

EVALUATING EARLY NUMERACY SKILLS IN PRESCHOOL CHILDREN:  
A PROGRAM EVALUATION OF RURAL HEAD START CLASSROOMS

BY  
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A DISSERTATION  
SUBMITTED TO THE FACULTY OF  
ALFRED UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF  
DOCTOR OF PSYCHOLOGY  
IN  
SCHOOL PSYCHOLOGY

COLLEGE OF PROFESSIONAL STUDIES  
DIVISION OF COUNSELING AND SCHOOL PSYCHOLOGY  
ALFRED, NY  
JUNE 2015

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## ACKNOWLEDGEMENTS

I would like to thank Dr. Lynn O'Connell for guiding me through my work at Alfred University as my academic advisor, clinic supervisor, and finally as my dissertation chair. It has been an incredible experience. I would like to thank Dr. Cris Lauback for supporting my academic interests and emotional well-being; Dr. Edward Gaughan for helping me to realize the aspirations of a doctoral degree; and Dr. Andrea Burch for helping me through the complexities of statistics. I appreciate all of your guidance.

I would like to thank the ACCORD Corporation Head Start, for their collaboration and willingness to partake in this research study. Thank you specifically to Lynn Langworthy and Stacie Woodruff. Additional thanks to the teachers and staff at Head Start for welcoming me and my research assistants into your programming.

This dissertation would not have been possible without the financial support of the Women's Leadership Center at the Beth Robinson Judson Leadership Center at Alfred University, for funding the majority of the testing materials. This dissertation was also funded by the Lea R. Powell Institute for Children and Families, for providing financial assistance to my research assistants.

I would also like to thank the research assistants who provided their time and energy helping to collect data with preschool children: Elise Mangano, Nicole Marinnacio, Danielle Gentile and Paul Ninos. I would have not been able to collect the data on my own.

Finally, thank you to my family, my new family, and Mitchell for your support, love, and patience.

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## Abstract

Early numeracy skills are a critical component of daily preschool instruction, according to the National Council of Teachers of Mathematics (NCTM; 2002); however, there is variability in how mathematics-driven instruction is implemented in the preschool classroom (Graham, Nash, & Paul, 1997; Brown, Malfese, & Molfese, 2008). Research indicates that children from low income backgrounds who qualify for Head Start programs do not make comparable growth in early numeracy skill development when compared to children from higher SES levels (Puma, et. al., 2012). The objective of this dissertation was to evaluate a selected mathematics curriculum utilized by the Happy Faces Head Start<sup>1</sup> program, after program data indicated that children's mathematics achievement was below established targets (Happy Faces Head Start, 2012). Results indicated that the curriculum, *Mathematics: A Creative Curriculum Approach*, which was implemented in rural Head Start classrooms did not show significant gains in math skills compared to children in the control group.

<sup>1</sup>Identifying information has been changed to protect confidentiality.

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Chapter 1: Introduction

Research indicates that not all children enter kindergarten on an even footing in terms of mathematics knowledge. While much research has been conducted regarding the development of early literacy skills, less has been done to assess the extent of math development especially in the preschool years (Aunola, Leskinen, Lerkkanen, & Nurmi, 2004). However, research does indicate that introducing mathematics concepts in preschool education contributes to future mathematics achievement (Aunola et al., 2004), and that early mathematics skills are a powerful predictor of future reading achievement (Duncan, Dowsett, Claessens, Magnuson, Huston, Klebanov et al., 2007).

Children who recognize their letters, who are read to at least three times a week, who recognize their basic numbers, and shapes, and who demonstrate an understanding of the mathematical concept of relative size as they enter kindergarten are more likely to understand the mathematical concept of ordinality and sequence, successfully solve addition and subtraction problems, and successfully solve multiplication and division problems. (Denton & West, 2002, p. xi)

Research also shows that children who are successful with mathematics experience fewer problem behaviors, such as social and attention problems, and positive correlations with initiative-taking skills, self-control, and attachment (Dobbs, Doctoroff, Fisher, & Arnold, 2006). In sum, children who have a foundation in basic literacy and numeracy skills demonstrate later school success.



According to a report of the 2010-2011 Early Childhood Longitudinal Study (ECLS-K: 2011) submitted to the National Center for Education Statistics (Mulligan, Hastedt, & McCarroll, 2012), first-time kindergarten students from households with incomes below the federal poverty level demonstrated the lowest reading and mathematics scores. Additionally, according to the results of the 2009 Head Start Family and Child Experiences Survey (FACES) outcomes report, 63% of children who completed their first year of Head Start lived in households where the total household income was at or below the federal poverty threshold (Moiduddin, Aikens, Tarullo, West, & Xue, 2012). Therefore, it is likely that many of the children enrolled in Head Start programs are not adequately prepared with prerequisite mathematics skills prior to entering kindergarten.

### **Preschool Education and Head Start**

Early childhood education was introduced to the United States in the late nineteenth century in the form of kindergarten programs, due primarily to Friedrich Froebel, a German educator, who constructed an educational system for young children based on geometry and symmetry (Balfanz, 1999). As the United States moved into the twentieth century, public kindergarten programs expanded in popularity, as did the fields of education and psychology. In the 1930's, nursery school and traditional preschool programs increased in popularity, and in 1964, Head Start was developed in reaction to research regarding the effects of poverty and the impact of education (Office of Head Start, n.d.).

Head Start was originally designed to support disadvantaged families and individuals, break the cycle of poverty, and provide preschool children from low-income families with a program that comprehensively met social, emotional, health, nutritional, and psychological needs (Office of Head Start, n.d.). Head Start was most recently reauthorized in 2007 with conditions

for improving quality in the program. Changes in Head Start included readiness goals that were aligned with state learning standards for early education, advanced qualifications of the teaching workforce, the implementation of advisory councils within each state, and increased review of child outcomes and finances.

As compared to general preschool programs, Head Start programs are designed to specifically meet the needs of children from economically disadvantaged backgrounds, with an emphasis on parental involvement and family support (Office of Head Start, n.d.). Head Start service models vary depending on the needs of the community served, and services are determined based on family needs assessments.

### **Mathematics in Preschool and Head Start**

According to a joint statement of the National Council for Teachers of Mathematics (NCTM) and the National Association for the Education of Young Children (NAEYC; 2002), “high-quality, challenging, and accessible mathematics education for 3- to 6-year-old children is a vital foundation for future mathematics learning. In every early childhood setting, children should experience effective, research-based curriculum and teaching practices (p. 1).” In order for this to happen effectively, the joint statement indicates that organizational supports, adequate resources, and effective policies must be in place within the organizational system. Additionally, the Federal Office of Head Start (Hulsey, et al., 2011), New York State’s Early Childhood Advisory Council and the New York State Council on Children and Families (2012), and the New York State Education Department (2011), based on recommendations by the National Council for Teachers of Mathematics and the National Association for the Education of Young Children, produced guidelines that promote skill development in number sense and operations, number relationships, patterns, geometry, and measurement.

In terms of mathematics skills in children enrolled in Head Start programs, the Third Grade Follow-Up to the Head Start Impact Study, noted that “in the 3-year-old cohort’s kindergarten year, a significant difference was found between the average math proficiency scores for Head Start children and those in the control group” (Puma et al., 2012; p. viii). Surprisingly, the children in the control group, who were applicants to a Head Start program, but placed in a non-Head Start preschool program, outperformed children in the Head Start classrooms. While the report indicated that early literacy skills of Head Start children were on par with the control sample, children who attended Head Start did not make comparable gains in mathematics skills. In contrast, research conducted by Hindman, Skibbe, Miller, and Zimmerman (2010) found that children in Head Start from urban settings demonstrated greater initial kindergarten mathematics knowledge than those children from rural settings, indicating that the populations served by rural Head Start systems are entering public schooling without the same level of prerequisite mathematics skills as peers in more urban environments. As a whole, the research body indicates that children who are from economically disadvantaged backgrounds are at a greater risk for experiencing academic challenges particularly in mathematics, and the challenges these children face are compounded if they are from a rural environment.

