based on hands-on experiences yield higher retention (NAEYC & NCTM, 2002; NRC, 1989, 2001, 2005). Children are born with the natural tendency to make sense of their world and construct meaning (Geist, 2004; Macnamera, 1972; NAEYC & NCTM, 2002). The problem is that with math being a natural part of the child's daily routine and vocabulary, are teachers recognizing and taking advantage of these teachable moments?

Purpose of the Study

This parallel mixed methods study described the interaction between teachers and preschoolers and the extent to which teachers scaffold children's everyday language into expressions of mathematical concepts. Of primary concern was the teachers' responsive interaction to children's expressions of an implicit mathematical utterance made while they were engaged in block play.

Research Questions

The primary research question was: How do teachers interact with preschoolers who use everyday language to express mathematical concepts? Subsidiary questions included the following:

1. How do children use everyday language to express mathematical concepts? Do they use everyday language to express classification, dynamic, spatial relations, quantities, or pattern and shapes?
2. How do teachers respond to children's everyday language in their teaching of math? Do they elaborate, extend, escalate, or otherwise scaffold the children's utterances into mathematical expression?
3. How do teachers define the role of language in early childhood mathematics?

Conceptual Framework

With the widespread adoption of Vygotskian, socio-cultural approaches to education in the 1980s, many teachers began to use a more context and language-centered approach to teaching (Berk & Winsler, 1995). A socio-cultural approach to learning suggests knowledge is shared through social tools (Wells & Claxton, 2002). Language is used as a tool for learning and restructuring children's conceptual systems into more abstract forms. As such, teachers can use language to bridge the child's concrete experience with a concept to its more abstract and scientific form. The metaphor of language as a "tool" for learning gained wide acceptance, and the culture of the classroom changed to reflect a community of learners rather than a collection of individuals (Dixon-Krauss, 1996; Wells & Claxton, 2002).

At the same time that socio-cultural learning theory was being introduced into the field of early childhood education, linguists began articulating exactly how language shapes meaning (Lakoff & Johnson, 1980; Lakoff & Nunez 2000; Winner, 1988). Linguists began looking at metaphors and saw metaphors "pervasive in everyday language and thought" (Lakoff & Johnson, 1980, p. ix). Metaphors are part of our

conceptual system and are used to organize our thoughts and actions. A metaphor involves not only understanding, but also experiencing one kind of thing in terms of another (Lakoff & Johnson, 1980). The idea that all language is metaphorical, with one thing standing for another, suggests that instructors can observe children's use of everyday language to help bridge the everyday language to appropriate mathematical concepts.

The intersection of these two lines of inquiry, socio-cultural learning theory and the metaphorical nature of language led to the concept of *Math mediated language* to explain how understanding math in the early years is related to general linguistic development (Moseley & Bleiker, 2003). Mathematical concepts begin as innate understandings that later become shaped and defined by the emergence of language. Language is a tool used to express early math concepts such as quantity, shape, and space (Lakoff & Nunez; 2000; Winner, 1998). Prepositions, for example, in this conception are essentially spatial markers describing the topological properties of the world (i.e., prepositions such as *around*, *over*, and *under* evolve into more formal geometric terms such as *perimeter*, *circumference*, and *coordinate plane*). Everyday language is therefore used to introduce more formal mathematical vocabulary (Moseley & Bleiker, 2003).

Significance of the Study

Success in math in the early years is a predictor of later academic success (Duncan et al., 2007). Early success in school can help students remain in school. Preventing students from dropping out in return can help the economy (Belfield & Levin, 2007). Many drop out intervention programs cost the nation thousands of dollars per child (Belfield & Levin, 2007). Many of these programs focus on making learning

meaningful to the student. Therefore, if teachers are encouraged to recognize and scaffold a young child's everyday language to mathematical concepts, it would not only be cost efficient, but beneficial to all early learners.

The teacher's role in scaffolding mathematical concepts from a child's early experiences is a key ingredient to effective instruction in mathematics. Developing effective instruction requires understanding the role of language in teachers' interaction with children, particularly in the way math conceptualization augments children's use of everyday language.

Assumptions

I entered this study with five assumptions. First, I assumed everyone can succeed in math. People do not excel in math due to the belief that (a) math is hard, (b) math is boring, and (c) school math is not needed in the real world. Second, I assumed that teachers care about their students, and although they may not be strong in math content, they are willing to help their students to the best of their ability. Third, although teachers do not normally remain in the block center while children are engaged in play, I assumed if they are invited to remain in the block center they will interact with their students. The amount of interactions would not be any different than the amount of interactions with children during any other time of day. Fourth, I assumed all children enter school with varied experiences that have led to an understanding of mathematical concepts, but lack the scientific vocabulary to express their mathematical concepts. Finally, I assumed that children engaged in play are not only using language to interact socially, but also to express mathematical concepts. I assumed the frequency of utterances would be equal among all mathematical categories.

Delimitations

This study focused on twelve early childhood teachers in different Head Start centers throughout Miami-Dade County engaged in block play with five of their students. Although varied in geographic location, the small sample size may limit generalization of the results to the population in other parts of the country. This study would have to be replicated at other grade levels and centers and similar results would have to be obtained before further conclusions could be made about extending results to other populations.

Definition of Terms

Terms that are used throughout this study are defined as follows:

Accept/repeat idea. When an utterance is acknowledged or repeated (Flanders, 1970). Accept/repeat idea was an a priori code used to analyze teacher interactions.

Ask question. Responding to an utterance by asking a question (Flanders, 1970). Ask question was an a priori code used to analyze teacher interactions.

Classification. Sorting and categorizing into groups (Seo & Ginsburg, 2004). Classification was an a priori code used to analyze student talk.

Constructivism. Learning theory that believes the child builds meaning internally through direct experiences with the environment (Piaget, 1965).

Deductive analysis. The use of a priori codes (i.e., using a pre-assigned coding system to sort data; Bogdan & Biklen, 2003).

Dynamic. Exploring motions such as putting things together and taking things apart (Seo & Ginsburg, 2004). Dynamic was an a priori code used to analyze student talk.

Enumeration. Using a number word while speaking. Enumeration was an a priori code used to analyze student talk.

Everyday language. Spontaneous, non-specialized language that children and adults use in their typical conversations in their daily lives (Moseley & Bleiker, 2003).

Inductive analysis. Allowing themes to emerge while analyzing data (Bogdan & Biklen, 2003).

Ignore. Period of silence and lack of verbal communication between teacher and student (Flanders, 1970). Ignore was an a priori code used to analyze teacher interactions.

Magnitude. Statements that refer to an object's size and also statements that compare two or more objects (Seo & Ginsburg, 2004). Magnitude was an a priori code used to analyze student talk.

Mathematical concepts. Scientific terms for concepts mastered through instruction (Moseley & Bleiker, 2003).

Math mediated language. Concept that explains how understanding math in the early years is related to linguistic development, where everyday language becomes the carrier of early math concepts such as quantity, shape, and space (Moseley & Bleiker, 2003).

Mediate. Process of helping bridge a child's spontaneous vocabulary (i.e., everyday language) to a scientific concept (e.g., mathematical concept; Vygotsky, 1986). Mediate was an a priori code used to analyze teacher interactions.

Metaphors. A metaphor is not only understanding, but also experiencing one kind of thing in terms of another. Metaphor is not only a matter of language; thought processes are also largely metaphorical in a person's conceptual system (Lakoff & Johnson, 1980).

Pattern and shape. Discussing a pattern or a specific shape (Seo & Ginsburg, 2004). Pattern and shape was an a priori code used to analyze student talk.

Praise or encourage. Praising or providing encouragement (Flanders, 1970).

Praise and encourage was an a priori code used to analyze teacher interactions.

Socio-cultural. Constructing meaning by interacting with the environment, social others, and/or social tools (Vygotsky, 1986, Wells & Claxton, 2002).

Spatial relations. Exploration of distance, location, and direction (Seo & Ginsburg, 2004). Spatial relation was an a priori code used to analyze student talk.

Teacher interaction. For the purpose of the study, teacher interaction refers to teachers interacting with children after a mathematical utterance has been made. Teacher interactions to children could include: ignore, accept/repeat, praise or encourage, ask question, or mediate.

Summary

Educational reforms have been calling attention to the need for improvements to the math curriculum. Quality math stems from a child's natural environment. Mathematical opportunities exist within the child's daily context. Teachers should take advantage of these teachable opportunities.

Chapter 2 explored the relevant research and key concepts associated with the study. Chapter 3 described the parallel mixed method research design. Participant selection, data collection tools and data analysis methods will be explained. Chapter 4 described the findings of the study, and Chapter 5 interpreted the results and presented implications and suggestions for future studies.

CHAPTER II

LITERATURE REVIEW

“Quality mathematics education for all students is essential for a healthy economy” (NRC, 1989). Most careers require math literacy Math literacy is defined as being able to perform basic mathematical problem solving tasks needed to function competently in society (NRC, 2001a). p.1). Experience is key for acquiring math literacy (Bredekamp & Copple, 1996). A preschoolers’ world is full of mathematical experiences (Ginsburg, 2006). Children are continually counting, sorting and comparing. Whether it is counting how many children want cereal, or sorting toys during play, children are in a math rich environment. As children are engaged in these activities they are using language as a tool to express their mathematical thinking. If teachers are aware of these teachable moments and help children bridge their daily experiences to mathematical concepts, math literacy may be enhanced.

This chapter will synthesize the literature relevant to this study. First the conceptual framework will be presented. Second, early childhood mathematics will be explored followed by the importance of play. Play is a tool teachers can use to observe children’s mathematical thinking (Seo, 2003). The final section will discuss the key ingredient needed for math mediated language—a teacher who interacts with the children.

Conceptual Framework

Math mediated language explains how understanding math in the early years is related to linguistic development, where everyday language becomes the carrier of early math concepts such as quantity, shape, and space (Moseley & Bleiker, 2003). The

concept of math mediated language builds from Piaget's constructivist theory, Vygotsky's sociocultural theory, and Lakoff's metaphor theory.

Piaget's Constructivist Theory

The constructivist process is the mental organization of experiences into schemes of thought resulting in cognitive growth (Morrison, 2003). "Mental growth consists in the child 'moving' from simpler to more complex systems of logical operations; the process being effected by the transformation and internalization of action into thought" (Bruner, 1997, p. 66)

Piaget identified four stages of cognitive development: (a) sensorimotor—from birth to 18 months, (b) preoperational—from 2 to 7 years, (c) concrete operational—from 7 to 12 years, and (d) formal operational—13 years and older. During the sensorimotor stage, infants use their senses to create mental schemes, or thoughts. The second stage, preoperational, is a time of accelerated language development with an increased ability to represent things using symbols. The third stage, concrete operations, involves the ability to reverse operations. For example, through hands-on experience, the child is able to know that the amount of a liquid does not change when it is moved to a different-shaped container (i.e., conservation). The final stage of cognitive development, formal operations, is characterized by an increase in abstract and complex thought (Ernest, 1998; Morrison, 2003).

Piaget (1965) believed that through active manipulation and the processes of assimilation and accommodation, the child would acquire conservation, a necessary condition for all rational activity. Assimilation is incorporating new information into existing knowledge and accommodation is adjusting new knowledge to existing

knowledge (Morrison, 2003). Conservation is having the ability to understand that the quantity of an object has not changed simply because its physical properties have been transformed (Piaget, 1965). Conservation has three stages, or levels. During the first stage, there is an absence of conservation. During the second stage, there is a transition where the child will see conservation in some situations, but not all. At the third stage, the child is able to conserve. Piaget confirmed his theory by observing children complete tasks (Piaget, 1965). The educational implication of Piaget's theory is not to teach the stages, but to encourage the child's active manipulation of objects by providing meaningful activities (i.e., distributing materials, collecting things, cleaning up and in playing games; Kami, 1982), believing that "to accelerate development of these operations (would be)...idiotic" (Piaget, 1973, p. 22).

Piaget's first book was on children's language and thought. "Piaget's interest in the study of language was to provide a window into the child's process of thought" (Beilin, 1992, p. 261). Children's speech evolved from being self-centered (i.e., egocentric) to being more socialized. Social speech results from social interactions (Beilin, 1992). Through active engagement with their environment, children construct or adapt schemas. The construction of schema based on children's experience is an important component of math mediated language. Listening to a child's use of everyday language is a window to their thinking. Teachers can assist the child in assimilating new information through social interactions.

Vygotsky's Socio-cultural Theory

Vygotsky, a social constructivist, believed learning occurred through the interaction of the child and social others (Vygotsky, 1978,). Social others are the people

taking part in the child's life. Children's experiences are developed through the guidance and encouragement of adults (Davydov, 1995). Three concepts central to social constructivist theory are zone of proximal development, scaffolding, and language as a tool.

Zone of proximal development is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). The teachers' role is to know their students' zone of proximal development and to help maximize their potential.

Scaffolding is support given by social others to help maximize the zone of proximal development. Although Vygotsky did not use the actual term, it was coined by Bruner (1975) to explain the process of moving a child along his zone of proximal development. The purpose of scaffolding is for the adult to withdraw control gradually as the child begins to master a task. In order to achieve this, the adult keeps the child motivated and assists the child in becoming successful at problem solving. A first step in becoming successful in any given task is to assist the child in redefining the problem from the adult's perspective. This is called intersubjectivity. This process requires more than teacher modeling; it requires the child to use language as a tool to communicate his/her plans to solve the task.

Children use private speech to help regulate their thinking. Private speech consists in self-talk while performing a task. As a child gets older, this private speech becomes inner verbal thoughts; although thinking out loud may still occur when a child is trying to solve a challenging task.

Language is the “primary cultural tool” (Berk & Winsler, 1995) used to mediate a child’s development. Language is not only helpful for a child to internalize concepts, but it is a window into the child’s internalized thoughts. Teachers should observe children’s speech in order to provide the necessary support to move the child along his/her zone of proximal development.

Children communicate and enter school using spontaneous vocabulary (i.e., everyday language) concepts, but they lack scientific vocabulary (i.e., content words) to express their thoughts (Vygotsky, 1986). “The acquisition of scientific concepts is carried out with the mediation provided by already acquired concepts” (p. 161). Mediation is the act of facilitating concept formation. Math mediated language is the process of bridging the child’s use of everyday language to express a mathematical concept to the actual mathematical term. For example, if a child is playing with blocks and says, “Hey, put the blocks around the farm,” the teacher could mediate by responding, “You want me to place the blocks around the perimeter of the farm?” In this example the child’s everyday language *around* is bridged to the mathematical term *perimeter*.

Lakoff’s Metaphor Theory

In order to express an idea, one uses words tied to his/her conceptual framework. Human thought processes are metaphorical and tied to one’s culture (Lakoff, 1980). “The essence of metaphor is understanding and experiencing one kind of thing in terms of another” (Lakoff, 1980, p. 5). Metaphors are structural or orientational and grounded by experience. Structural metaphors are when one concept is understood in terms of another (e.g., man as a machine). Orientational metaphors deal with spatial orientation and vary from culture to culture. For example, in our culture, happy is seen as up and sad is seen as

down (i.e., He is feeling down today, means he is sad). Different cultures shape their thoughts differently (Boroditsky, 2001). For example, time is seen differently by Mandarin and English speakers. English speakers see time as moving horizontally, while Mandarin speakers see time as moving vertically (Boroditsky, 2001).

Math is grounded on four metaphors: (a) arithmetic as object collection, (b) arithmetic as object construction, (c) arithmetic as a measuring stick, and (d) arithmetic as motion along a path (Lakoff & Nunez, 2000). Arithmetic as object collection views math as grouping objects, adding objects, and taking away objects. Arithmetic as object construction sees math as objects consisting of parts, or unit size (e.g., five is made up of three plus two). Arithmetic as a measuring stick sees math as measuring using physical segments (e.g., line segments). Arithmetic as motion along a path uses the number line to conceptualize numbers. These four metaphors arise from everyday experiences.

Young children use metaphors to express their ideas. By listening to a child's use of metaphors, teachers can get a better understanding of the child's conceptual system. Through a better understanding of a child's conceptual system, the teacher can promote conceptual understanding.

Math Mediated Language

Math mediated language conveys how math in the early years is related to linguistic development. Everyday language becomes the carrier of early math concepts such as quantity, shape, and space (Moseley & Bleiker, 2003). Piaget, Vygotsky and Lakoff saw language as a window into children's thinking. Teachers should be aware of how children use common words to express mathematical thinking. "If teachers fail to see the mathematical meaning that is present in the language they use or could use to

describe mathematical relations, then possible avenues for transfer of mathematical knowledge may be lost” (Moseley & Bleiker, 2003, p. 20). Mathematical concepts are embedded in a child’s daily activities (Ginsburg, 2008). Everyday mathematics is embedded in play. As children play in centers they are using math words concerned with classification, dynamic, magnitude, enumeration, spatial relation and pattern and shape (Seo & Ginsburg, 2004).

Early Childhood Mathematics

In order to bridge children’s everyday language to mathematical concepts, it is important for teachers to understand what the key early childhood mathematical concepts are and which practices are developmentally appropriate for children. According to Frede et al. (2007), early childhood teachers are not encouraging math concepts nor using mathematical terminology. Lack of mathematical terminology may be due to lack of teacher preparation. According to some, the United States is suffering from a “preparation gap” (Schmidt et al., 2007). Teacher preparation needs to focus on content and on pedagogy (e.g., developmentally appropriate practices).