### **Prior Research in Early Numeracy Curricula**

Several studies were reviewed that incorporated a mathematics intervention or curriculum into preschool instruction with the intent of increasing child outcomes in mathematics. For example, Arnold, Fisher, Doctoroff, and Dobbs (2002) implemented a six-week intervention for emergent mathematics skills in a preschool classroom, and found that children in the experimental group scored significantly higher on standardized measures of mathematics achievement than did their peers in the control group. Starkey, Klein, and Wakeley (2004)

developed and implemented a prekindergarten mathematics intervention with students across socio-economic status (SES) in order to determine SES related mathematics differences. They found that a significant SES difference was found at the beginning of the year, but the intervention significantly increased the scores of low SES students by the conclusion of the intervention.

Other researchers have developed comprehensive programs specifically designed to increase mathematics achievement. The Building Blocks PreK Math Curriculum (Clements & Sarama, 2008) was developed according to national standards for mathematics education and prior research in the teaching of mathematics to young children in order to promote mathematics achievement. Additionally, the Big Math for Little Kids mathematics curriculum was also developed and researched as an instructional program for preschool-age children (Ertle, Ginsburg, Cordero, Curran, Manlapig, & Morgenlander, 2008). *Mathematics – The Creative Curriculum Approach* (Copley, Jones, & Dighe, 2007) was developed following the guiding framework of the *Creative Curriculum* (Dodge, Colker, & Heroman, 2002), with an expansion of teaching strategies and research for teaching mathematics to preschool children.

### **Lack of Mathematics Instruction**

Despite policy directives, research indicates that mathematics instruction does not consistently appear in the preschool educational setting nor do children make statistically significant gains in mathematics achievement even when teachers believe it is an important area of preschool education (Graham, Nash, & Paul, 1997; Brown, Molfese, & Molfese, 2008). Additionally, a study completed by Tudge and Doucet (2004) found that of the preschool children observed in their sample, very few were engaged in mathematics related activities, either teacher-directed or academically-related play. This is in contrast to other researchers who

indicate that children engage in mathematics play on their own (Clements, 2004); however there is also the argument that children still need formal and concrete mathematics instruction in order to explicitly understand the concepts of mathematics (Greenes, Ginsburg, & Balfanz, 2004). As a precursor to an educational system that is moving in the direction of accountability and higher standards for students, it is only natural that mathematics curricula in the preschool years will begin to come under scrutiny. That scrutiny will also bring forth support for published mathematics programs which have been researched within high-needs settings like Head Start. Implementing such math curriculum could only help to increase the mathematics skills of children who may need the instruction the most.

### **The Current Study**

The objective of this program evaluation was to evaluate a mathematics curriculum that was chosen by the Happy Faces Head Start Program which is located in rural New York State. Specifically, the purpose of this study was to evaluate the math achievement outcomes of children in a rural Head Start program who were provided with math instruction using the *Mathematics - The Creative Curriculum Approach (MCCA)*. According to data gathered during the 2012-2013 school year, three- and four-year old Head Start children did not make gains in mathematics achievement despite targeted interventions (Happy Faces Head Start, 2012). The Head Start program indicated that they were looking for a means to increase the mathematics achievement of their students, based on previous unsuccessful attempts to do so with standard curriculum and materials. Thus, the Head Start administration requested assistance in implementing the MCCA, which was already on hand within the program offices, but had not been disseminated to the teaching staff for classroom use.

This program evaluation was differentiated from other research on early numeracy curriculum studies for several reasons. First, it was a year-long investigation with a program that is aligned with the Head Start Child Development and Early Learning Framework (United States Department of Health and Human Services (USDHHS; 2011), the NCTM Curriculum Focal Points (NCTM, 2006), the New York State Early Learning Guidelines (New York State Early Childhood Advisory Council & the New York State Council on Children and Families, 2012), and the New York State Prekindergarten Foundations for the Common Core (NYS Education Department, 2011). Second, teachers in the experimental group were provided with professional development activities focused on the five content strands of mathematics and classroom activities developed for each strand. Third, this research used multiple measures to evaluate student outcomes and math instruction in the classrooms. This research was designed to evaluate the extent to which the chosen curriculum, *Mathematics – The Creative Curriculum Approach*, impacted the early mathematics skills of children in rural Head Start classrooms?

## **Chapter 2: Review of the Literature**

The intent of the federal Head Start program is to provide a foundation of skills necessary for school readiness to children from low-income families (Puma et al., 2012). With the addition of mathematics into the scope of many preschool programs, including Head Start, there is a growing need for research specifically focused on mathematics curricula. Locally, the need for quality mathematics-focused instruction in the Happy Faces Head Start classes is also apparent based on data collected throughout the 2012-2013 academic year. Specifically, children in the Happy Faces Head Start program made fewer gains in early numeracy skills than the other areas evaluated, including cognition, language, physical, social-emotional, and early literacy skills (Happy Faces Head Start, 2012). Due to the lack of growth in early numeracy skills, the administration of the Head Start program was interested in implementing a different mathematics curriculum with the intent of increasing student mathematics achievement scores. In order to implement such a program successfully, pertinent background information needed to be considered. This included the capability of children to learn mathematical concepts; the extent of mathematics achievement in young children based on socioeconomic status, race and gender; a review of the national Head Start program's stance on mathematics; current research in the field of preschool mathematics curricula; and the applicability of each topic to the local population of students.

### **Math Constructs in Young Children**

Developmental theorists underpin the conceptual abilities of young children, especially in the area of mathematics. Early instruction in the preschool years has been primarily guided by Piaget's (1972) constructivist theory, in that young children "construct" their own knowledge through interactions with the environment. Additionally, the work of Vygotsky's (1978) social

learning theory is also critical to the research of how children learn mathematics (Anderson, Anderson, & Thauberger, 2008). However, according to Sophian (2008), there are two early numeracy skills that are the competing theoretical foundations for future math development including (1) counting, in which infants are born with an innate ability to count, and (2) comparison of quantities, in which number sense develops through the comparison of quantities.

Building on the developmental theories of cognitive development in young children, Gelman (1998) proposed four key themes that have a direct influence on research of young children's early numeracy development. The four themes identified by Gelman (1998) include: "(1) concepts are tools, and as such have powerful implications for children's reasoning both positive and negative; (2) children's early concepts are not necessarily concrete or perceptually-based; even preschool children are capable of reasoning about non-obvious, subtle, and abstract concepts; (3) children's concepts are not uniform across content areas, across individuals, or across tasks; and (4) children's concepts reflect their emerging 'theories' about the world; to the extent that children's theories are inaccurate, their conceptions are also biased" (p. 3).

In terms of actual activities with mathematical concepts, research has indicated that children have the capability to deal with numbers before they enter formal schooling (Anderson, Anderson, & Thauberger, 2008), and further, children learn foundational mathematical knowledge throughout infancy and the preschool years (Sarama & Clements, 2008). Between the ages of two and five years, children learn the system of number words in order to eventually connect the written numerals (i.e., graphic shapes) to verbal counting. Additionally, children develop the ability to "see" perceptual patterns (i.e., groups of manipulatives) before developing the ability to conceptualize imagined patterns. Very young children are also aware of the differences in small groups of items when individual items are either added or taken away.



In terms of geometry, children are able to learn the names and characteristics of many two dimensional shapes before kindergarten, and by four years of age are able to make representative pictures out of individual shapes (Sarama & Clements, 2008). At four years of age, children can build structures with blocks using spatial relationships and flexible thinking. By five years of age, children are able to incorporate several different shapes into more complex representations, and mentally transform shapes when solving simple problems. Patterning is another common skill for preschool-age children who are capable of extending and creating simple linear patterns, as well as patterns in rhythm and music.

Young children can commonly be seen showing interest in length, measurement, and quantities (Sarama & Clements, 2008). They often compare two items, and are able to utilize tools such as rulers to make the connections between abstract concepts and the written numeral in order to formalize the concept of length.

While some researchers have identified normative numeracy skills in preschool children, others have argued that not all children utilize metacognitive abilities to the same degree (Pappas, Ginsburg, & Jiang, 2003). Pappas et al. (2003) conceptualized metacognition as having three major components, which includes the recognition of mistakes, adaptability, and the awareness and expression of thought. They investigated metacognition differences in preschool children from different SES groups, and found that all of the preschool children in their sample demonstrated minimal metacognitive abilities. More specifically, preschool children were mostly unaware of the mistakes that they made, and demonstrated lower levels of adaptability. However, children from higher SES groups were more likely to be able to express and describe their thinking than were peers in the middle and lower SES groups. Further, the research

indicated that regardless of age all children demonstrated adaptability of metacognitive skills when provided instruction by an adult.

### **Mathematics Achievement in Young Children**

The research literature had tended to focus primarily on mathematics achievement as an outcome-related construct, for example as a standard score on a mathematics test or a score on an explicit measure of mathematics application. It is this outcome-based score that is the basis for measuring mathematics achievement. Research has documented differences in mathematics achievement between various populations, specifically between SES, gender, and children enrolled in Head Start programs (Robinson & Lubienski, 2011; Davis-Kean, 2005).

**Socioeconomic Status.** Generally, research demonstrates that children from lower SES groups, such as those who attend Head Start, demonstrate lower academic success (Mulligan, Hastedt, & McCarroll, 2012). Research using the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999 conducted by Magnuson, Ruhm, and Waldfogel (2007) incorporated two definitions of economic disadvantage: the first to include children living in poverty, or whose parent did not complete high school; and the second to consist of children who received welfare services during the fall or spring of kindergarten. Results of their research indicated that children from both definitions of economic disadvantage demonstrated lower levels of achievement. Their research also noted that prekindergarten attendance has a higher estimated effect on economically disadvantaged children's achievement over time than the total sample of children in the database, and that these estimated effects last longer, into first grade. Specifically, by the spring of first grade, effect sizes for the two defined groups of economically disadvantaged children were 0.13 and 0.20 for mathematics, compared to 0.03 for the general population. In sum, while disadvantaged children initially demonstrated lower achievement, by

attending prekindergarten those children were able to make increased academic growth that was sustained through first grade. However, this effect is only for disadvantaged students who attend prekindergarten.

Research indicates that children from high SES backgrounds demonstrate statistically greater skills in addition and subtraction, as well as the use of math strategies when compared to children from middle and low SES backgrounds (Ginsburg & Pappas, 2004). However, those researchers also noted that their sample included children from the working poor, and not those who were from families receiving welfare. Children from higher SES backgrounds are also more likely to be able to verbally explain their thinking processes regarding math problem solving than their counterparts from lower SES backgrounds (Pappas, Ginsburg, & Jiang, 2003).

**Race.** Research conducted by Aratani, Wight, and Cooper (2011), which was incorporated into a report for the National Center for Children in Poverty, indicated that from birth, African American males had a lower socioeconomic status when compared to White male counterparts. Further, research found significant differences between mathematics achievement of African American and White males in preschool and kindergarten. While African American males manifested lower math achievement than White males, those differences disappeared when socioeconomic status was controlled for, indicating that the initial racial differences in achievement were better attributable to differences in socioeconomic status rather than racial differences.

**Gender.** Thus far, the evidence is inconsistent regarding differences in mathematics achievement based on gender. Some research indicates that there are no differences between girls and boys in regards to mathematics (Dobbs, Doctoroff, Fisher, & Arnold, 2006; Ginsburg & Pappas, 2004); however, other research findings indicate that there are potential differences in

mathematics achievement between boys and girls (Kenney-Benson, Pomerantz, Ryan, & Patrick, 2006).

Research conducted with Head Start children investigated potential differences between math skills and socio-emotional functioning, with sex as an interacting variable (Dobbs, Doctoroff, Fisher, & Arnold, 2006). Although study findings indicated that there were differences in socio-emotional functioning between boys and girls, there were no interactions with sex when determining math skills. Additionally, research by Ginsburg and Pappas (2004) found no sex differences with a sample of preschool aged children, either in terms of overall mathematics achievement or with the strategies children used while performing mathematics.

A study completed by Kenney-Benson and colleagues (2006) investigated potential gender differences in math grades of middle school children. Authors hypothesized that sex differences in grades would be related to sex differences in how students of each gender approached school work, learning strategies used, and self-efficacy. Research findings indicated that girls approach schoolwork in ways that promote higher grades (i.e., goal setting and classroom behavior), yet boys and girls demonstrate similar levels of self-efficacy. The authors noted no differences between genders in terms of overall mathematics achievement, potentially as a result of similar levels of self-efficacy which is a potential determining characteristic for achievement tests. Thus, girls in this study were found to demonstrate higher academic goal attainment in math in the classroom, yet those differences were not carried over into overall mathematics achievement testing results.

Research conducted by Bull and colleagues (2011) investigated potential differences in executive control, crystallized knowledge, and mathematics achievement in preschool children based on gender. Their results indicated that overall, boys tend to utilize crystallized knowledge

(i.e., skills such as counting, identifying numbers, and understanding quantity) more often than girls. However, girls utilized executive control (fluid skills which require the retaining of information for planning and goal-directed behavior) *and* crystallized knowledge. This suggests that mathematics achievement of preschool children may not be differentiated by gender; however, that it is potentially differentiated by the type of processes boys and girls use to complete mathematical problems. Spelke (2005) discussed similar conclusions to Bull and colleagues, in that there are no differences in overall mathematics and science achievement between genders, but that there are differences in the strategies preferred between males and females. Additionally, since the differences between gender come down to the strategies used, the means of measuring mathematics achievement must be scrutinized in order to ensure that the measure is not biased towards a particular type of strategy.

**National Head Start.** A report of data collected from the 2009 cohort of the Head Start Family and Child Experiences Survey (FACES; Aiken, Kopack Klein, Tarullo, & West, 2013) indicated that children enter and exit Head Start below the national norm despite making progress while enrolled in Head Start. Specifically, in terms of gains made throughout Head Start enrollment, 16 percent of three year-old children were able to identify numbers and shapes in the fall of their Head Start year, while 73 percent of those same children demonstrated the same skills by the spring of the following year. In terms of four year-old children, 44 percent entered the fall with that skill set, and 68 percent left Head Start in the spring with math skills. However, despite gains made, children in Head Start were still performing below the national average in mathematics skills. Additionally, longitudinal research indicated that while Head Start programs positively effect the development of school readiness skills for children enrolled in such programs, progress made during Head Start attendance is rapidly lost by the time

children reach third grade (Puma et al., 2012). Unfortunately, this loss of growth is potentially indicative of the pervasive and lasting effects that are caused by poverty. Additionally, with children entering new grades each year in school, encountering new teachers with different teaching styles, and meeting new peers, academic consistency cannot be a steady force.

Additional outcome data from the 2009 FACES outcomes data indicated that the 2009 cohort of Head Start children was equally divided between genders and more than 60 percent were from an ethnic minority (Hulsey, Aikens, Kopack, West, Moiduddin, & Tarullo, 2011). Specifically, 36% of enrolled students were Hispanic/Latino, and 33% were African American. In terms of family composition, more than 68% of children who entered Head Start in the fall of 2009 had a parent with at least a high school diploma or GED, and the median household income was \$22,714. Of every 10 children who were enrolled in Head Start, nine lived in households where family income was significantly less than the federal poverty threshold. To summarize, while children in Head Start appeared to make gains throughout their enrollment in the program, many face social and economic disadvantages that potentially deter them from making enough gains to place them on par with the national average at the time of their transition to kindergarten programming.