The National Association for the Education of Young Children (NAEYC) identified developmentally appropriate practices for early learners (Bredekamp & Copple, 1996). The National Council of Teachers of Mathematics (NCTM) published preschool mathematics standards (NCTM, 2000; NCTM, 2006). NAEYC and NCTM (2002) combined their expertise and created a position statement on how to promote good beginnings in early childhood mathematics. This next section will present developmentally appropriate practices, the math standards, math focal points, and ways to promote good beginnings in early childhood mathematics.

Developmentally Appropriate Practices

Developmentally appropriate practices are broken into curriculum goals, teaching strategies, integrated curriculum, guidance of social-emotional development, parent-teacher relations, and assessments (Bredekamp & Copple, 1996). Developmentally appropriate practices are concerned with the well-being and education of the child based on child development research, individual variations, and social and cultural backgrounds of the child (NAEYC, 2006). The purpose of identifying developmentally appropriate practices is for early childhood centers to provide high quality programs for their students. Quality programs focus on promoting a nurturing environment while meeting the physical, social and emotional needs of each child (Bredekamp & Copple, 1996). High quality programs will yield children who feel supported and capable of success (Frede, Jung, Barnett, Lamy, & Figueras, 2007).

Curriculum Goals

Developmentally appropriate curriculums are designed to meet the individual needs of the child while developing the child's self-esteem. The curriculum takes into account all areas of development: physical, social, emotional, and intellectual (i.e., cognitive). These domains are closely related. In other words, development in one domain influences the development of the other domains (Bredekamp & Copple, 1996). For example, early math success has been correlated to success in other areas of development (Duncan, et al., 2007).

Teaching Strategies

Teachers integrate the curriculum through projects and learning centers that reflect the child's interest. The teachers guide, enrich, and interact with their students and

families. Teachers create a learning environment that is conducive for exploration, interactions, and collaboration. Teachers encourage the child to reflect on learning experiences by providing support and guidance (Bredekamp & Copple, 1996), which is one of the components of math mediated language. Math mediated language helps guide and enrich mathematical concepts through teacher-child interactions.

Integrated Curriculum

A curriculum “delineates the content that children are to learn, the processes through which children achieve the identified curricular goals, what teachers do to help children achieve these goals and the context in which teaching and learning occur” (Bredekamp & Rosengrant, 1992, p. 10). The curriculum is connected across subject matters to help the child make meaningful connections. Communicating, exploring, discovering, and problem solving are integrated into projects and learning center activities (Bredekamp & Copple, 1986, 1996, Bryant, Clifford & Peisner, 1991). Since play is such an important part of the early childhood curriculum, it should make sense to integrate math concepts while the child is engaged in play. “Play can indeed produce learning—even mathematics learning (Ginsburg, 2006, p. 145).

Guidance of Social Emotional Development

Children are valued as individuals and their uniqueness is celebrated. “Children develop and learn best in the context of a community where they are safe and valued, their physical needs are met, and they feel psychologically secure” (NAEYC, 2006, p. 8). Opportunities are provided to promote communication and to develop social skills such as playing in activity centers and helping each other and the teacher. An important component to scaffolding is “the emotional tone of the interactions” (Berk & Winsler,

1995, p. 29). In accordance with the social-emotional guidelines of developmentally appropriate practices, math mediated language scaffolds mathematical concept in a safe and secure environment.

Parent-Teacher Relations

Parents are viewed as partners and efforts are made to involve parents. In establishing relationships with the child's home, the teacher becomes more aware of the child's social context and can better meet the needs of the child and the family. Teachers need to be culturally responsive to the child's background and find ways to include parents into the curriculum (Bredekamp & Copple, 1996). In developmentally appropriate classrooms, teachers value the role of parents and welcome their input. Many parents also welcome teacher input. This is an important component for early math education. Teachers can help parents find teachable moments outside of school to bridge a child's everyday language to mathematical concepts. Math mediated language is not only a characteristic of formal schooling. Parents can also help bridge a child's spontaneous speech to mathematical concepts.

Assessment

"Assessment is the process of observing, recording, and otherwise documenting the work children do and how they do it, as a basis for a variety of educational decisions that affect the child" (Bredekamp & Rosengrant, 1992, p. 10). Assessment should be varied (e.g., focused observations, portfolios, and summative evaluations) and impact instruction. Through focused observations, teachers can find teachable moments to mediate mathematical concepts throughout the day and determine if the way in which

they are utilizing teachable moments is improving the children's math skills/understanding.

Developmentally appropriate practices were established to meet each child's individual need and provide each child with a high quality early childhood education. Through an integrated curriculum and a guiding teacher, children can achieve their maximum potential and have academic, and specifically mathematic, success. What is considered mathematical academic success? The National Council of Teachers of Mathematics have defined math standards used to determine mathematical achievement.

Principles and Standards for School Mathematics (PSSM)

Seeing the importance of the early years, the NCTM revised their standards to include pre-kindergartners in 2000. Standards are defined as "guidelines that help realize visions of high-quality mathematics education" (Clements & Sarama, 2004). NCTM produced five content standards and five process standards for mathematics education. The five strands of the process standards are (a) problem solving, (b) connections, (c) reasoning, (d) representation, and (e) communication (Clements & Sarama, 2004; NCTM, 2000).

The five strands of the content standards are (a) number sense and operations; (b) algebra; (c) geometry; (d) measurements; and (e) data analysis and probability. The content standards are connected by process standards that relate to all content areas. Number and operations consist of counting, comparing, ordering, grouping, adding to and taking away a quantity. The emphasis of algebraic thinking in early childhood involves finding patterns. Patterns are a way for children to recognize order and to organize their environment (NCTM, 2000). Data analysis uses information to classify, organize, and

answer questions. “Geometry can be used to understand and to represent objects, directions and locations in our world, and the relationship between them” (Clements & Sarama, 2004, p. 39). The subtopics of geometry include shape, location direction and coordinates, visualization and spatial reasoning, and transformations and symmetry. Measurement, one of the most widely used applications, determines how much of an attribute an object possesses, such as length, weight, and capacity. Measuring may involve the use of tools, such as rulers, but include nonstandard ways of measuring, such as paper clips.

Curriculum Focal Points

Although NCTM has provided standards to help guide the mathematic curriculum, states are providing inconsistent mathematical programs resulting in a math curriculum that is “a mile wide and an inch deep” (Schmidt, McKnight, & Raizen, 1997 as quoted in NCTM, 2006, p. 3). NCTM established which mathematical topics were imperative to cover in prekindergarten through grade eight. Curriculum focal points consist of the primary important mathematical concepts for each grade level (NCTM, 2006). The focal points should be addressed in contexts and should emphasize the process standards (i.e., communication, reasoning, representation, connections, and problem solving). In prekindergarten, the focal points are number sense, geometry, and measurement. Number sense in prekindergarten centers on developing an understanding of the meaning of whole numbers, including one-to-one correspondence, counting, and comparison. Geometry in prekindergarten focuses on recognizing spatial relationships and identifying shapes. Measurement in prekindergarten concentrates on using terms such as more or less to identify and compare measurable attributes (NCTM, 2006).

Early Childhood Mathematics: Promoting Good Beginnings

In 2002, NAEYC and NCTM developed a joint position statement in order to affirm the necessity for high quality early childhood mathematics education. Their recommendations reflect the necessity to build on the child's early experiences and on the importance of providing strong foundational experiences. Children are trying to make sense of their world (NAEYC & NCTM, 2002).

Teachers need to capitalize on these moments and also build on the experiences the child brings into the classroom. Classroom instruction should be integrated and emphasize problem solving and reasoning. The curriculum needs to be coherent and focus on the big ideas. The teacher serves as a guide and provides learning opportunities at the child's interest and cognitive level (NAEYC & NCTM, 2002).

Play

Early experiences are key in setting the foundation for future learnings (Bredekamp & Copple, 1996). Play is viewed as an important vehicle for learning through context. "Any activity that is self-chosen, open-ended, spontaneous, and enjoyable is considered play" (Trawick-Smith, 1994, p. v). Play is a part of the child's preschool day. In short, "play = learning" (Singer, Golinkoff, Hirsh-Pasek, 2006, p. 10). This next section will discuss types of play, stages of play, the play crisis and the benefits of play.

Types of Play

Play can be divided into sensorimotor or functional play, dramatic play, and construction play (Phelps, 2002). Early childhood classrooms offer children opportunities to play in varied situation using varied settings.

Sensorimotor Play

Sensorimotor play involves interacting with the environment using one's senses. "Toddlers are interactive learners. They must touch, feel, see, and hear to learn" (Phelps, 2002, p. 45). Sensorimotor play is supported in an environment where the child is given opportunities to play inside and outside with different materials in order to maximize sensory experiences (Phelps, 2002).

Dramatic Play

Dramatic play is make-believe play in which children use their imagination and pretend. Children could assume make believe roles or situations. "Action in the imaginative sphere, in an imaginary situation, the creation of voluntary intentions and the formation of real-life plans and volitional motives—all appear in play and make it the highest level of preschool development" (Vygotsky, 1967, p. 16). Dramatic play is supported by providing spaces in the classroom for the child to pretend (e.g., a kitchen area). Children use props or materials to enhance this form of symbolic play.

Construction Play

Construction play is considered fluid, messy, and structured. It includes a child putting together materials such as water, blocks, paint, sand, or clay into a structured product (Phelps, 2002). To support construction play, the children should have access to a variety of materials and be provided with time and space throughout the day.

Stages of Play

As children are engaged in play they go through several stages. Teachers should be aware of these stages in order to best work within the child's zone of proximal development. Parten (1932) observed 42 children from 1-5 years playing to define stages

of social behavior in play: (a) unoccupied, (b) onlooker, (c) solitary, (d) parallel, (e) associative, and (f) cooperative. During the unoccupied stage, the child is not watching or interested in the surrounding environment. The child is not interacting and is keeping to himself/herself. An example of this behavior is a child sucking a thumb while holding a blanket (Phelps, 2002). During the onlooker stage, the child is observing other children engaged in an activity. The child is interested in the activity he is observing and may want to enter into play. A child at this stage is engaged in an activity alone, such as a child painting at an easel or playing alone in the sandbox. Parallel play, the most common form of play among toddlers, consists in children in the same activity side by side, without interacting with each other. This may include two children painting their own pictures at an easel or two children playing in the sandbox side by side, but not with each other. Associative play involves a child playing with others, but without a planned purpose. An example of associative play is several children in the sandbox discussing their trip to the zoo. In cooperative play, children play together with an intended goal. An example of this is a group of children playing hide and go seek.

Knowing the stages of play will help the teacher accommodate his/her interactions and help maximize the benefits of play. Children engaged in block play can demonstrate any of these stages of block play. From playing side-by-side with another child to working with a child to build a structure, block play offers the opportunity for all children to develop mathematical skills (Wellhousen, 2001).

Play Crisis

With all the benefits play provides (Armstrong, 2006, Ginsburg, 2006; Phelps, 2002; Seo, 2003; Vygotsky, 1967), it is surprising to be in a play crisis. With hurried

schedules, academic pressures, and growing technology, young children are not playing as much as they used to. Concerned over this crisis, the American Academy of Pediatrics (AAP) issued a clinical report entitled, *The Importance of Play in Promoting Healthy Child Development and Maintaining Strong Parent-Child Bonds* (Ginsburg, 2006).

Hurried Schedules

According to the report, free play has declined significantly and is being replaced with overscheduled children engaged in organized activities. Child-driven play, which benefits children, has decreased. Downtime that allows parents and children some of the most productive time for interaction is at a premium when schedules become highly packed with adult-supervised or adult-driven activities (Ginsburg, 2006). Classrooms are also suffering from hurried schedules. With pressures to perform on standardized tests, many classrooms are replacing play time with back to basic time (Kontos, 1999).

Academic Pressures

With an increase in school accountability, parents are opting for children to use their free time to engage in enriching, cognitive activities. Young children are given more homework, longer school days, less nap time, and less recess (Armstrong, 2006).

Growing Technology

“The decrease of free play can also be explained by children being passively entertained through television or computer/video games” (Ginsburg, 2006, p. 185). Television and computers are not considered sensory rich environments for young children (Armstrong, 2006). If creative, free play is substituted with passive forms of entertainment, the child will not reap the benefits of play and the child’s development can be affected. Blocks have been around since the beginning of kindergarten, and provide

the child many opportunities to actively create and socially interact with others (Hirsch, 1993; Johnson, 1928; MacDonald, 2001; Wellhausen, 2001).

Benefits of Play

Play helps the child develop physically, cognitively, and socially (Armstrong, 2006; Ginsburg, 2006; Phelps, 2002; Seo, 2003; Vygotsky, 1967). This next section will focus on the social and cognitive benefits of play.

Social Benefit of Play

Play encourages children to interact and develop social skills they will need to negotiate through situations in life (Smilansky, 1968). Play also helps the child get along with his peers and negotiate through rules. “Whenever there is an imaginary situation in play there are rules...rules stemming from the imaginary situation” (Vygotsky, 1967, p. 10). Dramatic play, involves taking on roles children have observed others perform. In other words, through play, rules of culture are reinforced and applied (Vygotsky, 1967).

Cognitive Benefit of Play

Play benefits all areas of cognitive development, including literacy and math. Play facilitates oral language (Trawick-Smith, 1994). As children interact with peers and adults, they are enriching their vocabulary and learning proper modeling of language using appropriate intonation, grammar, and semantics (Isbell & Raines, 1991; Phelps, 2002; Trawick-Smith, 1994). Mathematical skills, such as understanding number and spatial relationships, are also naturally enhanced while a child is engaged in free play. “Play offers young children opportunities to develop informal mathematical understanding as they manipulate objects, interact with their peers, and explore the world

around them” (Seo, 2003, p. 22). These informal understandings become the foundation to the formal mathematical concepts.

Block Play

According to Trawick-Smith (1994), the block center is the area in the classroom that best promotes mathematical learning. Blocks date back to the beginning of kindergarten and have been studied extensively (Davis, 1997, Hirsch, 1993; Johnson, 1928; MacDonald, 2001; Wellhousen, 2001). This next section will explain the history of blocks, stages of block play, and benefits of block play.

History of Blocks

Blocks are an integral part of most early childhood classrooms dating back to 1880s. “The initial use of blocks as a vehicle for teaching young children in an educational setting is attributed to Froebel, German educator and father of the kindergarten” (Wellhousen, 2001, p. 5).

The unit blocks that are found in most early childhood centers were created by Caroline Pratt. Pratt, realizing the importance of play in a child’s development, created materials allowing young children to express and recreate their experiences (Winsor, 1984). “Blocks would remain simply pieces of wood, unless infused with a body of information which is gleaned from experience” (p. 3). Pratt believed blocks could only be effective when the child engaged in block play with a teacher providing experiences to further the child’s thinking (Winsor, 1984).

Stages of Block Play

Harriet Johnson, a colleague of Caroline Pratt, directed The Nursery School in New York (now the Bank Street School for Children), an experimental school for

children from 14-36 months. She observed children at play, including playing with blocks. Her observations are still used today when exploring the benefits of block play (Johnson, 1928).

Blocks serve many purposes. First, blocks give children the potential to deal effectively with his/her environment through the power of building materials. Second, blocks provide opportunities to express rhythm, pattern, and design. Third, blocks allow a child to express past experiences (Johnson, 1928).

Johnson's extensive observations and record keeping of children with blocks led to seven stages of block play that are still referred to today: carrying, stacking, bridging, enclosures, patterns and symmetry, early representational, and later representational (Johnson, 1928). In the first stage, carrying, blocks are carried around and not used for construction. In the second stage, stacking, blocks are stacked repeatedly either vertically or horizontally. In the third stage, bridging, children use two blocks to support a third, such as a roof. In the fourth stage, enclosures, children use blocks to enclose a space. In the fifth stage, patterns and symmetry, children use their previous knowledge of blocks to create patterns and symmetrical designs. In the sixth stage, early representational, children begin to use a greater number of blocks to construct towers, rows, bridges, and patterns. Children use blocks to create structures they can identify by name, although they may not be accurate representations. In the final stage of block building, later representational, children use blocks to create cities, airplanes, houses, and the like. At this stage, children are using blocks to role play (Cuffaro, 2006; Hirsch, 1984; Johnson, 1928, Wellhousen, 2001).

Benefits of Block Play

Blocks are everywhere and easily accessible. Children enjoy to construct and explore with blocks. Block play enhances: (a) art, (b) social studies, (c) science, (d) and (e) math (Davis, 1997; Hirsch, 1993; Johnson, 1928; MacDonald, 2001; Wellhousen, 2001).

Art

Block play is open ended and children are free to express themselves in artistically creative ways (Johnson, 1984). Having blocks in the classroom encourages children to construct towers, rows, bridges, enclosures and patterns and to create representations (Johnson, 1984).