### **Recommended Content and Standards for Preschool Early Numeracy Skills.**

Mathematics, as a component of early childhood education, is now recommended as daily instruction in preschool settings. In 2011, the Federal Office of Head Start incorporated mathematics objectives into the Head Start Child Development and Early Learning Framework, which is a description of the necessary components believed to be essential for a child's success in school and later in life (Persell, 2012). In NYS, the New York State Early Learning Guidelines (NYS Early Childhood Advisory Council & the NYS Council on Children and

Families, 2012) provided a developmental progression of typical development, and these guidelines impact potentially all children under the age of five years. NYS also recently released the Prekindergarten Foundation for the Common Core (NYS Education Department, 2011) in October 2011, a document that identifies necessary skill sets for children in preschool. All of these guidelines include skill development in number sense and operations, number relationships, patterns, geometry, and measurement. As there are currently approximately 55,000 children enrolled in Head Start, and program leaders are encouraged to utilize these recommended sources for alignment with their individually chosen curricula, finding a curriculum that satisfies the recommendations is a pertinent and timely investigation.

In 2000, the National Council of Teachers of Mathematics (NCTM) included prekindergarten mathematics with the Principles and Standards for School Mathematics. Additionally, a joint statement by the NCTM and the National Associations for the Education of Young Children (NAEYC) provided guidance regarding high quality preschool classroom practices that are salient for providing preschool children with the foundational knowledge of mathematics that will help them be successful in school (2002). Recommendations for high quality mathematics instruction include (1) inclusive practices of mathematics education and instruction within the child's natural and physical environment; (2) incorporation of the various backgrounds of children; (3) teaching practices that are age- and developmentally-appropriate with a specific sequence of instruction; (4) supporting interactions between the child and the key mathematics ideas; (5) the provision of adequate time and resources in order for children to fully conceptualize the material; (6) adequate assessment of children's knowledge and skill level.

In terms of the specific mathematics content recommended for preschool education, the NCTM devised five content standards that describe the type of content children should learn, as

well as five process strands that are meant to be the means for learning the content strands (NCTM, 2002). Through the process strands of problem solving, mathematical reasoning and proofs, communication, connections and integration of mathematics concepts, and various representations, children learn the following mathematics content:

*Number and operations.* Children begin to formulate an understanding of number sense by counting, comparing quantities, and beginning to understand the base-10 system.

*Algebra.* Children begin to think in terms of quantitative relationships as they explore patterns and relationships between number sets.

*Geometry.* Children begin to analyze characteristics of shapes, using visualization and spatial reasoning.

*Measurement.* Children understand the units and systems of measurement, as well as applying tools and techniques to determine measurements.

*Data Analysis and Probability.* Children learn to collect, organize, display, and analyze data, make inferences and predictions, and begin to understand the basic concept of probability.

The Head Start Child Development and Early Learning Framework (United States Department of Health and Human Services, 2011) was revised by the Federal Office of Head Start in 2011, and provides a description of the building blocks for children ages three to five years that are the most important for a child's school and long-term success. In the area of mathematics development, the following five areas of mathematics constructs are identified:

*Number Concepts and Quantities.* This is the understanding that numbers represent quantities and have ordinal properties.



*Number Relationships and Operations.* This is the use of numbers to describe relationships and solve problems.

*Patterns.* This is the recognition of patterns, sequencing, and critical thinking skills necessary to predict and classify objects in a pattern.

*Geometry and Spatial Sense.* This is the understanding of shapes, their properties, and how objects are related to one another.

*Measurement and Comparison.* This is the understanding of attributes and relative properties of objects as related to size, capacity, and area.

The New York State Early Learning Guidelines (NYS Early Childhood Advisory Council & the NYS Council on Children and Families, 2012) are meant to provide information and guidance regarding the development of children ranging from birth through 5 years of age. Included in the guidelines is information regarding the creation of a supportive learning environment, development of relationships between children, families, and support networks, and the creation of learning opportunities appropriate for the developmental stages of children. Mathematically focused information is delineated under the domain of cognitive and general knowledge, Domain IV, and includes critical thinking, problem-solving, number sense and operations, measurement, and ordering. Within the domain, each mathematics concept is described in terms of age-appropriate skills. Additionally, the guidelines suggest that children learn best when they are provided with learning opportunities within their current environment, and provided strategies for parents and teachers for promoting learning in the child's environment.

In October 2011, NYS released the Prekindergarten Foundation for the Common Core (NYS Education Department, 2011). The foundation is intended to be used as a starting point for

developing and implementing high quality curricula in prekindergarten settings, and to be an extension of the Common Core. Users are provided information for determining what children should be learning and how to evaluate progress. Mathematical content is described in Domain 5: Cognition and Knowledge of the World, and prekindergarten children are expected to demonstrate awareness and competence in counting and cardinality, operations and algebraic thinking, measurement and data, and geometry. Each mathematic strand is delineated into specific targets (i.e., identification of grouped objects as more or less than other group of objects). The foundation also asserts that mathematics education can, and is, incorporated into everyday activities in which children already engage.

### **Developments in Early Numeracy Curricula**

With the increased demand for preschool programs to provide research-based curriculum and instruction in early numeracy, researchers have begun to develop and publish programs that are based on developmental and theoretical frameworks that comprise key math constructs. Four math curricula that have been developed include: (1) Big Math for Little Kids, (2) Building Blocks, (3) Number*Fun*, and (4) Mathematics: The Creative Curriculum Approach. Each program was created with the purposeful intent of teaching young students about mathematics in a fun, developmentally appropriate manner. These programs were noted to align with best practices in mathematics instruction, content, and program implementation. Additionally, the first three programs demonstrated a research base that included Head Start programs.

**Big Math for Little Kids.** Developed over a four year period, the Big Math for Little Kids (BMLK) curriculum was created in response to a need for a research-based, developmentally appropriate early childhood mathematics program (Balfanz, Ginsburg, & Greenes, 2003). The curriculum incorporates six strands of mathematics: number, shape,

measurement, constructing and partitioning numbers, patterns and logic, and navigation and spatial sense (Greenes, Ginsburg, & Balfanz, 2004; Presser, Clements, Ginsburg, & Ertle, 2012). BMLK was designed to be implemented at least 20 to 30 minutes per day, for approximately 32 weeks. Lessons include whole groups, small groups, and individual lessons, and incorporate games, activities with manipulatives, and stories, among others. Research conducted on the use of BMLK used an experimental design in which eight classrooms implemented the BMLK curriculum and the other eight served as the control group and implemented an alternate previously-implemented curriculum. Professional development was provided to the teachers who were implementing the BMLK curriculum in the form of eight workshops lasting approximately two hours roughly once per month. Each workshop was dedicated to one of the content units, and consisted of a group debrief of the previous workshop, as well as instruction on the specific mathematics content unit, taught how children learn the specified content, how that content fit into the BMLK goals, and the major activities in the curriculum that supported the individual units. The primary outcome measure utilized was the Early Childhood Longitudinal Study, Birth Cohort Direct Mathematics Assessment. Trained observers observed the classrooms twice per year in order to evaluate curriculum implementation. Results indicated that children who received the BMLK curriculum learned significant more mathematics (the equivalent of approximately 1.6 months of instruction) and at a faster pace than the control group. When student outcome scores were compared to national norms, students who had begun the year below the national mean ended the year above the national mean. Researchers noted that while the professional development was incorporated into the study, additional research was needed in order to determine its specific effectiveness on curriculum implementation.

**Building Blocks.** Created by Clements and Sarama (2008), Building Blocks – Foundations for Mathematical Thinking, PreKindergarten to Grade 2: Research-Based Materials development was funded by the National Science Foundation in order to “create and evaluate mathematics curricula for young children based on a theoretically-sound research and developmental framework” (p. 445). The basic approach of the Building Blocks curriculum is to find the mathematics in, and then subsequently develop mathematics from, the natural activity of children (Sarama, 2004). Building Blocks is a software-based program that is designed for use at home, day care, and classroom environments, and is meant to be utilized with children from various backgrounds, interests, and levels of ability.

The researchers recruited 36 preschool classrooms in NYS, and included state-funded and Head Start programs in order to include children from disadvantaged backgrounds. The 36 classrooms were randomly assigned to one of three experimental groups, the Building Blocks curriculum, a comparison preschool mathematics curriculum, and the control group. Mathematics skill outcomes in all three classrooms were assessed using the Early Math Assessment three times per year. Additionally, the classroom environment was assessed three times per year with the Classroom Observation of Early Mathematics – Environment and Teaching (COEMET) protocol. Children in the Building Blocks classrooms received small group mathematics lessons once per week, for 10-15 minutes per session, with four to six peers. They also received whole group instruction four times per week, for 5-15 minutes, and completed computer activities twice per week for 10 minutes each. Letters were also sent home to parents explaining the current mathematics content being taught, and provided family activities. Teachers in the Building Blocks and comparison groups (but not the control group) received four days of training on the programs, as well as two hour refresher classes once every

other month and monthly in-class coaching. Results indicated that the Building Blocks curriculum had significant, positive effects on the quality of the mathematics instruction observed in the classroom environment when compared to the control group. While there was nor a significant difference between the Building Blocks and comparison classroom in terms of instructional quality, the researchers noted that this was potentially due to low statistical power. In terms of student outcomes, both the Building Blocks and comparison curriculum produced significant gains in student mathematics achievement over the control group; moderate gains were found for the Building Blocks curriculum compared to the comparison curriculum. In terms of specific skill gains, children receiving the Building Blocks curriculum made significant gains in verbal counting, number recognition, shape comparisons, and shape compositions.

**NumberFun.** A dissertation completed by Reid (2010), a recipient of a past Head Start Graduate Student Research Grant, implemented a mathematics intervention entitled *NumberFun* within a Head Start system. Over 13 weeks, three teachers implemented the mathematics curriculum which included three types of activities: 10-20 minute small or whole group activities; transition activities meant to reinforce skills taught in the primary lessons; and a mathematics center activity. The mathematics skills taught were aligned with the NCTM content strands (NCTM, 2002). Results of the study indicated that the teachers in the intervention group spent one third more time instructing students in mathematics, and that those teachers were also observed to have more characteristics of effective and quality instruction. However, while the students who received the intervention demonstrated significant gains on the post-test measures of mathematics achievement, the gains were not significantly greater than the gains of children in the control group, who did not receive additional mathematics instruction.

**Mathematics - The Creative Curriculum Approach.** *Mathematics: The Creative Curriculum Approach* (MCCA; Copley, Jones, & Dighe, 2007) was created to further the foundational constructs within the *Creative Curriculum for Preschool, Fourth Edition* (Dodge, Colker, & Heroman, 2002). *The Creative Curriculum for Preschool, Fourth Edition* was designed as a blueprint for teachers in order to plan and implement a developmentally-appropriate program for preschool students. According to its developers, the curriculum is formulated on the research and theories of Maslow's hierarchy of needs (Maslow, 1999), Erikson's developmental stages (Erikson, 1994), Piaget's stages of cognitive development (Piaget, Inhelder, & Weaver, 2000), Vygotsky's zone of proximal development and social interaction (Vygotsky, Rieber, & Hall, 1999), Gardner's theory of multiple intelligences (Brualdi, 1999), and Smilansky's role of child's play in learning (Smilansky & Shefatya, 1990). The research base on which the curriculum rests provides the five components of the curriculum: how children develop and learn; the learning environment; the curriculum content; the teacher's role; and the family's role. The mathematics content covered by this edition of *The Creative Curriculum* include the five key components of mathematics as recommended by the National Council for Teachers of Mathematics (NCTM; 2002), and they include: (1) number concepts; (2) patterns and relationships; (3) geometry and spatial sense; (4) measurement; and (5) data collection, organization, and representation.

*MCCA* provides a more in-depth guidance on teaching mathematics to preschool children and includes research-based teaching strategies. Information for teachers regarding the five content standards of mathematics as recommended by the NCTM is included and discussed, and each content strand is discussed specifically in relation to the teacher's role in teaching mathematics in the preschool classroom. Expanded research in each of the five content areas is

included, focusing specifically on the capabilities and expectations for preschool-age children. Assessment techniques are also provided for each content strand, as are a sample basis for teachers to begin to evaluate their students' progression individually and in groups. Teachers are provided with methods for teaching each process strand, and are encouraged to be interactive and demonstrative throughout their lessons.

Following the in-depth discussion of the content and process strands, the *MCCA* provides teachers with guidelines for planning specific mathematics activities within the classroom environment. These include incorporation of mathematics into the space and materials used by the students, individual and teacher guided lessons with a mathematics focus, and incorporation of mathematic ideas throughout other activities, including transitions and outdoor time. Finally, numerous mathematically-focused activities are provided for teachers to plan and implement in their classrooms. At this time, no experimental studies or program evaluations investigating the effectiveness of the *MCCA* on early numeracy skill development of children has been published.

Little effectiveness research has been completed regarding *The Creative Curriculum* that meets the standards for many experimental research reviews. A systematic review of 38 experimental studies using quantitative measures of child outcomes reviewed the outcomes and effect sizes of 27 different preschool programs, including *The Creative Curriculum* (Chambers, Cheung, Slavin, Smith, & Laurenzano, 2010). Overall, findings for The Creative Curriculum indicated insufficient evidence of effectiveness. Specifically, two studies were referenced, and across the two evaluations, the mean effect sizes for math were +0.12 at prekindergarten and +0.07 at kindergarten.

The same two studies of *The Creative Curriculum, Fourth Edition* were evaluated by the What Works Clearinghouse (WWC; 2013). In all, the WWC originally identified 14 studies that

investigated the effects of *The Creative Curriculum, Fourth Edition*, but 12 of the 14 studies did not meet eligibility criteria for review. Specifically, the first study was conducted during the 2003-04 and 2004-05 academic years in 18 full day Head Start preschool classrooms in five Head Start centers (WWC, 2013). The classrooms were broken down into two centers with 10 classrooms in Georgia, and three centers with eight classrooms in North Carolina serving 194 children. The intervention group, which consisted of nine randomized classrooms and 97 randomized children, implemented *The Creative Curriculum, Fourth Edition*, while the control group implemented a variety of teacher-developed curricula. Child outcomes in mathematics were assessed using the Woodcock-Johnson Tests of Achievement, Third Edition Applied Problems test, the Child Math Assessment-Abbreviated, and the Building Blocks Shape Composition task. Findings indicated no significant differences in math skill performance between the treatment group and the control groups.

The second study reviewed by the What Works Clearinghouse (2013) was a randomized controlled study conducted in 14 full-day preschool classrooms with 193 students in public schools in Tennessee. Conducted during the 2003-04 and 2004-05 school years, there were three groups in the study: *The Creative Curriculum for Preschool*, *Bright Beginnings*, and a comparison group. Evaluation of *The Creative Curriculum for Preschool* occurred one year after a full year of curriculum implementation. Seven classrooms were assigned to each of the three groups, with 93 children in the Creative Curriculum group and 100 children in the comparison group. No significant mathematics skill improvements were found for the *Creative Curriculum* treatment group.