Social Studies

Social Studies focus on social skills in the early years of school. Block play encourages communication and helps develop social skills (Winsor, 1984). Children learn to get along with their fellow peers and negotiate rules of play in order to get along (Miller, 2006). Children also use blocks to express their knowledge about their community and community helpers (Winsor, 1984).

Science

Science is best learned through observation, discovery, and problem solving. Children learn about properties of blocks and begin to observe attributes associated with matter (i.e., size, shape, and weight). They learn about gravity and implicitly discover how balance and stability help keep their structures from falling down (Chalufour & Worth, 2004; Moffitt, 1984).

Literacy

“Block play provides a basic foundation for promoting language and literacy learning” (Wellhousen, 2001, p. 92). Through interactions, children communicate and expand their vocabulary. Children are using everyday language to express mathematical concepts (Moseley & Bleiker, 2003). Isbell and Raines (1991) studied children’s oral language while engaged in play. They observed young children’s language production while playing in the dramatic center, housekeeping center and the block center. Results found children were producing more language while playing the in the block center.

Math

Blocks encourage children to learn about space, shapes, size, order, number, counting, patterns, symmetry, measuring, classification, and fractions (Leeb-Lundberg, 1984; MacDonald, 2001; Newburger & Vaughan, 2006; Wellhousen, 2001; Wolfgang, 2001.). Children are learning these concepts through concrete experience and building the foundations to develop abstract concepts in upper grades (Leeb-Lundberg, 1984). Block play in the early years has also proven to increase school achievement in mathematics (Wolfgang, 2001).

Summary of Play

Play provides an opportunity for learning. There are three types of play: sensorimotor, dramatic and constructive. Block play is a type of constructive play that enhances mathematical thinking. Teachers are key in helping the child achieve his/her maximum potential. Teachers can enhance learning through “carefully crafted” interactions (Trawick-Smith, 1994).

Teachers

In order to reap the benefits of block play, the classroom needs to have a teacher who nurtures and facilitates block play and encourages interactions during block play. This next section will focus on the teachers' practices and beliefs, teacher preparation and professional development, and teacher interactions.

Teachers' Practices and Beliefs

"Teachers' beliefs, views, and preferences about mathematics and its teaching, regardless of whether they are consciously or unconsciously held, play a significant, albeit subtle, role in shaping the teachers' characteristic patterns of instructional behavior" (Thompson, 1991, pp. 124-125). Teacher beliefs tend to fall into two theoretical frameworks: basic skills or child-centered (Stipek, 1997). A basic (i.e., back to basic) skills approach emphasizes drill and memorization. States advocate this academic-oriented, skills-centered curriculum to prepare the child for first grade (Hatch & Freeman, 1988). A child-centered approach emphasizes child-initiated activities. The teacher is a facilitator and uses the child's interest as a springboard for curriculum decisions. According to Bredekamp & Copple (1996), the latter framework is more developmentally appropriate for preschoolers.

Factors Influencing Teacher Practices

The Horizon Group (2003) observed 364 mathematics and science lessons. Extensive teacher interviews were conducted to determine why they selected and how they taught lessons. The most influential factors were state and district standards, textbook design, and state-mandated tests. With the state and district mandates focusing on literacy, teachers spend less time focusing on mathematics (Ginsburg, 2008).

Factors Influencing Teacher Beliefs

The Horizon study found the most influential factor of instructional practices was the teacher's beliefs (Horizon, 2003). Early childhood teachers appear to be afraid of math and do not want to teach it (Ginsburg, 2008). Several factors play a role in teacher beliefs: (a) self-efficacy, (b) locus of control, (c) stress and anxiety, and (d) educational background and experience (McMullen, 1999). Self-efficacy is a teacher's belief that he/she has the power to make the child succeed. Locus of control is either internal, where teachers feel they can control/help children succeed, or external, where teachers feel children's success is contingent upon external factors (McMullen, 1999). Teachers who focus on basic skills tend to lack self-efficacy and have higher levels of stress. These teachers let external factors, such as state mandates and state assessments, guide their instruction. Through professional development, teachers become familiar with state mandates and how they influence mathematic instruction.

Teacher Preparation and Professional Development in Early Math

Educational background and experience play a vital role in how teachers provide mathematical experiences. Although early childhood teachers integrate curriculum and advocate a child-centered curriculum, opportunities to teach math are overlooked (Graham, Nash, & Paul, 1997). Teacher preparation and professional development play a critical role in fostering the importance of providing early mathematical experiences.

Teacher Preparation

According to Nolan (2007), preservice teachers lack mathematical preparation. Some teachers have expressed an interest in early childhood in order to avoid teaching math (Copley & Padron, 1998). Teacher preparation assists in shaping teachers'

conceptions of math, which, in turn, influence their mathematics instruction. Instruction combined with experience with children is the strongest way to affect teachers' beliefs (Phillip, Clement, Thanheiser, Schappelle, & Sowder, 2003).

Professional Development

Teachers' beliefs can be affected through professional development. Professional development in early childhood mathematics should address the following standards (a) having a positive attitude towards math; (b) being exposed to good mathematical instruction, which includes problem solving, communicating, and working with peers; (c) focusing on what children are doing and what they are interested in learning; (d) participating in professional learning communities that emphasize mentoring from experienced teachers; (e) integrating mathematical concepts throughout the child's day; and (f) creating family partnerships (Copley & Padron, 1998).

Many early childhood educators lack preparation related to early childhood math (Coppie, 2004). If given the proper training, math instruction could be enhanced. When teachers have an "awareness and knowledge about mathematics and the rich potentials for early math learning, a great many will think of wonderful ways to *mathematize* their classroom and curriculum" (p. 87).

Importance of Interaction

To *mathematize* is to find everyday opportunities to infuse math into the daily context (Clement & Sarama, 2004). Teacher observation and interactions are key to finding these teachable moments that develop math concepts in the context in which they occur. Teacher interaction is a "key ingredient of high quality early childhood programs"

(Kontos, 1999, p. 363). The school day offers many opportunities to interact in order to mathematize.

Math in the Early Childhood Context

Children experience math in the early childhood classroom mostly through songs and math-related stories (Graham, Nash, & Paul, 1997; Smith, 2001). Within songs, poems, and books, many math words are integrated into the language: comparing words, positional words, number words, sequence words, time words, and shape words. “The challenge to the teacher is to take the powerful tool of the language of math and guide the child to a deeper understanding based on what is already known” (Smith, 2001, p. 33).

Math can also be taught through opportunistic teaching and spontaneous teaching. Opportunistic teachings are math discussions initiated by the teacher and spontaneous teachings are initiated by students. Unfortunately, both spontaneous teaching and opportunistic teaching are very scarce (Graham et al., 1997). Many classrooms suffer from what Bredekamp and Rosegrant (1992) call the “early childhood error” where teachers prepare a learning environment full of learning opportunities, but fail to guide or support children as they are engaged in play (Kontos, 1999).

Types of Interaction

Interactions consist of three categories: teacher talk, student talk, and no talk (Flanders, 1970). These categories can be broken into sub-categories. Teacher talk includes accepting feelings and ideas; praising; asking questions; explaining; and redirecting behavior. Student talk is broken into teacher-initiated and student-initiated talk (Flanders, 1970; Kryspin, 1974).

Developmentally Appropriate Interactions

Mathematical concept building does not occur just because students and teachers are interacting (Clement, 1997; (deKruif, McWilliam, Ridley, & Wakely, 2000). Interactions stem from the child's natural curiosity and lead to reflective thinking (Haroutunian-Gordon, 1996). Successful interpretive discussions result from teachers who validate the child's thinking (Schwartz & Brown, 1995) and elaborate on the child's responses (deKruif et al., 2000). Teachers need to find teachable moments to introduce or elaborate on a new concept. "Such moments might come and go without significance unless carefully phrased questions, suggestions, or warm encouragement are provided by an adult" (Trawick-Smith, 1994, p. 12).

Benefits of Developmentally Appropriate Interactions

Classrooms that are rich in mathematical discussion produce higher levels of mathematical growth (Brenner, 1998; Kilbanof et al., 2006, Kontos, 1999). "Through active discussion with their teachers and peers, students are expected to gain a greater understanding of the conceptual underpinnings of mathematics and become better problem-solvers" (Brenner, 1998, p. 5). Discussions and interactions enrich the child's conceptual system.

Summary

Children enter preschool with mathematical knowledge. Math mediated language takes into account Piaget's constructivist theory, Vygotsky's socio-cultural theory, and Lakoff's metaphor theory. Children use language as a tool to construct meaning by interacting with peers and their teachers. Developmentally appropriate practices take into account the value of child-initiated curiosity and integrate their experiences to the

curriculum. The early childhood mathematics curriculum takes into account NCTM math standards and focus on specific focal points. Curriculums present math concepts through motivating and experience-rich context. Play, such as block play, offers an opportunity to infuse mathematical concepts. Teachers need to observe children at play and interact with children in order to promote mathematical learning. Teacher preparation and professional development opportunities need to address these instructional practices. Professional development needs to address the importance of interactions and the benefits of interacting with children in order to foster mathematical understanding stemming from the child's everyday context.

In summary, children's learning is enhanced when they are interacting with teachers while engaged in play. Although there has been research on the benefits of interaction (Kilbanoff et al., 2006; Kontos, 1999; Trawick-Smith, 1994) and on student talk while engaged in play (Ginsburg, 2006; Isbell & Raines, 1991; Seo, 2003; Seo & Ginsburg, 2004), there appears not to be a study describing how teachers interact with children who have used everyday language to express a mathematical concept. Chapter three described the research design to study how teachers interact with preschoolers who use everyday language to express mathematical concepts. Chapter four described the results and Chapter five interpreted the findings and discussed the implications of the study.

CHAPTER III

METHODS

This chapter begins with the background of the study and research questions repeated from chapter one. The parallel mixed method framework used in the study will be presented and followed by an autobiography and assumptions of the researcher. A description of the population, sample, data collection, data analysis, and data management will follow. The final section will address integrity measures.

Background of the Study

From birth, a newborn's environment is surrounded with mathematical opportunities (Geist, 2004; Macnamera, 1972). As infants become toddlers and enter school, they are engaged in free play. In free play, preschoolers sort, count, classify, add, and subtract throughout the day. Math is everywhere and integrated into the child's daily context. Whether children are standing in line (ordinal numbers) or buying lunch (counting money), they are continually surrounded by mathematical opportunities. Reports to date have supported that curriculum based on hands-on experiences yield higher retention (NAEYC & NCTM, 2002; NRC, 1989; NRC, 2001; NRC, 2005). Children are born with the natural tendency to make sense of their world and construct meaning (Geist, 2004; Macnamera, 1972; NAEYC & NCTM, 2002). With so much evidence in support of taking advantage of the child's natural context, why is reading put first? With math being a natural part of the child's daily routine and vocabulary, teachers need to become aware of these teachable opportunities.

This parallel mixed methods study described the interaction between teachers' and preschoolers' in the extent to which teachers scaffold children's everyday language into expressions of mathematical concepts. Of primary concern was the teachers' responsive interaction to children's expressions of an implicit mathematical utterance made while engaged in block play.

Research Questions

The primary research question was: How do teachers interact with preschoolers who use everyday language to express mathematical concepts? Subsidiary questions included the following:

1. How do children use everyday language to express mathematical concepts? Do they use everyday language to express classification, dynamic, spatial relations, quantities, or pattern and shapes?
2. How do teachers respond to children's everyday language in their teaching of math? Do they elaborate, extend, escalate, or otherwise scaffold the children's utterances into formal mathematical expression?
3. How do teachers define the role of language in early childhood mathematics?

Parallel Mixed Method Design

Mixed method research designs are "a type of research design in which QUAL and QUAN approaches are mixed across the stages of a study" (Teddle & Tashakkori, 2006, p. 16). In a parallel mixed method design, the strands or phases of the research are independent of the other. Commonly one of the strands involves a quantitative analysis and the second strand consists of a qualitative analysis. "Although the two sets of analyses are independent, each provides an understanding of the phenomenon under

investigation. These understandings are linked, combined, or integrated into meta-inference(s)” (Teddle & Tashakkori, in press, p. 29-30). A phenomenon could be an emotion, a relationship, or a program (Patton, 2002). The phenomenon under investigation was the teachers’ responsive interaction to children’s expressions of an implicit mathematical utterance made while engaged in free block play.

About the Author

In order to prepare to explore a phenomenon, a first step is to set “aside our prejudgments, biases, and preconceived ideas about things” (Moustakas, 1994, p. 85). The following section presents a brief autobiography and assumptions of the researcher.

From Mangos to Ice Cream: A Brief Autobiography

Early in life, I learned an important mathematical lesson: bartering. One of my favorite memories as a child was bartering mangos from our tree for ice cream from the local ice cream vendor. Even though I viewed this as a wonderful business venture, my mom saw it as sharing one’s gifts with others. Mom insisted that everyone had a special gift and needed to share that gift with others and hope that they would reciprocate. Although I wasn’t clear on what she meant, I knew if I shared the ripe mangos from our tree, the ice cream man would give me delicious, creamy ice cream. It took years before I truly understood that trading mangos was not about bartering, but about sharing talents.

I knew I wanted to be a teacher quite early in life. Although I was never pressured, I heard the tales of how my mom’s dream to become a teacher was cut short due to the political situation in Cuba. I still remember putting my teddy bears in rows and “teaching” them my homework. During junior high and high school, I would help any classmate in need of extra instruction. I found my education quite easy and never

struggled with any subject area. Math was always one of my favorite subjects. It was a shock to hear later in life how girls did not perform as well as boys and how mothers would tell their daughters not to worry about math, since they had struggled with it too.

I married a math teacher in 1990 and we have been blessed with three wonderful children: Christina, Luis, and Gaby. Christina and Luis have also excelled in math. Both are in accelerated math programs and are constantly getting maximum scores on the state test and in their honors classes. Luis is in 7th grade taking Honors Algebra (a 9th grade course), and Christina is in a special math track in high school where she takes two honors math classes per year.

Mathematics and I actually created a special bond in 2004. Shortly after beginning my doctoral degree in 2003, I found out that I was expecting my third child. My two other children were 12 and 10, so the news came as a surprise. The pregnancy was complicated during the first trimester, but everything seemed normal during the second trimester. At the beginning of the final trimester, Gaby decided it was time to enter the world 13 weeks early. She was born weighing 2 pounds 1 ounce and measuring 14 inches. As an amateur mathematician, I am accustomed to order and structure. Needless to say, a premature baby was definitely not something I was ready to deal with. I continued my doctoral studies that semester taking an independent study course and statistics. Statistics and I became very close friends, while I would wait to hold my daughter. I was only allowed to hold her during specific times of the day, since being out in the cold would cause her to burn calories and lose weight. So in between holding my tiny baby, I would review descriptive statistics and t-tests. On Wednesdays, I would leave the hospital to attend class and then return to the hospital. My professor was phenomenal

and quite supportive. At the end of the semester, I was not only able to take Gaby home, but I had one of the highest grades in the class.

My husband, children, and I have been fortunate to have a strong mathematical foundation, and I have always wanted to find a way to share that gift with others. Finding a way to make a child's early experience with math successful is my current-day *mango*. In contributing to the field of research in early mathematics, I am giving and modeling what my mom taught me as a child... *if you give mangos, you will get ice cream*.

Assumptions of the Researcher

I entered this study with several assumptions. I believe everyone has the capability to succeed in math. The problem is barriers are placed in the way of success, such as the following beliefs: (a) math is hard, (b) math is boring, and (c) school math is not needed in the real world. I also believe teachers care about their children, and although they may not be strong in math content, they are willing to help their children succeed in school. I believe children enter school with experiences. Based on these experiences they have an intuitive sense of mathematical concepts, although they might not know the scientific term. Finally, I believe children are using everyday language to express mathematical concepts while engaged in block play and if teachers would recognize it as math; they would help bridge the everyday language to the mathematical concept.

Participants

The participants for this study were Head Start teachers and their students in pre-kindergarten classrooms. The next section will elaborate on the population and then focus on the sample for the research.

Population

Head Start programs were created in 1965 as part of former president Lyndon Johnson's War on Poverty, which created a government program for economically disadvantaged preschool children (Head Start, 1990). The emphasis of the program is to help young children succeed in society and to help narrow the achievement gap. "The achievement gap is an indicator of disparities between groups of children usually identified (accurately or not) by racial, ethnic, linguistic, or socioeconomic class with regard to a variety of measures" (NCTM, 2004, p. 2).

Head Start is a comprehensive program with four major components: (a) health, (b) education, (c) parental involvement, and (d) social services. The health component includes dental care, medical visits, and nutritional services. Education is built upon a child-centered approach that helps build self-esteem and socialization skills. The Head Start philosophy views parents as the key to their child's success in school. Parents are even recruited to work in Head Start programs as volunteers, teacher assistants, teachers, and policy council members. Finally, Project Head Start attempts to meet the individual need of families by connecting them to community programs and social services (Head Start, 1990).

National Demographics

Head Start served 1,054,740 children in 2005 (Center for Law and Social Policy [CLASP], 2006). The population served was 35% White, 41% Black, and 33% Hispanic. The children in the Head Start programs were supported by 216,663 staff members and 1,360,167 volunteers (CLASP, 2006). Of the Head Start teachers, 69% had degrees—

33% had earned an Associate in Arts degree, 31% a Bachelor's degree, and 5% a graduate degree.

State Demographics

In Florida (2005), Head Start served about 40,000 children. The population served were 15% White, 57% Black, and 24% Hispanic. The children in the Head Start Program were supported by almost 9,000 staff members and volunteers, of whom 4,500 were teachers or teacher assistants. In Florida, 55% of the Head Start teachers have minimally earned an Associate in Arts degree (Florida Head Start Association Research Committee, 2005).

Local Demographics

The Community Action Agency in Miami served about 6,210 children. The population served were 2% White, 55% Black, and 40% Hispanic. A total of 872 staff members were responsible for Head Start's 156 classrooms (Florida Head Start Association Research Committee, 2005). To meet the minimum teacher qualification mandate that requires at least 50% of teachers to hold a Bachelor's degree by September 2006 (Florida Head Start Association Research Committee, 2005), Head Start will only hire teachers with a Bachelor's degree in early childhood education (F. Gordon, personal communication, November 11, 2006). In order to meet the minimum teacher qualification, teachers are continuously encouraged to pursue higher educational degrees and are offered scholarships to attend local universities.

Sample

For the first strand of the study, 12 Head Start teachers and five of their students ($n = 60$ students) were selected to participate. For the second strand of the study, the same

12 who were part of the first strand participated ($n = 12$ teachers). There is some evidence that a sample size of twelve is the average sample needed to reach the point of saturation (Guest, Bunce, & Johnson, 2006). Saturation is the point where no new information is obtained.

Sample Selection

A criterion-based, convenience sample of twelve Head Start teachers was selected with the assistance of a key informant (see Table 1). The teaching experience of the twelve Head Start teachers ranged from 3- 30 years, with an average of 14 years of classroom experience. The twelve teachers had attained varied levels of degrees, ranging from minimum certification to a Master's degree. Two teachers had their Child Development Associate (CDA), four had an Associate in Arts, five had earned a Bachelor's in Arts, and one teacher had a Master's degree. All twelve teachers were female. Eleven of the teachers were Black and one teacher was Hispanic. The same twelve teachers were used for the both strands of the study (i.e., the same twelve teachers were observed and interviewed).

For the first strand of the study, teachers selected five children who expressed an interest in playing with blocks. The 60 children ranged in age from 3-5 years old. Thirty nine of the children were boys and 21 were girls. The children observed were 92% Black and 8% Hispanic.

Table 1

Sample Selection

Per Session	Total
Strand 1: Observations	
1 teacher	12 teachers
5 students per class	60 students
Strand 2: Interviews	
1 teacher	12 teachers

Criterion-based. Criteria for selection included: (a) being a Head Start teacher in Miami-Dade County serving 3-5 year old children, (b) teaching in an English speaking center, and (c) being proficient in English. Proficiency in English for the purpose of this study is defined as the ability to speak and communicate fluently in English (Cooper, & Kiger, 2001). In this study, an English-speaking center was defined as a center where the children in the classroom can communicate in English.

Convenience. Head Start teachers were a sample of convenience because not only were the sites available, but these sites met the characteristics identified above.

Key Informant

A key informant is knowledgeable about the setting and participants (Patton, 2002). Participant selection was determined with the assistance of a key informant, the Head Start Training Specialist. The key informant (a) assisted in selecting teachers that

met the study's criteria, (b) facilitated access to the centers by introducing the researcher to the director, and (c) aided in the dissemination and collection of media release forms. Individuals being observed (i.e., the teachers and the children) were required to provide consent by signing a media release form prior to video taping the observations.

Access to the Site

The researcher called the center's curriculum specialist to schedule observations and interviews of teachers. Arrangements for teacher coverage and a space to conduct an interview with the teachers were also discussed. Teachers participating in the study were asked by the curriculum specialist if they were comfortable being observed. The curriculum specialist let the teachers know observations will be conducted during center time, followed by an interview. Teachers were asked to sign an informed consent approved by Florida International University Internal Review Board.

Visits were scheduled during center time to observe teacher interactions with a group of children engaged in block play. Block play is a form of construction play that gives the children opportunities to (a) enhance interaction skills, (b) strengthen communication abilities, (c) develop fine and gross motor coordination, (d) think mathematically, and (e) increase visual discrimination (Isbell & Raines, 1991; Phelps, 2002; Seo, 2003; Seo & Ginsburg, 2004). Block play was chosen because it has the potential of providing teachers the opportunity to hear and respond to children using everyday language to express mathematical concepts.

Head Start Classrooms

The Head Start daily routine includes a scheduled time for children to work at centers. Centers are areas in the classroom where a small group of children, usually about

five children, interact with each other and explore. Centers may include blocks, art supplies, items to play house, and computers (Phelps, 2002).

Before engaging in center play, children discuss with the teacher which center they plan to visit. Based on the class discussion of child-initiated play, the teacher selected the first five English-speaking children who expressed an interest in playing in the block center. If less than five children wanted to go to the block center, the teacher motivated other preschoolers to participate. The rest of the class was divided among the other centers and supervised by the teacher assistant. Most Head Start classrooms have about 20 children. The adult child ratio is 1:10, and since both teachers remained in the classroom, adequate supervision guidelines were being met (C. Brogan, personal communication, January 30, 2007). The teacher and five children were asked to remain in the block center during the entire session to allow for opportunities to interact.

Data Collection

The data collected for the first strand of the study included one observation session per teacher. Field notes and digital video were used to record interactions during block play. The second strand of the study consisted of one interview session per teacher. The interviews were digitally recorded (see Table 2).

Table 2

Data Collection

Data collected per session	Total
Strand 1: Observations	
1 video segment per class	12 video segments
20 minutes per segment	240 minutes
Strand 2: Interviews	
1 session per teacher	12 interview sessions
60 minutes per teacher	12 hours

Strand 1: Observations

“Observers attempt to see the world through the eyes of those they are studying” (Hatch, 2002, p.72). Observations give the researcher an opportunity to develop a deeper understanding of a phenomenon (Creswell, 2003; Patton, 2002). The researcher’s presence has some effect on the study (i.e., observer effect), which is impossible to avoid (Bogdan & Biklen, 2003).

Young children are naturally curious and some may have questions about the researcher’s presence. Since the researcher was aware of this, the videographer and researcher were at the center for a half hour prior to conducting the observations in order for the children to feel comfortable with their presence. The teacher introduced the researcher and videographer to the class and addressed any questions the children had.

Although cameras are a novelty, young children quickly ignored their presence, especially when they are highly engaged (Bogdan & Biklen, 2003).

Recording of Observations

Field notes and videotapes were used to record the children and teacher during block play.

Field notes. Using a spiral notebook, the researcher took notes on moments when the students used everyday language to express a mathematical concept. Notes included (a) who the student was, (b) what the student was doing, (c) what the student said, and (d) how the teacher responded to the mathematical utterance. The notes focused on the following verbal interactions: (a) student-to-self, (b) student-to-student, (c) student-to-teacher, or (d) teacher-to-student.

Within a day of the visit, the researcher recorded general impressions following Hatch's (2002) protocol. These entries varied depending on the affective experience and points of interest that stem from the overall observation.

Videotapes. Videotapes add to the study by providing a picture of the physical environment (Patton, 2002). A videographer videotaped each 20-minute session of block play. The videographer and researcher were located next to each other and remained in the block area during the 20-minute session.

Strand 2: Interviews

Interviews are useful for further understanding experiences from the participant's point of view. The purpose of interviews is "to uncover the meaning structures that participants use to organize their experiences and make sense of their worlds" (Hatch,

2002, p. 91). The key to a successful interview is to be a good listener in order to capture the participants' responses (Bogdan & Biklen, 2003).

Interview Guide

The researcher developed the interview guide with assistance from a committee member who specializes in Early Childhood and Math mediated language (see Figure 1). An interview guide was used to get the teacher's view of the role of language in the development of early childhood mathematics (see Appendix A). The interview guide contained 34 questions about the (a) participant; (b) the participant's teaching and learning beliefs; and (c) the relationship of language and math.

Figure 1. Interview Guide Construction Process.

The interview guide was first piloted on an early childhood teacher. The pilot interview consisted of 12 questions and seven scenarios where children used everyday language to express mathematical concepts. During the pilot test, the teacher had difficulty with the scenarios. She felt guided by the scenarios to agree that the children

were expressing mathematical concepts, but did not know how the children were using math.

After the pilot interview, the interview guide was sent to the researcher's dissertation group for further feedback via email. The dissertation group consists of 26 members who meet monthly to discuss issues related to their dissertation topics, methods, writing styles, and the doctoral process. Based on feedback from 11 members via email, the guide was revised to include: (a) initial demographic questions to set participants at ease, as well as to find out more about them; (b) questions that were more focused on the study's purpose and consistent with the research questions; and (c) questions to find out how the participant defined language. Another major revision was the removal of the scenarios. Based on the feedback, I decided the scenarios were not effective because they were guiding the responses. For example, if a participant is asked, "Do you see math being used when a child says, Do it this way," he/she may feel compelled to say, "Yes," without truly understanding why the child is using math.

The 26 members of the researcher's dissertation group discussed the revised guide from email feedback during a monthly meeting. Based on the dissertation group meeting feedback, a series of questions were included concerning the teacher's beliefs about learning styles based on age, gender, and ethnicity. Two additional summative questions were added: (a) Is there anything else you think I should have asked you and didn't? and (b) Is there anything else you think I need to understand?

Interview Administration

Using the interview guide, the twelve participants were interviewed for about an hour each immediately following the observations. The shortest interview session lasted 45 minutes and the longest interview session lasted 90 minutes.

Recording of Interview

Interviews were face-to-face and digitally recorded. The teachers were asked for permission to be recorded. The digital recorder was placed in front of the teacher to best capture responses. Interviews were transcribed verbatim within a month of the data collection.

Data Analysis

Interaction analysis was used to deductively analyze the observations during the first strand. Initially, observations were going to be analyzed two times: (a) first, a deductive analysis of student talk was going to be conducted using a priori codes (see Appendix C); and (b) second, teacher talk was going to be analyzed (see Appendix D). It quickly became apparent that observations needed to be analyzed simultaneously for student talk and teacher talk. A Chi Square analysis was used to determine if the observed frequencies of student talk were significantly different among the coded categories.

Thematic analysis was used to inductively analyze the interviews as part of the second strand. A meta-inference was “employed to reconcile the information gleaned from the two concurrent strands” (Teddlie & Tashakkori, 2006, p. 21).

Strand 1: Treatment of Observations

Interaction analysis is a method used to investigate the interactions of people with each other in their environment (Jordan & Henderson, 1993). Interaction analysis

protocol recommends establishing a team of investigators to assist in confirming findings (Jordan & Henderson, 1993). In this study, two graduate students assisted in analyzing the video segments—a National Board Certified teacher in math with 16 years teaching experience and an early childhood language consultant.

Interaction analysis has its roots in Flanders' (1970) method of gathering information on teacher-student interactions. Interaction analysis consists of three categories: (a) teacher talk, (b) student talk, and (c) no talk. Flanders' framework breaks these three categories into sub-categories. Teacher talk includes (a) accepting feelings and ideas, (b) praising, (c) asking questions, (d) explaining, and (e) redirecting behavior. Student talk is broken into (a) teacher-initiated and (b) student-initiated (Flanders, 1970; Kryspin, 1974).

The videotapes of the observations were watched and compared to field notes. Each viewing was divided into 5-minute segments to provide the team of investigators time to analyze the video and discuss their findings (Learning Mathematics for Teaching [LMT], 2006). In interaction analysis, the team can either investigate the videotape in order to find some patterns for coding or use a preconceived coding scheme (Jordan & Henderson, 1993). Each mathematical utterance and teacher response was negotiated as they appeared. If disagreements occurred, they were discussed in order to reach a consensus. If a consensus could not be reached, then a two thirds vote determined the code. Although disagreements did occur, at least 90% of the codes were agreed upon by all members. A five-minute segment of video lasted from one hour to two and half hours. Student talk was coded using a priori codes of how children use everyday language to

express mathematical concepts (Seo & Ginsburg, 2004). Teacher talk was coded using a priori codes based on Flanders' (1970) framework.

Deductive Analysis of Student Talk

The research team analyzed deductively student initiated talk where the child used everyday language to express mathematical concepts. Student initiated talk could be (a) student-to-self, (b) student-to-student, and (c) student-to-teacher. An a priori coding rubric was used based on the content codes created after observing young children engaged in free play (Seo & Ginsburg, 2004). The mathematical content codes included (a) *classification*—sorting, categorizing and grouping; (b) *magnitude*—comparing two or more; (c) *enumeration*—using number words, quantifying, counting; (d) *dynamic*—exploring transformation, such as putting things together or apart and exploring motions; (e) *pattern and shape*—creating patterns or shapes; and (f) *spatial relations*—using position or direction (see Appendix C).

Deductive Analysis of Teacher Talk

Initially a second viewing was planned in order to analyze teacher talk after the child made a mathematical utterance based on the results of the first viewing. After coding student talk during the first video segment, the research team had a hard time remembering what utterance had been initially coded. The research team decided to analyze teacher interactions immediately after identifying a mathematical utterance. Teacher interactions were based on Flanders' interaction framework and included: (a) ignore; (b) repeat or accept idea; (c) encourage and praise; and (d) ask question. A fifth a priori code, mediate, was developed based on the literature review and research question (see Appendix D).

Contact Summary Sheets assisted the research team in triangulating the data. Within a day of the observations, the field notes were converted into contact summary sheets (Miles & Huberman, 1994) focusing on questions related to interactions during block play after a child uses everyday language to express a mathematical concept (see Appendix B). The purpose of contact summary sheets was to focus on particular questions and to fill in information from the raw field note data (Hatch, 2002; Miles & Huberman, 1994). Raw field notes, contact summary sheets, and interaction analysis of video served to triangulate data in order to compare findings from multiple data recording procedures. Triangulation “means comparing and cross-checking the consistency of information derived at different times and by different means” (Patton, 2002, p. 559).

Chi Square Analysis

After the research team coded the student talk, a one sample chi-square test was performed in order to determine if the observed frequencies among the coded categories were significantly different. A chi-square test is a nonparametric measure used with nominal data. Nominal data “classifies objects into categories based on some defined characteristic” (Hinkle, Woers, & Jurs, 1998, p. 13). A Chi Square could not be performed to analyze the teacher interactions because the observations were not independent of each other. SPSS was used to perform the test.

Strand 2: Treatment of Interviews

Transcriptions were checked for accuracy by listening to the digital recording while following along in the transcript. The researcher used the word file of the transcriptions in order to create two documents. The first document was based on the interview guide. Each question was converted into a separate chart. The question charts

consisted of (a) the teacher, (b) the lines corresponding to the teachers' response, and (c) the teacher's actual response. The second document was based on emergent themes pulled from the first document. Each theme was converted into a chart. Each theme chart consisted of (a) the teacher's name, (b) the lines corresponding to the teacher's comment, and (c) the teacher's words expressing the theme.

Meta-Inference

"The inference process is the process of making sense out of the results of data analysis" (Teddlie & Tashakkori, in press. p. 6). After conducting the interaction analysis of observations and the thematic analysis of interviews, the outcomes of the two strands were compared in an attempt to make meaning.

Data Management

The field notes, contact summary sheets, videotapes, digital recordings of interviews, and transcripts are being kept in a locked, fireproof box in the researcher's home office. The data will be kept for 3 years from completion of the study (Florida International University Regulations for Thesis and Dissertation Preparation Manual, 2007).

Integrity Measures

To maximize the accuracy of the findings, measures were taken to obtain trustworthiness. Trustworthiness is achieved by establishing credibility and verifying data (Miles & Huberman, 1994). Accuracy of the findings was strengthened through triangulation and peer debriefing (Creswell, 2003).

Triangulation

Two types of triangulation methods were used: multiple data sources and multiple analysts.

Multiple Data Sources

Multiple sources and multiple data recording procedures will help validate findings. Multiple sources of data were used: observations and interviews (Patton, 2002). The researcher observed the setting and talked with the participants about what was happening. Combining observations with interviews provided for more in-depth research.

Observations also consisted of multiple data sources. Two data recording procedures were used during the observations: field notes and video. While analyzing data, the researcher compared the field notes to the video in order to verify results.

Multiple Analysts

A second type of triangulation is using multiple analysts. Using a team of investigators to help analyze the video strengthens the study through investigator triangulation (Patton, 2002). The researcher and two specialists, one in math and one in early childhood, coded and compared findings. Disagreements arose and were reconciled, sometimes even leading to discussions (LMT, 2006). Understanding inconsistencies can be viewed as illuminative because it offers “opportunities for deeper insight into the relationship between inquiry approach and the phenomenon under study” (Patton, 2002, p. 556). Each code was negotiated among the multiple analysts.

Peer Debriefing

A team consisting of the major professor and 26 doctoral students reviewed the study periodically. The dissertation group meets in a large group setting on a monthly

basis and provides feedback on all sections of the dissertation. The dissertation group is divided into peer review groups of four. The peer-review team provided feedback on each chapter prior to it being sent to the entire group. The role of the reviewers is to “ask questions about the qualitative study so that the account will resonate with people other than the researcher” (Creswell, 2003, p. 196). Feedback from the peer review group and the dissertation group was incorporated into future drafts.