In summary, in terms of effectiveness for the two studies reviewed, no discernible effects were found for mathematics gains, indicating that despite a medium to large extent of evidence



(large sample size), the estimated impact of the curriculum for producing effects in mathematics skill was neither statistically significant nor large enough to be important.

Variability among programs continues to exist, even when created using the most up-to-date research and best practice implementation. Big Math for Little Kids and Building Blocks were noted as having produced significant gains in mathematics achievement for those students who received the curricula. Building Blocks and NumberFun were noted to produce higher quality observed mathematics instruction, even if the outcome results from the NumberFun program were not statistically significant. The Creative Curriculum and Mathematics: The Creative Curriculum Approach was found by the What Works Clearinghouse to have no discernible evidence for its use, particularly in mathematics content. Thus, this research lends importance to a need for a structured mathematics curriculum that includes explicit instruction in mathematics content.

### **Early Numeracy Skills of Children in Local Classrooms.**

A review of the aggregate assessment data for the Happy Faces Head Start 2012-2013 program indicates that both 3- and 4-year old children demonstrate less growth in mathematics skill development than the other areas assessed (i.e., cognitive, language, physical, social-emotional, and literacy). Specifically, in the fall of 2012, 36% of Head Start children were below development in mathematics; in the winter, 30% were still below development. At the time of the winter data collection and data analysis, Head Start administrators were considering professional development topics in mathematics for classroom teachers, as well as preliminary investigations into a new mathematics curriculum. Within the mathematics domain, students' knowledge of number concepts and operations was lowest (3 year-olds = 33% below; 4 year-olds = 36% below), followed by spatial relationships (3 year-olds = 16% below; 4 year-olds = 32%

below). Three year old children in Head Start performed relatively stronger on content related to comparisons and measurements (1% below) than did 4 year-olds (23% below). Conversely, more 4 year-olds demonstrated greater performance on items of pattern knowledge (5%) compared to the 3 year olds (18%).

As a result of the lack of growth in mathematics scores, the Head Start program indicated a desire to evaluate the newly-chosen math curriculum. In an effort to improve mathematics performance, it was decided that the implementation of an additional mathematics curriculum to the instructional environment would be the best use of time and resources. When provided with different options for mathematics curriculum, the Head Start program chose the MCCA due to its accessibility and relationship to The Creative Curriculum, the program's core curriculum. Due to the aforementioned implications and a need for a specific early numeracy curriculum, the program evaluation attempted to answer the following research questions:

1. Did teachers in the experimental group modify their classroom mathematics instruction and activities to a greater extent than did teachers in the control classrooms?
2. To what extent did the mathematics curriculum, *Mathematics – The Creative Curriculum Approach*, impact the early mathematics skills of children in Head Start classrooms?

### Chapter 3: Research Design and Methodology

#### Setting

**Happy Faces Head Start Demographics.** The Happy Faces Head Start program began in 1991 with a single center-based classroom for 34 children. As of spring 2013, the Head Start program was funded to serve 314 children and their families with 204 children in Head Start and 110 children in Early Head Start. Since its founding in 1991, the program has served over 4,000 children and their families, and approximately 3,300 children have graduated from the Head Start program. The Happy Faces Head Start program is comprised of 10 Head Start classrooms with approximately 20 students in each.

**Curricula.** To date, the curriculum utilized by the Happy Faces Head Start program has been *The Creative Curriculum for Preschool, Fourth Edition (CC)*. The *CC* is intended to serve as a blueprint for teachers to plan and implement a developmentally appropriate program for preschool learners. This includes attention to how children learn and grow, the environment in which this growth should occur, the actual knowledge children should learn in the preschool years, how the teacher can influence and guide learning, and finally how to involve families in their children's learning. Academic content knowledge discussed within *CC* includes literacy, mathematics, science, social studies, the arts, and technology. However, despite having math content imbedded in *CC*, child outcome scores in mathematics from the 2012-2013 school year indicated that children demonstrated less growth in mathematics than the other content areas indicated on the local assessments (Happy Faces Head Start, 2012). Specifically, 36% of children scored in the below development range in mathematics in the fall of 2012, and in the winter 30% of children were in the same range. In order to remedy this, the Head Start program chose to implement the *Mathematics – The Creative Curriculum Approach (MCCA)* which is

based on the guiding theoretical framework of *CC*. It includes specific and focused content regarding the implementation of mathematically focused activities and lessons into the school day.

**Current Data Collection Procedures.** As mandated by the 2007 reauthorization of Head Start, programs must implement research-based methods of evaluation in order to ensure high-quality education. Thus, the Happy Faces Head Start program utilizes the Classroom Assessment Scoring System (CLASS; Pianta et al., 2005) and the Teaching Strategies GOLD Assessment System (Teaching Strategies, Inc., 2010) as the two measures of instructional effectiveness and child outcomes. Specifically, the CLASS is designed to measure teacher-child interactions rather than specific classroom content or curriculum. Broadly, it assesses emotional support, classroom organization, and instructional support; however, it does not have a mathematics-specific focus. The CLASS is administered through cycles of unannounced and scheduled observations and note-taking which each last approximately 15-20 minutes. Happy Faces Head Start administers the CLASS throughout the winter months.

The Teaching Strategies GOLD, developed by the same publishers as the *CC*, was created in order to expand on the developmental continuum that includes key elements for school readiness and aligns with state early learning standards. Thirty-six basic objectives are organized into nine areas of development and learning: (1) social-emotional; (2) physical; (3) oral language; (4) cognitive; (5) literacy; (6) mathematics; (7) science and technology; (8) social studies; and (9) the arts. Within the math area, The Teaching Strategies GOLD only measures four objectives: use of number concepts and operations, exploration and description of spatial relationships and shapes, comparisons and measurement, and knowledge of patterns. Teachers completed the Teaching Strategies GOLD assessment three times per year; 2012-2013 due dates

were November 30, 2012 for the fall assessment, March 1, 2013 for the winter assessment, and May 31, 2013 for the spring assessment.

### **Participants**

Participants for this study were children enrolled in the Happy Faces Head Start classes in a rural, western New York State county, and their classroom teachers. Within the Happy Faces Head Start organization there are a total of 10 Head Start classrooms with approximately 20 students in each. These classrooms are located within six communities across the county and serve approximately 200 children annually. For the purposes of this study, five of the ten classrooms were randomly selected for inclusion in the experimental group; the remaining five classrooms were assigned to the control group. Thus, approximately 100 students were initially included in the experimental group and approximately 100 students in the control group. Approximately 10 teachers were included in the study, with five randomly assigned to the experimental group that implemented the new curriculum, and the remaining five assigned to the control group.

Within the early stages of the fall data collection, several conflicts came to light. The primary conflict was an interaction with Universal Prekindergarten programming. Although all ten classrooms were technically labeled as Head Start programs, the two classrooms that were located in public school buildings taught the Universal Prekindergarten curriculum rather than the Head Start curriculum. This necessitated the removal of the two classrooms and teachers, dropping the sample to eight classrooms, with eight teachers. The second conflict was also related to UPK, in that children from the 4 year old classrooms were given the opportunity to attend morning program with Head Start, and then transfer to their public school to receive UPK program in addition to the Head Start curriculum. As there was no feasible means of measuring

students' mathematics gains from the Head Start curriculum or the UPK curriculum, those students were removed from the study, unfortunately, reducing the sample by approximately half.

**Student participants.** Pretest data was collected from 63 students after excluding students who were also in UPK. In the control group, there were 29 children, comprised of 18 male students and 16 female students. The average age of the students in the control group at the time of pretest data collection was 45.56 months. The experimental group consisted of 29 children, 14 of whom were male and 15 were female, with an average age of 45.40 months.

At the time of posttest data collection, there were 43 student cases with complete data. The sample size decreased from the fall data collection due to a number of variables, including family relocation, student age-out, and student removal to different programs. At posttest, there were 27 student cases in the control group, which included 13 male and 14 female students. Child ages ranged from 38 months to 57 months, with an average age of 46.04 months. Of the students in the control group, four were classified by the Committee for Preschool Special Education (CPSE). On average, the amount of prior time spent in Head Start programming was 16 months. Within the experimental group, there were 16 student cases in the experimental group, which included 8 males and 8 females. Ages ranged from 36 months to 59 months, with an average age of 45.50 months. Average amount of time spent in Head Start programming prior to the study was 19.88 months. Only one student in the experimental group was classified as having a disability. See Table 1 for complete student demographic information.

**Teacher participants.** Eight teachers participated in the study; four in the experimental group and four in the control group. The average age of the teachers in the experimental group was 25.31 years; the average age of teachers in the control group was 36.38. The average amount

of teaching experience was 2.31 years for the experimental group; average teaching experience for the control group was 10.41 years. Of the teachers in the experimental group, one held an Associate's degree, two held Bachelor's degrees, and one held a Master's degree. In the control group, one teacher held an Associate's degree, and three held Master's degrees. For complete teacher demographic information, see Table 2.

## **Materials**

The *Mathematics – The Creative Curriculum Approach (MCCA)* is produced by Teaching Strategies for Early Childhood (Copley, Jones, & Dighe, 2007) and is intended to expand upon the mathematics content within *The Creative Curriculum, Fourth Edition*, which is Head Start's current core program. The *MCCA* provides guidance on research-based teaching strategies within the child-centered and developmental approach to teaching children. It includes specific information for teachers regarding mathematics content in the main domains of mathematics knowledge as recommended by the NCTM and NAEYC including: (1) Number and Operations; (2) Geometry and Spatial Sense; (3) Measurement; (4) Patterns; and (5) Data Analysis. Additionally, the program addresses mathematics process skills including: (1) problem solving; (2) reasoning; (3) communicating; (4) connecting; and (5) representing, also as recommended by the NCTM and NAEYC. A main focus is the incorporation of mathematics into the daily environment for young learners, specifically the provision of learning opportunities in mathematics and the incorporation of mathematics into the various interest areas within the classroom, presented in the form of guided activities for individual, small group, and large group lessons.

## **Variables and Measures**

**Demographic variables.** Teachers completed demographic questionnaires about their students' gender, age, ethnicity, special education classification, and prior length of time spent in Head Start and Early Head Start programming (see Appendix A). Teachers also completed demographic questionnaires about their own gender; age; degree and teacher certification; and prior teaching experience with prekindergarten, Head Start, and total teaching experience (Appendix B).

***Gender.*** Gender was coded as a categorical, dummy variable.

***Ethnicity.*** Ethnicity was coded as a categorical variable, in which three variables were created. The three variables were: White, Black, and biracial.

***Age.*** Ages of students and teachers were coded into continuous variables. Student age was measured in months. Teacher age was measured in years.

***Primary Language.*** The primary language of each child was coded as a categorical dummy variable. The variables were: English and Other.

***Degree.*** The degree of teacher was coded as a categorical variable into four categories: High School; Associate's Degree; Bachelor's Degree; and Master's Degree.

***Certification.*** The certification of teacher was coded as a categorical variable into three categories: No certification; NYS Certification; Pennsylvania (PA) Certification.

***Teaching experience.*** Teachers reported their prior experience teaching in Head Start, teaching in preschool, and total teaching experience in years.

**Independent and Dependent Variables.** The independent variable for this program evaluation was the instruction delivered from the *MCCA* curriculum. The dependent variable was the student learning outcomes as measured by the *Test of Early Mathematics Ability, 3<sup>rd</sup> Edition* (TEMA-3; Ginsburg & Baroody, 2003) and the *Tools for Early Assessment in Math*



(TEAM; Clements, Sarama, & Liu 2009). The second dependent variable, reported math instruction in the classroom, was measured using Weekly Math Activity Logs.

**Mathematics Curriculum.** The independent variable for the program evaluation was the implementation of a mathematics curriculum into the existing Happy Faces Head Start system, specifically the *MCCA*. The curriculum incorporates the mathematic content and process strands as recommended by the NCTM and NAEYC. Teachers in the intervention group were assigned to implement this curriculum with the intent of increasing student outcomes in age-appropriate mathematics skills. The *MCCA* is meant to be a guiding framework for implementing mathematics instruction into the daily learning environment; thus, specific guidelines for curriculum implementation are not included. However, teachers are presented with informational texts within the curriculum on how to incorporate mathematically-related activities and interactions into the different components of the day. Mathematically-guided environment preparations and interpersonal interactions are suggested for students' arrival, large group and small group activities, choice time, snack and mealtime, transitions, rest time, and departure. Additionally, teachers are encouraged to plan mathematics experiences through various approaches, specifically during child-initiated learning in which teachers observe them and engage children in order to facilitate learning, and teacher guided instruction in large and small groups. Teachers are encouraged to observe, judge, and plan mathematically-based activities for children based on their developmental readiness, current skill level, and personal characteristics (i.e., disabilities or English language learners).

**Early Numeracy Skills.** The first dependent variable for the program evaluation was the early numeracy mathematics skills of children in the Happy Faces Head Start. In order to evaluate student learning outcomes, two measures were utilized. The *Test of Early Mathematics*

*Ability, 3<sup>rd</sup> Edition* (TEMA-3; Ginsburg & Baroody, 2003) and the *Tools for Early Assessment in Math* (TEAM; Clements, Sarama, & Liu 2008) were used to measure the dependent variable; the TEMA-3 is a norm-referenced measure while the TEAM is a curriculum-based measure.

***Test of Early Mathematics Ability, Third Edition (TEAM-3)***. The TEMA-3 is an individually administered, norm-referenced test of early mathematics skills for children between the ages of three years, zero months and eight years, 11 months. The test is designed to measure mathematic skills and concepts that are learned in school and every day settings. It is available in two forms (i.e., Form A and B) and each form consists of 72 items. Scores derived from the TEMA-3 include standard scores, percentile ranks, and age- and grade-equivalents. Average time for test administration is 45 minutes (Bliss, 2006). The TEMA-3 was normed in the fall of 2000 and spring of 2001 on a sample of 1,228 children. The sample reflects the four major demographic regions, designated by the US Census. Geographic region, gender, race, and ethnicity reflected the 1999 US Census data.

Acceptable levels of internal consistency reliabilities were reported across all six age intervals, with coefficient alphas ranging from .92 to .96. For all subgroups, coefficient alphas were reported to be .98 or .99 (excluding Native Americans). Immediate and delayed alternative forms reliabilities were correlated at .97 and .93, respectively. Test-retest reliability data was sufficiently stable over time with a 2-week test-retest period ranging from .82 for Form A to .93 for Form B. Although Form A's .82 reliability is low compared to the reliability of Form B's .93, it is still within the recommended limits.

The TEMA-3's content validity was examined through item discrimination and item difficulty and is reported by age level and test form. Item discrimination indexes are correlations between individual items and the total score. An index of .35 or higher is a generally accepted

number (Bliss, 2006). The item-total correlations range from .45 to .68 with a median of .55 for Form A and .58 for Form B. Median item difficulties ranged from .15 to .87 across forms and age groups; suggested best practice indicates average item difficulties ranging from .15 to .85 (Bliss, 2006).

Evidence of moderate correlations with other measures of mathematics and criterion validity is evident. The TEMA-3 is moderately correlated with the Basic Concepts subtest of the KeyMath-R (.54) and is highly correlated with the mathematics quotient from the Young Children's Achievement Test (.91). Reviews also noted moderate to high correlations with the Woodcock-Johnson Tests of Achievement, Third Edition and the Diagnostic Achievement Battery, Third Edition; however, specific correlations were not reported (Crehan, 2012).