The peer review group met with the researcher after all the data was coded. At that meeting, the researcher reviewed the research design and shared one session of block play. The peer review team observed the video and coding of the segment. The peer review team and researcher discussed implications of the study and suggested future studies.

Summary

This chapter began with the purpose of the study and research questions guiding the research. The parallel mixed method framework used in the study was presented. A brief autobiography was offered and assumptions about the study were stated. The final section addressed parallel mixed method design. A description of the population, sample, data collection, data analysis, data management, and integrity measures were clarified. The next chapter will describe the results of the study.

CHAPTER IV

DESCRIPTION

Chapter 4 begins with a description of the study. A description based on Strand 1 will follow. Strand 1 included a description of students' use of everyday language to express mathematical concepts and description of the teacher's interactions after a child made a mathematical utterance. Finally, a description based on Strand 2 will be presented. Strand 2 consisted of a description of the teachers and their beliefs concerning the role of language in early childhood mathematics.

Description of the Study

This parallel mixed method study consisted of two strands. The first strand consisted of exploring children's use of everyday language to express mathematical concepts and how teachers interact with children after making a mathematical utterance. The participants in this strand were 12 Head Start teachers in preschool classrooms engaged in block play with five of their students ($n = 60$). The data collected for this strand included observations. Field notes and digitally recorded video were used to capture interactions during block play. Interaction analysis was used to deductively analyze the observations. Interaction analysis protocol recommends establishing a team of investigators to assist in confirming findings (Jordan & Henderson, 1993). The team of investigators included the researcher and two graduate students—a National Board Certified teacher in math with 16 years teaching experience and a specialist in language and early childhood. The research team watched the video segments and negotiated each code as they were observed. Negotiating involved discussing each instance a member of the research team observed a child make a mathematical utterance and coming to a

consensus prior to marking the code. The research team used a priori codes to analyze children's use of everyday language to express mathematical concepts (Seo & Ginsburg, 2004) and teacher interactions (Flanders, 1970). Chi-square tests were run to evaluate if the observed frequencies of student talk codes were significantly different.

The second strand of the study explored how early childhood teachers view the role of language in preschool classrooms. The same 12 teachers from the first strand were interviewed. The interviews were digitally recorded. Three themes emerged after the transcribed interviews were read and analyzed inductively: (a) the importance of a child's environment, (b) the importance of an education in society, and (c) the role of math in early childhood. After completing both strands of analysis, a meta-inference was conducted. Three codes emerged after conducting a thematic analysis based on teacher interviews and observations: (a) teacher conception of math, (b) teacher practice, and (c) teacher sensitivity.

Description of Strand 1: Observations

Student Talk

Of primary concern of this study was the teacher's responsive interaction to children's expressions of an implicit mathematical utterance made while engaged in block play. Before describing teacher responses, it is first necessary to describe children's use of everyday language to express mathematical concepts. The research team observed mathematical utterances made by children. The 60 children observed produced 2,831 mathematical utterances while engaged in 240 minutes of block play. The codes ((Seo & Ginsburg, 2004) were: (a) classification, (b) dynamic, (c) spatial relations, (d) magnitude, (e) enumeration, and (f) pattern and shape (see Figure 2).

<u>Type of Utterance</u>	<u>Total Utterances</u>
classification	1,056
dynamic	787
spatial relations	433
magnitude	226
enumeration	185
pattern and shape	144

Figure 2. Total mathematical utterances for each math code.

The results of a one-sample chi-square test indicated that each of the observed frequencies of math talk were significantly different from chance, $\chi^2(5) = 1467.19, p < .05$. The observed frequencies of 1,056, 787, 433, 226, 185, and 144 deviate significantly from the expected frequency of 471. Since an overall difference was indicated, a pair analysis was run to determine which pairs of observed frequencies were significantly different from each other (see Table 3).

Table 3

Paired Comparison of Observed Frequencies Student Talk

Pairs	Significance
classification/dynamic	.000*
classification/spatial relations	.000*
classification/magnitude	.000*
classification/enumeration	.000*
classification/pattern and shape	.000*
dynamic/spatial relation	.000*
dynamic/magnitude	.000*
dynamic/enumeration	.000*
dynamic/pattern and shape	.000*
spatial relation/magnitude	.000*
spatial relation/enumeration	.000*
spatial relation/pattern and shape	.000*
magnitude/enumeration	.043*
magnitude/pattern and shape	.000*
enumeration/pattern and shape	.024*

The results of the paired frequency comparison indicate all pairs at $p < .05$ were significantly different.

Classification

Classification involved sorting into groups and categorizing (Seo & Ginsburg, 2004). Classification was the highest observed code resulting in 1,056 mathematical utterances. The total number of codes was significantly higher than the expected frequency, based on chance of 471. In other words, children were using classification words more than would be expected by chance.

A classification code was marked every time a child was observed making a reference to a particular thing/object. For example, a child created a structure and commented to his peer, “These are windows. This can’t be the hallway. Look at my puppy house” (Teacher 1, Student 3). In these examples, Student 3 was classifying the parts of her block structure: the windows, the hallway, the puppy house.

In another classroom a child was observed stating, “My house is strong. This is a tree. This is parking” (Teacher 2, Student 5). In these examples, Student 5 was also classifying his block structure: the strong house, the tree, the parking.

Dynamic

Dynamic included exploring motions, such as putting things together and taking things apart (Seo & Ginsburg, 2004). Since playing with blocks sparks a great deal of construction, 787 dynamic utterances were observed. Dynamic was the second highest observed code and was higher than the expected frequency of 471 which means children were using dynamic words more than would be expected by chance.

While playing with a toy shark inside a block structure, a student remarked, “The shark jumped all the way up” (Teacher 6, Student 3). Jumped was coded as dynamic. The action of jumping involves moving through space. Another student announced to the

teacher, “I’m making a bounce house” (Teacher 8, Student 3). Making was coded as dynamic. Making, building, and constructing all involved putting things together.

Spatial Relations

Spatial relations incorporated exploration of distance, location, and direction (Seo & Ginsburg, 2004). Spatial relation utterances were coded 433 times. Spatial relation was the third highest code observed, although it was less than the expected frequency of 471. In other words, children were using spatial relation words less than would be expected by chance.

While engaged in block play, children referred to the positions of their block structures, especially when giving directions to their peers. While creating a block structure with a peer, a student said, “Put it down” (Teacher 8, Student 2). Putting down blocks focuses on the direction of the block’s placement. Another student told his friend, “Put ‘em in there” (Teacher 10, Student 3). Using the word *there* specifies where the block should go.

Spatial relation utterances were also made by children describing the location of a particular structure or object. While sharing the zoo she had created, the student told the teacher, “Here’s our gorilla” (Teacher 12, Student 5). In this example, the teacher was asking the child about her structure. Student 5 was telling her about the zoo she made and pointing out the location of the animals “inside” the zoo.

Spatial relations utterances also occurred while the children role-played. After creating a perimeter with quadruple wooden blocks a child announced, “I’m going to go in the pool” (Teacher 8, Student 5). In this example, the child had created a perimeter and

announced he had made a pool and was going inside. After his announcement, many of the other children “jumped inside the pool.”

Magnitude

Magnitude statements referred to an object’s size and also involved making comparisons between two or more objects (Seo & Ginsburg, 2004). Magnitude also took into account “making magnitude judgments without quantification” (Seo & Ginsburg, 2004, p. 94). Words such as some, none, a lot, were included in this code. Magnitude utterances were coded 226 times. Magnitude utterances were less than would be expected by chance (i.e., 471 expected frequency).

Object size. While children were creating structures, they used words to refer to the object’s size. When asked about the structures they built the previous day, one child stated, “Tall building, tall building, tall building. It’s a tall building, tall building” (Teacher 1, Student 1). She repeated herself five times and even stretched out her arms to support her statement of magnitude.

Comparison between objects. Comparison words are words such as stronger, bigger, and smaller. While comparing her tower to her friend’s tower, one child noted, “They’re the same tall” (Teacher 3, Student 1). In this example, Student 1 is comparing the height of her building to her friend’s building.

Magnitude judgments. Some, a lot, none are examples of magnitude utterances that were not quantified. While pretending to take an item from the refrigerator, one child commented, “I’m going to get some milk” (Teacher 9, Student 1). Student 1 was making a house with the teacher and they had just added a refrigerator. He decided he wanted to eat cereal and needed some milk for his cereal.

Enumeration

When a number word was spoken, the math utterances were coded as enumeration. A total of 185 enumeration utterances were coded. Enumeration codes were less than the expected frequency of 471. In other words, children were using enumeration words less than would be expected by chance.

Enumeration codes referred to quantity such as, “I got 5 left” (Teacher 3, Student 1), or they could be used to quantify a measurement, such as, “Make my 4 feet” (Teacher 5, Student 1). When a child counted, each number was coded as a separate enumeration. For example, a student was using a measuring stick to measure his structure and counted “1, 2, 3, 5, 9, 6, 7, 8, 9” (Teacher 1, Student 3) totaling nine enumeration codes.

Pattern and Shape

When a child discussed a pattern or a specific shape, the mathematical utterance was coded as pattern and shape. Pattern and shape were coded the least. There were 144 utterances coded. Pattern and shape codes were less than the expected frequency of 471. In other words, children were using pattern and shape words less than would be expected by chance.

Pattern. An example of a pattern code occurred in Teacher 11’s classroom when a child wanted to build the same thing as his friend. Student 4 said, “I’m going to build that too.” In other words, he is going to follow the pattern set by his friend to guide his structure. Another example occurred in Teacher 3’s classroom when a child told his friend, “Step on it, like this” (Student 2).

Shape. Shape words were uttered while children were engaged in block play. For example, while building a house a child commented to himself, “I’m going to make a

square house” (Teacher 11, Student 3). In another video segment, a student was landscaping. After making the trees, she told the teacher, “It shaped like a heart” (Teacher 2, Student1). Children used the appropriate shape words to describe the physical appearances of their creations.

Summary of Student Talk

In summary, six a priori codes were used to constitute the 2,831 mathematical utterances observed while 60 children were engaged in 240 minutes of block play. Once a mathematical utterance was made, the next step was to see how the teacher responded to the utterance. The next section will describe the teacher interaction after everyday language was used to express a mathematical concept.

Description of Teacher Interaction

Of primary concern was how teachers interacted after a child made a mathematical utterance. After observing each of the 2,831 mathematical utterances, the research team focused on how the teacher responded to child’s use of everyday language. Teacher interactions were coded based on five a priori codes. Four codes were based on Flanders’ (1970) analysis of teacher interaction: (a) ignore; (b) accept/repeat idea; (c) praise or encourage; and (d) ask question. A fifth a priori code, mediating children’s vocabulary to the mathematical concept, was also added based on the literature review and research questions (see Figure 3). A chi square test was not run because the codes were not independent of each other (Green & Salkind, 2003). Teachers did not respond to 60% of the 2,831 mathematical utterances.

Figure 3. Observed teacher interaction using a priori codes.

Ignore

When a mathematical utterance was made and the teacher did not respond, it was coded as ignore. Ignore codes were characterized as periods of silence and lack of verbal communication between teacher and student (Flanders, 1970). Mathematical utterances were ignored 60% of the time (i.e., 1,698 mathematical utterances were ignored). Ignored utterances included situations where the teacher wasn't attentive to hear the utterance or when the teacher was attentive but did not respond.

Teacher not attentive. Student-to-student mathematical utterances while engaged in block play were sometimes ignored because the teacher was distracted by another child. After making a house, one child commented to another child, "I made a nice house. Do not knock my house down" (Teacher 11, Student 3). The teacher did not respond

because she was interacting with another student. In this ignored example, several mathematical utterances were coded: (a) made—dynamic, (b) nice house—classification, (c) knock—dynamic, (d) my house—classification, and (e) down—spatial relation. Since all five utterances were ignored, five ignore codes were recorded.

In the next example, Student 4 called himself *the man* and was in charge of the construction project. He used his power to tell his peers what to do. “What you made here? Move this in there. Ten minutes. Twelve minutes” (Teacher 2, Student 4). In this example, the teacher was talking with another student, so the following mathematical utterances were ignored: (a) made—dynamic, (b) here—spatial relation, (c) move—dynamic, (d) in there—spatial relation, (e) ten—enumeration, and (f) twelve—enumeration. All six utterances were recorded as ignored.

Teacher attentive. At times, the teacher was attentive, yet ignored a child’s mathematical utterance. The first mathematical utterance coded by the research team involved a child responding to the teacher’s question, “Do you remember what we built yesterday?” The child was standing in front of the teacher and responded, “Tall building, tall building, tall building. It’s a tall building, tall building” (Teacher 1, Student 1). The student even stretched out her arms to show tall. Although the teacher was directly in front of the student, she did not respond to her resulting in five ignored magnitudes (tall) and five ignored classifications (building) codes.

Accept/Repeat Idea

Accept/repeat idea interactions occurred when the teacher acknowledged what the child said or repeated what the child said (Flanders, 1970). Teachers accepted/repeated

idea for 18% of mathematical utterances (i.e., 510 mathematical utterances were accepted/repeated).

Accept. Responses such as *okay* or *uh-huh* were coded as accept. For example, Student 1 in Teacher 3's class was explaining what the *mama* was going to do in the structure she built. "The mama, climb up here. Climb up. She going to climb up and go down to see the hotel here. You have to come over here. You have to come over here" (Teacher 3, Student 1). The teacher responded, "Okay." In this example, the following mathematical utterances were coded: (a) mama—classification, (b) climb—dynamic, (c) up here—spatial relations, (d) climb—dynamic, (e) up—spatial relation, (f) going to climb—dynamic, (g) up—spatial relation, (h) go—dynamic, (i) the hotel—classification, (j) here—spatial relation, (k) come—dynamic, (l) over here—spatial relation. In this example, *she* was not coded as a classification because the research team decided not to code pronouns, such as *she*, *he*, *it*, and *they*. *See* was not coded dynamic because only actions that involved moving through the physical environment were coded. Since the teacher responded, "Okay," 12 accept/repeat idea interaction codes were tallied.

Repeat Idea. Repeat ideas were coded when a teacher repeated the child's statement or part of the statement. In following example, the children made a zoo with the teacher. Student 3 was talking about a time she saw some horses. "And I saw a horsey too. It was two. A boy and a girl" (Teacher 6, Student 3). In this example, the following mathematical utterances were coded: (a) horsey—classification, (b) two—enumeration, (c) boy—classification, (d) girl—classification. The teacher repeated part of the statement by responding, "A girl and a boy." Her interaction resulted in four accept/repeat idea codes.

Praise or Encourage

A third interaction code involved praising the child or providing encouragement. The research team also decided to include any classroom management statements in this category. Teachers use words of praise and encouragement as classroom management strategies in order to avoid conflict among children and to set positive learning environments (Gartrell, 2004). Praise or encourage interactions occurred 6% of the time (i.e., 170 mathematical utterances were praised or encouraged by the teacher).

Praise. Praise are “statements which carry the value judgment of approval” (Flanders, 1970, p.41), such as *good job*, and *way to go*. For example, in Teacher 1’s classroom, Student 3 told the teacher, “I’m putting windows now. These are the window.” Student 1 added, “I make it too.” The following mathematical utterances were coded: (a) putting—dynamic; (b) windows—classification; (c) window—classification; (d) make—dynamic; and (e) too—pattern and shape. The teacher responded to the children by saying, “Both y’all did good.” Since the teacher praised the children, four praise or encourage interactions were coded.

Encourage. Encouraging statements were observed while the children were engaged in block play. In Teacher 8’s classroom, the teacher asked Student 4 what she wanted to make. Student 4 told the teacher, “I want to make a castle bounce house.” In this example, the following mathematical utterances were coded: (a) make—dynamic; and (b) castle bounce house—classification. Teacher 8 gave the student a high five and responds, “C’mon we’re goin’ go build a castle bounce house.”

Classroom management. During block play, times of conflict among children were observed. For example in Teacher 7’s class, Student 5 wanted Student 1’s hammer.

He went to him and took it. The teacher walked over to see what was going on. At that time, Student 5 told the teacher: “I want to hold that hammer.” Teacher 7 responded by saying, “You have to ask nicely.” In this example, the following mathematical utterances were coded: (a) hold—dynamic, and (b) hammer—classification, resulting in two praise or encourage interaction codes.

Asks Question

At times, teachers responded to a mathematical utterance by asking a question. Asking questions include interactions when the teachers are expecting a response (Flanders, 1970). For the purpose of this study, the research team was looking for instances where the teacher asked questions that did not promote mathematical concepts. If a question was asked that promoted mathematical concepts, it was coded mediate. Asking questions that did not promote mathematical thinking occurred 6% of the time (i.e., 170 mathematical utterances were responded to by asking a question that did not promote mathematical thinking).

In Teacher 5’s classroom, the children created a stage made out of waffle blocks. The children started performing songs. Student 5 told the other children, “Let’s get Ms. J. (name intentionally deleted for confidentiality purposes) to come over and sing.” The teacher responded by asking, “Okay, what am I doing?” Student 1 responded to her, “Sing James Brown.” The teacher then asked, “How does James Brown sing?” Teacher 5 then joined her students on stage and started to sing. In this exchange, the following mathematical utterances were coded: (a) Ms. J.—classification, (b) come over—dynamic, and (c) James Brown—classification, resulting in three ask question interaction codes.

Mediate

The last coded interaction was based on math mediated language, a concept that explains how understanding math in the early years is related to linguistic development. Math mediated language views everyday language as a carrier of early math concepts such as quantity, shape, and space (Moseley & Bleiker, 2003). In this final coded interaction, the research team was looking for examples where the teacher used students' speech to bridge their everyday language to mathematical concepts. Ten percent of the mathematical utterances were coded as mediate (i.e., 283 mathematical utterances were mediated by the teacher).

An example of an interaction coded as mediate occurred while a student was making a tower. The student told the teacher, "I want you to help me" (Teacher 5, Student 5). The teacher responded, "Instruct me." Student 5 then said, "Put these." The teacher mediated by saying, "Put these? How? Stack?" Student 5 wanted the teacher to stack the blocks, but had only said put these. Teacher 5, bridged the everyday language into a more appropriate term, *stack*.

In another classroom, while building a castle bounce house, Student 2 asked, "Where do we put this one?" Student 3 tells her, "Put it right here." Teacher 8 responds, "Oh, around the perimeter." In this example the teacher let the child know the area Student 3 was referring to was the *perimeter* of the castle bounce house.

In another classroom a child was getting frustrated while building his structure. Student 2 tells Student 5 "I want it right here." Student 5 does not place the block where the student wanted, so Student 2 repeats, "No, this way." Teacher 7 walked over to see why the Student 2 was getting so agitated. She asked Student 2, "Which do you want it,

up or down?” Student 2 responded, “Down.” In this example, Teacher 6 is not only de-escalating a conflictive situation, but helping Student 2 use his words to express his needs. By specifying the position of the block, Student 2 was able to communicate successfully to Student 5 where to place the block.

In the following example, the teacher uses the child’s interest in drinking Gatorade as an opportunity to mediate. The children were building a house with the teacher. In the kitchen they placed a “refrigerator.” Student 5 announces to the group, “I want some Gatorade.” Student 4 joins in, “I want some Gatorade too.” Teacher 9 responds, “There’s some in the refrigerator. Is the Gatorade cold or hot?” Student 4 pretends to take the Gatorade out of the refrigerator and take a sip. After taking a sip, she responds, “hot.” Teacher 9 then comments, “Hmm. It was in the refrigerator. Let’s see if the refrigerator is working.” The first mathematical concept the teacher introduces in this interaction is space: the Gatorade is *in* the refrigerator.” The teacher then brings in the mathematical concept of temperature. She also uses the child’s response of hot, to problem solve. If the Gatorade was in the refrigerator and it is hot, it might mean the refrigerator is not working. The teacher used the children’s interest in drinking Gatorade as an opportunity to introduce mathematical concepts.

The research team also decided to code mediate anytime the teacher extended a child’s mathematical utterance. For example, the students in one class were putting the zoo animals to sleep. “We’re making ‘em [the animals] go to sleep, Ms. K.” (Teacher 12, Student 1). Student 4 added, “We’re putting them in some boxes.” The teacher asked, “How many boxes are you going to use?” In this example, the teacher is helping the child extend his mathematical vocabulary by replacing the word *some* with the actual number

of boxes they need. After the teacher asked her question, the children counted the animals and told the teacher, “Six boxes.” Student 4 and 1 proceeded to put each animal inside a box. This interaction not only involved counting, but also involved one-to-one correspondence, since there was one box for each animal.

Summary of Teacher Interactions

In summary five a priori codes were used to deductively analyze teacher interactions with children who had used everyday language to express a mathematical concept. The children observed produced 11.8 utterances per minute (2,831 utterances divided into 240 minutes). Sixty percent of the utterances were ignored. Teachers did not ignore 1,132 of the 2,831 utterances. In other words, teachers were responding to 4.72 utterances per minute (1,132 utterances divided into 240 minutes). Teacher interactions with children consisted of: (a) accept/repeat idea, (b) praise and encourage, (c) ask questions, and (d) mediate. Ten percent of the utterances were mediated. In other words, teachers bridged 283 mathematical utterances to mathematical concepts.

Description of Strand 2: Interviews

After observing the 12 teachers engaged in block play with five of their students, the teachers were interviewed using an interview guide (see Appendix A) in order to explore their views of the role of language in the development of early childhood mathematics. The interview guide contained 34 questions about the (a) participant; (b) the participant’s teaching and learning beliefs; and (c) the role of language in math. The following section presents a description of the teachers and their views of the role of language in early childhood mathematics.

Description of Teachers

The teaching experience of the twelve Head Start teachers, ranged from 3- 30 years, with an average of 14 years of classroom experience. Most teachers were motivated to become teachers due to their love for children.

Um, I just love being around kids. Just want to give back, you know, to the community. Just give back what I have learned to the children. You know, to teach the children what I have learned. I just love working with this age.
(Teacher 3, lines 4-6)

A few teachers expressed a desire to give back to the community that had once helped them.

What inspired me to become a teacher was that I had great teachers at both Head Start, elementary and high school. And I just wanted to make a difference in the way that children learn right here. This was my school. (Teacher 5, lines 3-10)

Teacher 5 was proud to be a teacher at the same school that had given her the foundational skills to succeed in life.

One teacher did not seem satisfied with her career choice. When asked what motivated her to become a teacher, her initial response was, “You don’t want to ask me that” (Teacher 9, line 1). After laughing she then replied, “I’d just gotten out of college and I was looking for a job and some one referred me to Head Start and I started in um, ’98” (Teacher 9, lines 4-5).

The twelve teachers had attained varied levels of degrees, ranging from minimum certification to a Master’s degree. Two teachers had their Child Development Associate (CDA), four had an Associates in Arts (AA), five had earned a Bachelor’s in Arts and one teacher had a Master’s degree. Three of the twelve teachers were in school pursuing a

Bachelor's degree. One teacher expressed a desire to go back to school. "I have a CDA...I'm going back to class um, as soon as I stop helping my son take care of his little ones. Um, when they get a little bigger, I'm going back" (Teacher 8, Lines 43; 58-59). Regardless of degree, all twelve teachers attended professional development opportunities on a regular basis, due to Head Start protocol.

Description of Teachers' Beliefs

After interviewing twelve Head Start teachers, three major themes emerged: (a) the importance of a child's environment, (b) the importance of an education in society, and (c) the role of math in early childhood.

The Importance of a Child's Environment

The first theme that emerged was the importance of a child's environment. Teachers expressed how children are learning through everyday experiences. Children are picking up information while interacting in their environment. A major part of a children's environment is their home life.

Learning through everyday experiences. Children learning through everyday experiences resonated with every teacher. Opportunities to learn surround a child.

To me, language is everywhere. Language could be spoken. It could be visual. It could be printed. It could even be when at home. I tell the kids when you go home [and] mommy is cooking, help mom cook. You know, then if she's gonna put an egg into something then [ask] what is it? So they learn things by name and then they learn things from a functional point of view. So everything is like a learning experience. So, everything is a learning process. (Teacher 8, lines 187-198)

Children are learning math through these everyday experiences. “They use math in play and, and in everyday activities. They don’t know they’re doing the math, but they are doing it. They’re doing math activities” (Teacher 10, lines 203-205).

Math and language are learned through everyday activities. Teachers stressed that language and math are taught “everyday in everyway” (Teacher 5, line 64). In taking attendance, setting the table, and sharing a cookie, teachers agreed that children are learning language and math skills.

Picking up information. Through everyday experiences in the environment, children pick up information.

I got some 3 year olds that can do fine because it depends on what that child is exposed to. What that parent that works with the child at home on. The more they’re exposed the better off they are (Teacher 10, lines 381-384).

By listening, observing, and interacting, children are picking up information without being explicitly taught. “We’re not forcing them to, but they’re just learning by being in that learning environment, exposed to the other children that are a little more advanced” (Teacher 2, lines 123-125).

Since some teachers expressed children pick up speech by listening to others, they were concerned about modeling correct speech.

They gonna look at the teacher and watch how they speak and use words in classroom or whatever. And they gonna learn from that, from their teacher’s way of speaking. So you just be careful how you speak to the kids in your classroom... It is very important that the teacher watch what they say around the kids because they gonna pick it up. (Teacher 1, lines 219-242)

A teacher plays a crucial role in modeling correct speech. Children are not only picking up information from their school environment, they are picking up information from their home environment.

Home environment. Most teachers agreed that the child's home environment plays a role in development. From birth, the child's environment plays a role in the child's cognitive growth.

A person is born, how the person is born. I believe that is a part of your genetics. You know, however you come. Whatever you come with when you are born. But sometimes environment, cultures affects development.
(Teacher 10, lines 153-157)

Parents play a crucial role in a child's education. Teachers felt parents who work with their children, read to their children, and talk with their children help the child acquire language and math.

I believe that environment has a very important part in the way a child learns. Is that child being talked to? Is that child getting in mathematics? Is someone reading to that child...All that plays a tremendous part of the way a child would develop. It's much easier to work with children that are all ready; the parents are already working with them at home. (Teacher 5, lines 71-77)

Teachers feel children who have supportive parents will be better off in school, regardless of their age.

I got some 3-year olds that can do fine because it depend on what that child is exposed to. What that parent that works with that child at home on. You could tell the parents that work with their children exposed. The more their exposed, the better off they are. (Teacher 12, lines 381-384)

Parent support plays a role in the success of a child. Teachers see the value of involving parents in their child's education. Head Start offers several workshops

throughout the year addressing parent involvement. Many of the Head Start teachers mentioned attending these trainings. In these trainings, teachers have acquired strategies to assist in working with parents and in working with the community.

The Importance of Education in Society

A second theme that emerged was the importance of education in society. An education is not only a matter of learning to some teachers, but also a matter of survival. A few teachers also expressed that the importance of education in society is to give children a voice to express themselves, in short, words have power.

Learning as survival. One teacher decided to become a teacher after working at a lawyer's office and being alarmed to see so many African-Americans males repeatedly going through the court system. She remarked, "I'm like, wow, how many black mans going to come through my table" (Teacher 6, line 65).

She decided to become an early childhood teacher in order to set the foundation young children need to survive in the community.

[An education] is the beginning of all, of everything, of learning, of uh, seeing a human being and the way I saw for me, I saw my black community going. I hear school is hard... If they have a strong foundation, if they have that, school's, a breeze. Everything else is just add-on. Everything is just a pile of information piled on top of each other. But a lot of times because they don't have a strong foundation and that's why they have problems later on.
(Teacher 6, lines 2-11)

Some teachers viewed school as a way to give children the tools they need to survive in society. "Math is a way of helping to understand things that could be more... to make a better way of life" (Teacher 11, lines 127-129). Schools prepare children to live in a community. "It teaches them how to work with other children, other people.

How to communicate, how to um, how do I want to say, get what they want and be better citizens” (Teacher 1, line 208-210).

Language and math help children communicate and become active members of society. Language is a tool to share what you have learned with other members of the community.

There’s nothing wrong with being curious, that’s about life, life is a whole, it’s a learning process. And you have to learn. And do go out and learn and share. Whatever you’ve learned, you found out something, share with someone else. Let someone else know. (Teacher 6, lines 144-147)

Teacher 6 sees learning as an opportunity to share what you have learned with your community. Communication is an important tool to help children pass on what they have learned. Through communication children have the power to express themselves.

Words have power. Many teachers also have attended classroom management trainings. A major theme of these trainings is to encourage children to use their words to express their wants and needs. Most teachers defined language as a way to communicate and express themselves. “Language, I think language is what we use to communicate to one another and express our thoughts and ideas” (Teacher 8, lines 188-189).

Teacher 2 provided an even stronger purpose for language. “It [language] helps them communicate. To let them know that words have power (Teacher 2, lines 240-241).

Language goes beyond reading and writing. Language is empowering. It allows children to use their words to express their needs, instead of finding inappropriate alternatives, such as hitting or throwing a tantrum.

They use language amongst themselves, they use it really to express themselves. How they feel, it’s a great way to let out feelings. You know, I’m going to hit him, instead of

hitting go over there and I'm going to tell him I don't like it when he does that to me. So I think it's very important for preschools to be given language and to show them different ways to solve problems because now I'm in the preschool environment now how am I going to let others know my feelings? And that's the best way is through words.
(Teacher 5, lines 142-149)

When children are using words instead of being aggressive to express their needs, they are using words as a tool to communicate. Words are powerful and help children express feelings and help avoid aggressive situations.

The Role of Mathematics in Early Childhood

A third theme that emerged was the role of mathematics in early childhood. Teachers saw the role of math as helping children count and helping children prepare for school.

Math as counting. Many teachers defined math as counting. For example, Teacher 5 commented, "Math has to with numbers, counting" (line 187). Teacher 6 also defined math in terms of counting.

Math is something you know on a regular basis. I have them count the students when we get in line. I have them count if it's something they're like, well, um, how many cameras do you have? I said well count and find out. You know everything's count, count. (Teacher 6, lines 223-236)

Many teachers viewed math as a daily activity including many opportunities to count. Students are counting how many children are absent, how many children are in line, and the like. Teachers used these opportunities to reinforce counting.

I learned that all these activities that they do when their sorting, their lining up, their grouping, they match; as a teacher, I learn how to expand those activities to teach them math concepts of counting. They're counting. (Teacher 10, lines 230-235)

Teachers expressed how throughout the day children are exposed to many opportunities that help reinforce counting. By taking advantage of these opportunities, teachers teach math. “Math is spur of the moment teaching. That’s just everyday” (Teacher 12, line 368).

Math for school readiness. School Readiness is a sentiment expressed by almost every teacher. Teachers felt pressured by parents, administrators and state policies to get their students ready to compete in the public school system and many felt the role of math in preschool is to get them ready for math in elementary school. “Well, I think math, math in preschool, is just to help children get ready for going to elementary school” (Teacher 2, line 243). Early childhood teachers are feeling pressure from the elementary schools to prepare the children.

Early childhood teachers are feeling pressure from the elementary schools to prepare the children.

When they go to public school they want them to be able to count, I think it’s to 30 or 30 to 50, ok, and their putting a lot of emphasis on a lot of things, numbers, to, to be able to identify 6 with 6 objects, which one is more, which one is less, so what I try to do everyday is use these more, less, some to expose these children to these, to these concepts. (Teacher 12, lines 548-553)

One teacher indicated that she had just spent the morning wondering if her children were ready to move on to kindergarten. With school ending in 2 weeks, she was curious if they were ready for school. After asking the children to count the number of windows in the class and the number of chairs, she felt her students were ready. “I said,

hell yes, I'm all right, all right. And then I know they are ready. I know they are ready” (Teacher 11, lines 322-325).

Summary of Interviews

Three themes emerged after analyzing the interviews: (a) the importance of a child's environment, (b) the importance of an education in society, and (c) the role of math in early childhood. The teachers were aware of the importance a child's environment plays on learning. Through everyday experiences at school and at home children learn. Secondly, an education is important in society. To the Head Start teachers interviewed, an education is a matter of survival in society. They want their students to succeed in life. The best tool they can give their students is the power of words. “Words have power” (Teacher 2, line 241). The third theme that emerged was the role of math in early childhood. Teachers saw math as a tool for counting. Some teachers also saw math as an indicator of school readiness. If their children can count, then they are ready for kindergarten.

As mentioned earlier in the study, Head Start programs were created in 1965 as part of former president Lyndon Johnson's War on Poverty, which created a government program for economically disadvantaged preschool children (Head Start, 1990). The major goal of the program is to help prepare children to succeed in society (see Chapter 3). Most of the teachers interviewed were concerned with their students and wanted to see them succeed in school and in society.

Summary of the Findings

Children were using everyday language to express mathematical concepts throughout the day (see Figure 2). As children were engaged in block play they made

references to (a) objects in a set (classification), (b) transformation of objects through space (dynamic), (c) quantification (enumeration), (d) positions of objects (spatial relations), (e) the size of objects (magnitude), and (f) the form of an object either to imitate it (pattern) or to describe its form (shape).

Teachers were not taking advantage of these opportunities to infuse mathematical instruction into the daily context. Most of the students' mathematical utterances were ignored. The teacher mediated only 10% of the mathematical utterances (see Figure 3).

Based on a thematic analysis of the interview three themes emerged: (a) the importance of a child's environment, (b) the importance of an education in society, and (c) the role of math in early childhood. The teachers who participated in this research all agreed that language and math occur everyday and should be taught throughout the day. Language and math are important in setting the foundation children needed to succeed in school and to succeed in society. Chapter V will present the results of a meta-inference based on the findings. It will also delineate implications and areas of future research.

CHAPTER V

INTERPRETATION, IMPLICATIONS, AND FUTURE RESEARCH

Chapter 5 begins an interpretation of the findings. Implications based on the findings are presented. Areas for future research and a summary of the study conclude the chapter.

Interpretation

“Interpretation addresses processual questions of meanings and contexts: ‘How (What) does it all mean?’ ‘What is to be made of it all?’” (Wolcott, 1994, p. 12). The purpose of this parallel mixed method study was to describe the interaction between teachers and preschoolers to the extent that teachers scaffold children’s everyday language into expressions of mathematical concepts. Of primary concern was the teachers’ responsive interaction to children’s expressions of an implicit mathematical utterance made while engaged in block play.

Classroom observations from Strand 1 along with the teacher interviews from Strand 2 were analyzed. Based on a thematic analysis three themes emerged: (a) teacher conception of mathematics, (b) teacher practice in comparison to teacher belief, and (c) teacher sensitivity. A teacher’s conception of mathematics can be categorized as either (a) a simple definition of math or (b) a more complex definition of math. Some had a simple definition of math and others had a more complex definition of math. A simple definition of math limited math to counting, and a more complex conception of math defined math as a tool to problem solve. A second theme that emerged was teacher practice in comparison to teacher belief. Teachers espoused teaching math throughout the day, but the observations of the teacher in action did not match their belief. A third theme

was concerned with teacher sensitivity. Math is a subject needed to succeed in society (NRC, 1997) and teacher practices tend to affect a child's perception of math (Wilson & Hart, 2001). Teacher sensitivity takes into account how a children's attitudes are affected by teacher practices.

Teacher Conception of Mathematics

"A teacher's conception of the nature of mathematics may be viewed as that teacher's conscious or unconscious beliefs, concepts, meanings, rules, mental images, and preferences concerning the discipline of mathematics" (Thompson, 1992, p. 17). Thompson (1991) created three levels of teacher conception of math based on the following framework: (a) What is mathematics? (b) What does it mean to learn mathematics? (c) What does one teach when teaching mathematics? (d) What should the role of the teacher and student be? (e) What constitutes evidence of student knowledge and criteria for judging correctness, accuracy or acceptability of mathematical results and conclusions? Based on this study, two levels of teacher conception of mathematics emerged from the interviews: low complexity and high complexity.

Low Complexity: Math as Counting

Based on Webb's (1999) conception of depth of knowledge, low complexity requires minimal cognitive demands. A low complexity conception of math is defined as narrowing the role of math to tasks such as counting. Most of the teachers defined math in terms of counting and recognizing numbers. When asked about the role of math, Teacher 1 responded,

The role of math in a preschool, that's getting them basically, like ready for Kindergarten and they be able to recognize numbers when they see numbers. They're gonna

be able to count to one to ten. When they reach kindergarten, so it's very, very important for kindergarten that they learn the little basic in math, and counting and stuff. (Teacher 1, lines 228-232)

Teacher 1 recognized the importance of school readiness, but expressed a limited view of mathematics. She emphasized the importance of counting and number recognition. Most teachers noted the use of math in daily context. But with a limited view of math, the practice of daily math was mostly defined in terms of counting. When asked to define math, Teacher 11 responded, "Ok, math has to with numbers, counting" (line 187). Math does involve counting and counting is considered one of the preschool focal mathematical concepts (NCTM, 2006), but math is much more. Limiting math to counting is a low complexity conception of math.

High Complexity: Math as Problem Solving

High complexity requires more cognitive demands (Webb, 1999). A high complexity conception of math is defined as viewing the role of math as a tool to problem solve. Three teachers demonstrated a complex definition of math. A High Complexity views the role of language as more than counting.

They use math everyday. You know, counting, comparing, you know, they like to weigh stuff and um, They make up quantity, you know, sizes. Uh, a lot of times when people think about math they just think about 1,2, 3, 4 and it's, it's more then just counting, it's sizes, it's shapes, it's a lot of things that's in there. You know, its fractions, so, a lot of these things when, a lot of these things is math, a lot of times teachers just think about counting. But it's, it go a little farther, a lot farther then just counting. (Teacher 12, lines 496-503)

Teacher 12 saw math as more than just counting. She realized that math is much more. Math is an important part of her daily life. Teacher 5 considered math an important part of her daily life too. She expressed applying math to problem solving. When asked how she used math, she responded, “I’m solving problems everyday” (Teacher 5, lines 201-205). Teacher 5 also recognized how children use math to problem solve in their daily context.

They use it to count. They use it among their friends to see how old each other are. They use it as a compare and contrast. Um, I mean I can see them doing mathematical problems in block area and they’re trying to stand that block in a way that they won’t fall down. Let me try to figure out, okay, should I put this rectangular block here or should I put the triangle here. Which one is going to help me so they’re using math in that way. They use it everyday, all day. I’m going to go first; you’re going to go second. In everyday life they’re using it in every way. (Teacher 5, lines 151-157)

Although Teacher 5 saw the importance of counting in math, she had an expanded definition of math involving higher order thinking skills, such as comparing, contrasting, and solving problems. Teacher 8 also had a high complexity conception of math.

Most of the kids in my class use math as far as counting. How many do I have left? How many more do I need? Oh, you have, so it’s more counting for some of them and the other ones use it as far as um, more analytical. Like putting together puzzle pieces, solving problems, doing sequence of events. Reasoning. I have like maybe five that will do math that way. (Teacher 8, lines 219-223)

In this example counting is seen as an important math skill, but Teacher 5 also views math as a means to solve problems. Math is a tool to solve problems that although it requires the knowledge of basic computation, it includes higher order thinking skills.

The three teachers with high complexity varied in levels of degrees. One of the teachers had her CDA, another teacher had an AA, and the third teacher had a Masters degree. Although the level of education did not seem to play a role in their beliefs, two of the three teachers did claim math to be their favorite subject, and not one teacher loathed math.

Teacher Practice in Comparison to Teacher Belief

All the teachers agreed that language and math are taught everyday throughout the day. This espoused theory was in contrast with their theory in action (Argyris & Schon, 1974). As mentioned earlier, teachers ignored 60% of the mathematical utterances. The 12 teachers professed teaching math through the child's daily routine, but were not observed acting on their espoused beliefs. Three factors that influence teacher practices are (a) the teachers' feelings towards math, (b) the social context, and (c) the teachers' reflective thought processes (Thompson, 1992).

Teachers' Feelings towards Math

When asked which subject was the teachers' most favorite and least favorite, only two teachers favored math. In contrast, five teachers claimed math was their least favorite subject in school. One teacher took the sentiment one step further. "I hated math" (Teacher 3, line 68). Another teacher commented, "I'm not crazy about math. Because the math nowadays does not apply to the things that you can teach in early childhood development" (Teacher 2, lines 80-81). Teacher 2 is currently pursuing her Bachelors in Education and was frustrated at the quality of math methods courses. She wanted math courses that made math fun. "I think (they should) create math courses that are fun for the

teacher. (So) that she can be creative and use that math and resources to teach children to make math fun” (Teacher 2, lines 85-88).

Regardless of how teachers felt about math, they reported children acquiring math throughout the day. “They [children] acquire math everyday with things that they do; with sounds, play, oh my God, it’s, it’s everything with math” (Teacher 7, lines 252-253). Math is part of the child’s daily routine.

Most teachers also felt math is necessary for school readiness. “When they go to public school they want them to be able to count” (Teacher 12, line 553). Math is not only necessary for school, but for life. “Math is something that we need. Language and math are something that we need in life” (Teacher 5, lines 118-119).

The Social Context

A second factor that may influence teacher practice is the social context. Another word for social context is social milieu. Social milieu is “the physical or social setting in which something occurs or develops” (Merriam Dictionary, 2003). Social milieu includes the subject area (i.e., block play), the learner (i.e., the children), and the teacher.

Subject area. Observations took place while children were engaged in block play during center time. Center time is a period in the day where the child explores different areas in the classroom (e.g., art area, sand/water table, housekeeping area, and reading area.) Block play is regarded as free choice activity that occurs during center time. During this free choice time, teachers are not usually interacting with their students. For the purpose of the study, the teachers were asked to remain in the block area with the five students.

The learner. Play encourages children to interact and negotiate. Through play children role play taking on roles of their culture and home life (Vygotsky, 1967). Many of the block play scenarios involved role playing situations children had experienced. For example, in one class, the children all climbed on a car and one child told the teacher. “We’re going to Chuck E. Cheese and college” (Teacher 5, Student 5). Blocks were used as tools to reenact an outing.

Head Start children are considered low-income and lack many of the experiences other children receive. Many of the children live in poverty and some are homeless (CAA, 2006). Their social context is different than most children. In one classroom, a child used a block as a gun. He kept walking around with his “gun” in his pocket, protecting his structure (Teacher 7, Student 3). By observing children in block play, the teacher can get a glimpse at the experiences the children may have had. Observation is defined as “watching to learn” (Jablon, Dombro, & Dictelmiller, 2007, p. 1).

Teacher. The teacher plays a major role in how a situation is observed. “As an observer, you are like a photographer, focusing on some things, ignoring others” (Jablon, Dombro, & Dictelmiller, 2007, p. 31). Four of the teachers observed had previous experiences with Head Start prior to teaching. One teacher began her career at Head Start as a cook (Teacher 6). A second teacher began working for Community Action Agency (the agency that oversees Head Start) in the elders program (Teacher 1). Another teacher began her experience with Head Start as a parent (Teacher 10).

Teacher 5’s first experience with Head Start was as a student. “What inspired me to become a teacher was that I had great teachers in Head Start... And I just wanted to make a difference in the way that children learn right here. This was my school” (Teacher

5, lines 3-4 & 8-10). Teacher 5 had attended the school she was teaching at when she was a preschooler. Her teaching practices were affected by her experiences as a Head Start student.

The Teacher's Reflective Practices

Reflection in how we think was defined by Dewey as “active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends” (Dewey, 1933, p. 118). Dewey’s model of reflection encompassed five phases: (a) suggestion of a solution, (b) intellectualization of the perplexity into a relevant context, (c) developing a hypothesis, (d) elaborating of the hypothesis, and (e) testing the hypothesis (Dewey, 1933).

Schön focused on the process of thought in action. Reflective practitioners think about their actions (Schon, 1983).

The practitioner allows himself to experience surprise, puzzlement, or confusion in a situation which he finds uncertain or unique. He reflects on the phenomenon before him, and on the prior understandings which have been implicit in his behavior. He carries out an experiment which serves to generate both a new understanding of the phenomenon and a change in the situation. (p. 68)

Dewey’s seminal work and Schon’s research led to three revised phases of reflection: (a) returning to the event, (b) connecting the event to feelings, and (c) evaluating the event (Boud, Keogh and Walker, 1985). Although many of the teachers interviewed had never reflected on a definition of math or how children are acquiring math, they were able to reflect on times they and their students use math in their daily lives. Teacher instances of mathematical events were tied to feelings, since most events

involved money. What was not apparent from the data, were instances where teachers evaluated the mathematical event.

Many teachers struggled with defining math. When asked to define math, one teacher reported, “Uh, boy, I was never asked that question before” (Teacher 6, line 233). Another teacher responded, “Math, uh well learning, um, uh, I don’t know” (Teacher 3, line 134). If teachers are struggling with reflecting on what is math, it will make the task of reflecting on mathematical teaching difficult.

Teachers were able to identify how they use math in their daily lives, but had difficulty articulating a definition for math. “I don’t try to think about math unless the gas prices going up. I’m like man, last week it was \$2.50. So basically when it’s out of my pocket” (Teacher 6, lines 416-418). Another teacher also thought of math when money was involved. “I use math when I cash my check, I count all the pennies that I’ve spent. Over and over and over and over” (Teacher 7, lines 345-348).

Teachers in the study were also able to identify events where students use math in their daily lives.

They use it in comparing. Some of them look at you put the cookies on the plate and they’d just look and eat and know when you’ve [given] somebody a different amount. (They will ask) “Why does she have more then I have?” (Teacher 4, lines 198-202)

The interviews were conducted after the observations. When teachers were asked how children use math in their daily lives, not one teacher reflected on an incident during the observed block play session. Teachers were not returning to the event of block play in order to reflect on their teaching practices.

Teacher Sensitivity

Teacher sensitivity is characterized by meeting each child's individual needs in a positive manner (Gartrell, 2004) based on gender, culture, or academic ability. Children vary based on cultural background and gender. Gender bias in mathematics tends to favor boys. Boys are asked more difficult questions, given more instructional time, and more praise than girls receive (Cantu, 1994; Wilson & Hart, 2001).

During the video segments there were classrooms where teachers tended to ignore the girls more than boys. During the interview, one teacher mentioned her motivation to become a teacher was because she had worked in an attorney's office and was tired of seeing Black males going through the system repeatedly.

I was a legal secretary for 3 years.
I was in the Attorneys office, I have 4 attorneys. I was tired of seeing the cases coming in front of me. Every single day, we're not talking you know, older people, we're not talking about you know, 40, 50 year olds, we're talking about an 18, 19. Um, 3 strikes you're out rule, it kicked in. It was sad, it was plain sad. I'm like, wow. I'm like how many black mans going to come through my table. (Teacher 6, lines 55-66)

She was alarmed at the number of cases she would receive a day and wanted to make a difference in the early years.

Really [if] they have the proper foundation, a strong foundation, if they have that, schools a breeze. Everything else is just add-on. Everything is just a pile of information, piled on top of each other. But a lot of times because they don't have a strong foundation. That's why they have the problems later on. (Teacher 6, lines 5-9)

Teacher 6, a young Black woman, expressed an interest in many careers, but felt she could best make a difference as an early childhood teacher. During the observation of

Teacher 6 interacting with three Black boys and two Black girls, it appeared that she paid more attention to the boys. One girl in particular had almost all of her utterances ignored. At a point in the video, the girl moved closer to the teacher and stood behind her to make another comment. The teacher's interaction at that point was to reprimand her for standing up. The children were talking about animals at the zoo and the girl was commenting about the animals she had seen once during a visit to the zoo. The other girl in the observed video segment had only two mathematical utterances.

Another classroom observation included a Black teacher and three Black boys, a Black girl, and a Hispanic girl. The Hispanic girl's only mathematical utterance was made towards the end of the observation. At first, I thought the teacher had placed a child who was not proficient in English in the group of children observed, but upon hearing her comment to her friend "You could put the police here," it was evident that she was proficient in English. The questions then became; why didn't the teacher try to include her in the interactions? Was it due to gender or cultural background issues? Why did the child not interact with the teacher and only once to a peer?

Cultural differences may lead to stereotypes and discrimination. In the next example a boy was not allowed to play because of his shirt. This classroom observation consisted of a White teacher, three Black boys, a Black girl, and a Hispanic girl. In this classroom, the teacher made many efforts to try to involve the Black girl. The shy girl did not want to leave the block area but had also chosen not to participate. Yet, during the block play session one of the boys told another boy, "You can't play with us, you don't got no letters." The boy was referring to the fact that the boy's shirt had numbers and the other boy's shirt had letters. This conflict lasted quite a while. Other kids would come up

to the first boy and ask to play and based on having letters or not, they were allowed to play. I couldn't help wonder why the teacher did not get involved in this case of discrimination. Was it because she was White? Was it because she didn't see it as I saw it? Although putting the children in sets based on the criteria of letter and no letters is a mathematical concept that was being addressed (and ignored by the teacher), the predominant social interaction should have addressed the issue of getting along with everyone regardless of what they wear.

“We are at risk of becoming a nation divided both economically and racially by knowledge of mathematics” (NRC, 1989, p. 13.) Minorities including women continue to be underrepresented in math. Quality math education begins in the early childhood years. Math is key to succeed in society. “Children can succeed in mathematics. If more is expected more will be achieved” (p. 2).

Summary of Meta-Inference

Data concerning children's use of everyday language to express mathematical utterances and teacher interactions after a child made a mathematical utterance were compared to the data from teacher interviews. Based on a thematic analysis of both strands of the study, three themes emerged: (a) teacher conception of math, (b) teacher practice, and (c) teacher sensitivity (see Figure 4).

Figure 4. Teacher's use of language in early childhood mathematics.

The first theme was concerned with the teachers' conception of math. Teachers demonstrated either a low complexity or a high complexity conception of math. Most teachers had a low complexity conception of math and limited math to counting. Only three teachers had a high complexity conception of math. A high complexity conception of math builds from foundational skills, such as counting, but uses these skills to problem solve throughout the day. A second theme that emerged was how teacher practice affected the teacher interactions. Teacher practice included more than a teacher's espoused belief, it was affected by the teacher's ability to be a reflective practitioners. To reflect in a teacher's theory in action, the teacher needs to evaluate the event and connect it to a feeling. In order to evaluate an event, the teacher needs to become aware of the social context. For the purpose of this study the social context included the subject area

(i.e., block play), the learner, and the teacher. A third theme was concerned with teacher sensitivity. Upon reflection a teacher needs to take into account issues of sensitivity. Minorities continue to be underrepresented in math. Teachers need to be aware of how their actions may be perceived by their students.

Implications

Implications based on the findings involve social policy, curriculum, and professional development. Social policies need to take into action what the math reports have been demonstrating for decades; we need quality math education. The curriculum needs to provide quality math education by making the math instruction meaningful (Clements, 2007). Meaningful instruction takes place when the math concepts are related to the child's daily context. Professional development needs to take place and needs to focus on quality math instruction in early childhood. If teachers become aware of these teachable moments, math instruction may be enhanced and children will develop a strong foundation in math.

Social Policy

Teachers' feelings and practices are influenced by social policy. "The political climate may also account for some of the observed discrepancies between teachers' professed beliefs and their instructional practice" (Thompson, 1992, p. 41). The need for school reform was expressed with a *Nation at Risk* (1983). Two decades later, we are still a nation concerned with improving our educational standards and producing reports in attempts to reform the educational system. Reports continue to advocate quality math education (NRC, 1989) and the importance of math literacy (NRC, 2001). Standards for quality math education have been created (NCTM, 1989) and expanded to include early

childhood (NCTM, 2000). The National Council of Teachers of Mathematics and the National Association of Education of Young Children created a joint position paper providing recommendations for high-quality, early childhood math instruction ((NAEYC & NCTM, 2002).

With the number of reports addressing the importance of quality mathematical instruction, legislation continues to ignore the necessity for mathematical reform in favor of literacy. The call for quality math programs is not being translated into a plan of action (NRC, 2005). Legislative decisions appear to be grounded on different assumptions (i.e., legislative practices are not aligned with research findings). Reports espouse a belief of the importance of high quality math reform, but theory in action is supporting literacy.

Literacy is also the priority of Head Start curriculum. In 2006, the Head Start lesson plan framework addressed literacy three times throughout the day (shared reading, phonological awareness, and teacher read aloud), but did not provide a specified time for math instruction (Community Action Agency, 2006).

Curriculum

Mathematics is best learned through context (NAEYC & NCTM, 2002). Children are exploring their environment and attempting to make sense of it. Observations of children's verbal speech during block play supports the theory that children are constructing meaning based on their surroundings (Piaget, 1975) and are using everyday language to express the mathematical concepts (Lakoff & Johnson, 1980; Moseley & Bleiker, 2003). These mathematical utterances have the potential to further promote a child's mathematical knowledge if the teacher bridges the everyday language to the

mathematical term (i.e., if the teacher bridges the spontaneous vocabulary to its scientific term; Vygotsky, 1962).

Interactions between teacher and student are imperative to help the children reach their maximum potential (Vygotsky, 1962). Mathematical concept building does not occur just because students and teachers are interacting (Clement, 1997; deKruif, McWilliam; Ridley, & Wakely, 2000). Interactions need to stem from the child's natural curiosity and lead to reflective thinking (Haroutunian-Gordon, 1996). Successful interpretive discussions result from teachers who validate the child's thinking (Schwartz & Brown, 1995) and elaborate on the child's responses (deKruif, McWilliam; Ridley, & Wakely, 2000).

If teachers do not take advantage of these teachable moments, math deficiencies may increase. As children get older the achievement gap widens. Bob Moses (2001) created a program called The Algebra Project to help narrow the gap. His program is not only an educational solution, but also a civil rights movement in that it gives disadvantaged students the tools needed to feel capable to succeed in math and hence succeed in life. Direct experiences stemming from real world scenarios provide a way to make math concepts meaningful. The program consists of giving students direct experiences with mathematical problems. After experiencing a physical event, students use "people talk" (i.e., everyday language) to explain what occurred. The teacher then scaffolds in order to bridge the people talk to the "feature talk" (i.e., the mathematical concept; Moses, 2001). His program is geared to finally give older students a concrete foundational experience in order to assimilate mathematical concepts. Although the Algebra Project has had positive results, if early childhood mathematics was addressing

the child's everyday language and using the child's direct experiences as the foundation to learning, mathematical deficiencies faced by these older students may be significantly reduced.

Professional Development

In the study, teachers all professed teaching math, "Everyday in everyway" (Teacher 5, lines 64), but this espoused theory was not evident in their teaching behavior. Teachers' behaviors are affected by many factors, including the teachers' knowledge base. "Some inconsistencies between teachers' professed beliefs and practices may also be manifestations of espoused teaching ideals that cannot be realized because the teachers do not possess the skills and knowledge necessary to implement them" (Thompson, 1992, p. 41). Many early childhood teachers enter the classroom without sufficient preparation to teach math. Most universities only require one math method course (Nolan, 2007). Without a content base and a pedagogical base, teachers are unaware of what to teach in early childhood mathematics and how to teach it.

Head Start protocol requires teachers to attend professional development on a regular basis. All 12 teachers have participated in professional development in the areas of behavior management, parent involvement, health, and literacy. Not one teacher mentioned having attended a workshop on math.

Every year we have to go to um, to seminars, upgrade and get our, get certified. They have different courses that they give—English, math, language arts, I normally attend the science and language arts when I do go. That's like mine. For me, I think that's the weak part for the kids. The kids they'll get counting because they like money. They'll always, get the hang of that a little better, but the reading and the science people think is not important. (Teacher 6, lines 161-165)

Teacher 6 expressed a desire to attend professional development to address the needs of her students and was motivated to learn new ways to teach. She continued to say:

So I always try to figure out new and better ways of bringing interest to having the kids, you know, 3, 4, 5 year olds, a little more interested. So I always go to the seminars to see if they have something going on. Or something new that I can learn from. Of course, again, share with the kids.
(Teacher 6, lines 162-169)

Math does not appear to be a priority on the professional development calendar as well. Early childhood math workshops are scarce. In the 2007-2008 school year, Head Start is not offering any workshops dedicated to early childhood math (C. Brogan, personal communication, October 19, 2007).

Areas for Future Research

Areas for future research include speech related to level of socioeconomic level, student interactions, and the effect of professional development on math-mediated language.

Speech Related To Level of Socioeconomic Level

After the initial results were coded, I met with my peer review team. At that time, one of the members raised a very interesting question: Would the number of speech utterances be affected if the centers were of different socioeconomic levels? For the purpose of the study, 12 Head Start Centers were chosen. Head Start programs were created for economically disadvantaged preschool children (Head Start, 1990).

There were 2,831 mathematical utterances observed while 60 children were engaged in 240 minutes of block play. Would more “advantaged” centers produce more mathematical utterances? Verbal interactions while children are engaged in sociodramatic

play have been studied (Hart & Risley, 1995; Smilansky, 1968). Sociodramatic play is a form of play where children take on roles and imitate situations. Sociodramatic play help children develop social skills needed to function in school and in a community. (Smilansky, 1968).

A seminal study, *The Effects of Sociodramatic Play on Disadvantaged Preschool Children*, (Smilansky, 1968) presented significant differences “between the advantaged and the disadvantaged groups in all areas measured” (p. 42). Advantaged children spoke more words (698 words) than the disadvantaged children (415 words). Advantaged children also had significantly longer utterances.

In another study, vocabulary of children from 42 families with different levels of socioeconomic levels was observed (Hart & Risley, 1995). “The vocabulary comprises all the words a person knows” (p. 6). Of the 42 families, (a) 13 were professional, (b) 23 were working-class, and (c) 6 were on welfare. Based on monthly observations over a large span of time conducted at the child’s home, the results of words per hour varied based on socioeconomic class: (a) professional families averaged 2,153 words per hour, (b) working class families averaged 1,251 words per hour, and (c) welfare families averaged 616 words per hour (Hart & Risley, 1995).

Based on these studies, future research concerning the number of mathematical utterances in more advantaged centers is indicated.

Student Interactions

The focus of this study was on teacher interactions after children made mathematical utterances. This study was designed as a first step to explore math mediated

language. Do children use everyday language to express mathematical concepts? If so, do teachers recognize the use of everyday language to express mathematical concepts?

Future studies should observe student interactions after a teacher has responded to a mathematical utterance. How is a child's behavior affected by the teacher's response? The data collected for this study focused on the child's mathematical utterance and the teacher's response. At times simultaneous conversations were coded and transcribed, causing transcripts that did not flow from teacher to student to teacher again. In other words, by the time we coded a child's utterance and the teacher's reaction, the research team moved on to another mathematical utterance. By chance, there were some instances where the interactions between teacher and child were captured. For example, in the one classroom a child was measuring her block and commented to the teacher, "That block is 8" (Teacher 2, Student 2). The teacher mediated by asking the child "Eight inches or eight feet." The child responded, "Eight inches." The teacher repeated, "Oh, eight inches." In this example the child's interaction was verbal. In other words the child used words to respond to the teacher.

Teacher interactions also had an effect on the other children in the class. In one classroom a child (Student 2) showed the teacher an alligator. The teacher commented, "I don't like alligators. They scare me" (Teacher 12). The student began to put the alligator away. Another student then commented, "Get it away from me" (Student 3). Another child then joined in to mention, "She scared of alligators" (Student 4). The teacher repeated the observation, "She is scared of alligators." At that point, the scared student commented to the teacher, "She almost scared me and gave me a heart attack" (Student 3). In this example, the teacher's interest in the alligator generated curiosity in other

children who joined in the interaction. Transcripts did not capture any further dialogue or discussion about the alligator. Although the teacher's repeat/accept interaction did not promote mathematical concepts, it did promote student interactions.

Interactions may also involve a child reacting to a comment made by the teacher. In one classroom a child was making an array of 3 x 5 blocks. She continued to build a tower of blocks organized in a 3 x 5 array (i.e., layering blocks on top of each other in a 3 x 5 array). The teacher commented to the child, "I thought you were going to build a house" (Teacher 4). Without saying a word, the child tore down her array tower and began to construct a house. Unfortunately in this example, the child's mathematical creativity was stifled by the teacher's request, but it is an example of how a child reacts to a teacher's comment. Interestingly, after a few minutes, the child appeared unengaged creating her house and went back to creating the 3 x 5 array.

The Effect of Professional Development on Math-Mediated Language.

Another area for future studies should explore the effects of teacher interactions once a teacher is made aware of these teachable moments. Does teacher awareness of children's use of everyday language to express mathematical utterances affect teacher practice? Will teachers mediate children's words to the mathematical concepts if they are aware of these teachable moments? Professional development in the area of early math should be offered to teachers. Teacher trainings should share the findings of this study and focus on best practices for teachers to interact with children.

"Teachers are key figures in changing the ways in which mathematics is taught and learned in schools. Such changes require that teachers have long-term support and

adequate resources” (NCTM, 1991, p. 2). Teachers need to become reflective and aware of how everyday language can be connected to mathematical concepts.

Limitations

After conducting the study a few limitations emerged. First of all, teachers do not normally interact with children in the block center. Maybe teachers assumed block play is a time to let children play independently without any adult support. Secondly, I had assumed children would be using everyday language to express mathematical concepts equally among categories. After coding the data, words that labeled things were considered classification. Since nouns label objects, the research team coded nouns as classification. Dynamic words consisted of verbs. After reviewing the results, maybe the expected value for classification and dynamic should have been larger. Since, I was not privy to this kind of data, the expected frequency was the average value of all mathematical utterances (i.e., 471).

Summary

The primary research question of this parallel mixed method study was: How do teachers interact with preschoolers who use everyday language to express mathematical concepts? Strand 1 of the study focused on students’ use of everyday language and teachers’ interactions after a child made a mathematical utterance. Twelve teachers and 60 students were observed while engaged in block play. Using a priori codes children produced 2,831 mathematical utterances. Teachers ignored most of the utterances (60% of the utterances were ignored). Only 10% of the mathematical utterances were mediated to a mathematical concept. Strand 2 focused on the teacher’s view of the role of language in early childhood mathematics. The twelve teachers who had been observed during the

first strand of the study were interviewed. Based on an inductive analysis three themes emerged: (a) the importance of a child's environment, (b) the importance of an education in society, and (c) the role of math in early childhood.

A meta-inference of both strands produced three findings: (a) teacher conception of mathematics, and (b) teacher practice in comparison to teacher belief, and (c) teacher sensitivity. Teachers had a limited view of math. Most of the teachers defined math as counting. Only three teachers in the study had a complex definition of math that encompassed not just counting, but comparing, measuring, and problem solving. Teachers were professing teaching math everyday in every way, but ignored 60% of the mathematical utterances during block play. The third theme focused on teacher sensitivity. Teachers need to reflect in their practices and become aware of how children can perceive their actions, especially how their actions may affect how children perceive math.

Implications based on the findings affect social policy, curriculum, and professional development. Social policy need to address quality math education in early childhood. The early childhood math curriculum needs to address the teacher's role in mediating math concepts that stem from children's direct experiences. Finally, professional development needs to make teachers aware of these teachable opportunities where children are using everyday language to express mathematical concepts. Although teachers attend professional development, there is a lack of early childhood math workshops.

Teachers are espousing a belief that math is taught everyday in context, but are not aware of children's use of everyday language to express mathematical concepts. Math

is a natural part of the child's daily routine and vocabulary. The role of language in early childhood mathematics should focus on the potential for teachers to see children's everyday language as a means for fostering meaningful mathematical discourse.

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APPENDIX A

INTERVIEW GUIDE

Math Mediated Language Interview Questions

Questions about You:

1. What motivated you to become a teacher?
2. What did you do prior to becoming an early childhood teacher?
3. What was your initial training in early childhood?
4. What degree(s) do you hold?
5. How many years have you worked as an early childhood teacher?
6. How long have you worked in your current job at this center?
7. What professional development have you attended?
8. What was your favorite subject in school? Why?
9. What subject was your least favorite in school? Why?

Questions about Teaching/ Learning

10. How often do you teach language?
11. How often do you teach math?
12. In what ways do children vary in learning styles?
13. In what ways do children vary in learning style by age?
14. In what ways do children vary in learning styles by gender?
15. What other factors influence learning styles?

Questions about the Role of Language in Math

Language and Math

16. How do you define language?
17. How do you define math?
18. In what ways do you think children acquire language?
19. In what ways do you think children acquire math?
20. How do preschoolers use language?
21. How do preschoolers use math?
22. What do you think is the role of language in a preschool classroom?
23. What do you think is the role of math in a preschool classroom?
24. What do you think is the role of language in learning in a preschool classroom?
25. What do you think is the role of math in learning in a preschool classroom?

Relationship of Language and Math

26. Do you think of yourself as thinking mathematically? Why? If yes, how do you think mathematically?
27. When and how do you use math?
28. How do you use language in your mathematical thinking?
29. How do you use language in your teaching of math?
30. How do children use language to express mathematical concepts?
31. How do children use everyday language to express mathematical concepts?
32. How do children's use of everyday language help us to understand their mathematical thinking?

Summative Questions

33. Is there any question you think I should have asked you and didn't?
34. Is there anything else you think I need to understand?

APPENDIX B

CONTACT SUMMARY SHEET

1. What people events or situations were involved?
2. What were the main issues or themes that stuck you in the contact?
3. Summarize the information you got (or failed to get) on each target question

Question	Information
Under what circumstances and how do children use everyday language to express mathematical concepts?	
Do teachers recognize the use of everyday language to express mathematical concepts? When they do, how do they recognize that everyday language express the mathematical concepts?	
When teachers incorporate children's everyday language in their teaching of math do they repeat, elaborate, extend, escalate or otherwise scaffold the children's utterances into mathematical expression?	

4. Anything else that stuck you as salient or anything to consider for next contact?

APPENDIX C

STUDENT TALK CODES

Clip 1	Student	Type of Interaction	Math Codes					
			classification	magnitude	enumeration	dynamics	spatial relations	pattern and shape
	1	Stu-Stu						
		Stu-Tea						
		Stu-Self						
	2	Stu-Stu						
		Stu-Tea						
		Stu-Self						
	3	Stu-Stu						
		Stu-Tea						
		Stu-Self						
	4	Stu-Stu						
		Stu-Tea						
		Stu-Self						
	5	Stu-Stu						
Stu-Tea								
Stu-Self								
Clip 2	Student	Type of Interaction	Math Codes					
			classification	magnitude	enumeration	dynamics	spatial relations	pattern and shape
	1	Stu-Stu						
		Stu-Tea						
		Stu-Self						
	2	Stu-Stu						
		Stu-Tea						
		Stu-Self						
	3	Stu-Stu						
		Stu-Tea						
		Stu-Self						
	4	Stu-Stu						
		Stu-Tea						
		Stu-Self						
	5	Stu-Stu						
Stu-Tea								
Stu-Self								

APPENDIX D

TEACHER TALK CODES

[illegible]

VITA

RAQUEL MUNARRIZ DIAZ

December, 2, 1968	Mayaguez, Puerto Rico
1986 – 1990	Florida International University Bachelor of Science in Elementary Education
1990 – 2006	Elementary Teacher Miami Dade County Public Schools
1990 – 1992	Florida International University Master of Science in Reading
2003 – Present	Florida International University Doctoral Candidate
2006 – Present	Miami Science Museum Early Childhood Project Coordinator

PUBLICATIONS AND PRESENTATIONS:

Diaz, R. (2006, September). *Block Talk*. Presented at the Impact II. Miami: FL.

Diaz, R. (2006, October). *ECHOS: Early childhood hands on science*. (with Juarez, C. and Leeder, I.). Presented at the National Black Child Development Institute. Miami: FL.

Diaz, R.M. (Accepted for 2008 conference. *Early childhood mathematics: How does it add up to teachers?*. Paper to be published in Florida International University College of Education Research Conference proceedings. Miami, FL.

Munarriz-Diaz, R. (in review). How to create young scientist: A recipe for science success in Head Start classrooms. *Children and Family*, *x(x)*, x-x.

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