In terms of its use with young children, the TEMA-3 may not adequately assess appropriate skill level. For example, reviews indicated that examinees ages 3 years, 0 months who score no points will still receive a standard score of 85, which is only one standard deviation below the mean. Best practices in test construction suggest that floors extend at least two standard deviations below the mean in order to appropriately distinguish among individuals with weaker skills (Bliss, 2006). Thus, scores must be interpreted with caution for children at a very young age.

***Tools for Early Assessment in Math (TEAM)***. The TEAM is a newly developed, individually administered interview-format measure that assesses the level of mathematical knowledge and skills of children ages three through seven years, and measures children's mathematics skills in the five strands of mathematic concepts: (1) Number and Operations, (2) Algebra, (3) Geometry, (4) Measurement, and (5) Data Analysis and Probability. The TEAM produces a Total Competency Score. Originally developed as the Research-Based Early Math

Assessment (Clements, Sarama, & Liu, 2008), content goals were developed by determining the mathematical topics that were most relevant to current research, educators, and mathematicians. The final instrument revision was evaluated in the 2003-2004 school year, using a population of NYS preschoolers, including children ages three to five years of age from 34 low-income classrooms. Children were assessed at the beginning of the school year and then again at the end of the school year. Scores were then determined using the Rasch model of score determination. The Rasch model (Bond & Fox, 2007) is a method of analyzing categorical values, and when used with an educational instrument, place individual children's scores on a common ability scale which allows for comparisons across ages, as well as the meaningful comparison of change scores. The model simultaneously maps item difficulty and person score onto a scale of the theoretical latent trait, in this case mathematical competence. According to the authors, reliability and construct validity were supported due to the theoretical implications of the Rasch model.

The Research-based Early Math Assessment is now entitled the *Tools for Early Assessment in Math* (TEAM). No other statistical information is available from the publishers of the TEAM. However, according to the product website, the TEAM is now correlated to state standards from all 50 states, the NCTM content standards, and Head Start (McGraw-Hill, 2013).

**Instructional Environment.** The second dependent variable for the program evaluation was the quantity of mathematics content. Comparisons were made between the math instruction provided by the teachers in the experimental group who utilized the MCCA as opposed to the teachers in the control group who taught the status quo curriculum. All teachers were asked to complete *Weekly Math Activity Logs* (see Appendix C) to determine the frequency and content of mathematics lessons.

***Weekly Math Activity Logs.*** Each of the Happy Faces Head Start classroom teachers were asked to record all formal mathematics instructional activities conducted during each week using the *Weekly Math Activity Log* in order to measure the amount of teacher instruction in mathematics. For each activity, teachers were asked to identify the following: (1) duration, in minutes; (2) description of activity; (3) learning objectives; (4) child engagement level; and (5) difficulty level for majority of children.

**Teacher Satisfaction.** At the conclusion of the study, teachers in the experimental group were asked to rate their satisfaction with the mathematics program using a semi-structured questionnaire. Questions targeted teachers' perceptions of the programs strengths and limitations, suggestions for future implementation, and overall feedback of the research study. For a copy of the MCCA – Teacher Satisfaction & Curriculum Review, please see Appendix D.

## **Procedures**

Several key procedures were involved in the implementation of this research study. The activities included (1) assignment of classrooms to groups; (2) training of teachers in the experimental group in the mathematics curriculum and instructional activities; (3) training of research assistants for data collection purposes, including child mathematics outcomes and classroom observations; (4) data collection procedures; and (5) data analysis procedures.

**Assignment of Groups and Preliminary Data Collection.** Classrooms were randomly assigned to the intervention and control groups. In order to avoid treatment contamination; however, classrooms that were located within the same center were assigned to the same group. Once classrooms were assigned, child demographic data was collected via the *Child Information Form* (see Appendix A), which was completed by classroom teachers based on Head Start records. Information regarding the following child characteristics was collected: age (years,

months), gender, ethnicity, primary language, and length of time in Head Start or Early Head Start (years, months). Additionally, teacher demographic data was collected via the *Teacher Information Form* (see Appendix B) which was completed by the teachers. Information regarding the following teacher characteristics was collected: age, gender, race/ethnicity, degree, teaching certification, years teaching experience in preschool, and total years teaching experience. Children and teachers were recruited to participate in the study using an active consent procedure. All students enrolled in the experimental group received the mathematics program while students in the control group received the status quo math instruction based on the previous years' approach which has utilized very little formal mathematics instruction.

At the start of the academic year, teachers distributed to parents/guardians of all children, an informational packet provided by the Head Start administration explaining: (1) the purpose of the study, guidelines regarding program implementation, and length of study; (2) their right to decline or withdraw from participation and subsequent consequences; (3) factors of benefits and risks; (4) limits of confidentiality; (5) incentives for participation; and (6) contact person(s) and information. Although the mathematics curriculum was implemented by the Happy Faces Head Start as an educational initiative, parental/guardian consent was required for the individualized information collected via individual test administration by outside researchers. Parents/guardians of children in the control and intervention classrooms were asked to return a signed consent form in an enclosed self-addressed stamped envelope if they approved of their child participating in the research collection of individualized data. It was anticipated that the majority of parents would allow their child to participate in the assessment activities as typically young children enjoy the one-to-one attention of a caring adult and with the explanation by Head Start that within the following years, all of the classrooms within the Head Start system would receive the

mathematics curriculum. Teachers were also asked to provide active consent in order to consent to individualized demographic data, and their participation in the experimental programming.

**Training of Teachers.** Training for the intervention teachers consisted of a series of four workshops that provided training in each of the five content strands, as well as a general discussion session. The first training focused on the research base for the MCCA, as well as the mathematics content and process strands, and primary purpose of the research study. The subsequent three trainings included a focus on specific mathematics content strands, a review of data relevant to that day's math content, and discussion and MCCA curriculum activities pertaining to that content. See Appendix E for the Professional Development Outline for MCCA.

Following each professional development workshop, teachers rated the quality of the professional development workshop, potential use of content in the classroom, and characteristics of presenter (i.e., researcher). They also reflected on their own knowledge and skill level in mathematics instruction. See Appendix F for a sample rating form, and Appendix G for a sample Self-Assessment.

**Training of Research Assistants.** Research assistants (RA) were recruited from the graduate school psychology program at Alfred University. The RAs were graduate students who had prior coursework in standardized assessment procedures using both norm-referenced and curriculum-based measures. Several of the RAs were compensated for their time in the form of classroom credit for an early-childhood graduate course, and travel expenses were reimbursed.

Prior to initial data collection, RAs attended training to review and practice administering the two child outcome measures, TEMA-3 and TEAM. To demonstrate mastery of assessments,

the researcher used a checklist to rate the RA's administration proficiency. Corrective feedback was provided, and RAs continued to practice administration until 100% accuracy was observed.

RAs were assigned to specific classrooms for data collection procedures in order to create a sense of familiarity with the children with the intent of producing representative scores. Also, it was anticipated that RAs with a predetermined schedule would be more likely to follow through with the data collection procedures over the course of the academic year.

**Data Collection.** Children's level of mathematics skills was measured using the TEMA-3 early in the school year prior to the implementation of the treatment and again at the end of the school year. Specifically, pre-test scores were collected by the RAs during late November and December, and post test scores were collected by the same RAs in late May and June. Progress in children's mathematics skill development was also assessed by the TEAM during the same time periods.

**Curriculum Implementation.** Teachers in the intervention group implemented the *MCCA* while teachers in the control group continued to use the *CC* as their core educational curriculum. Additionally, all teachers were asked to utilize the Weekly Activity Logs to document classroom mathematics instruction in both treatment and control classrooms.

**Control Group Procedures.** Comparison classroom teachers attended a brief meeting in the fall which provided information as to the purpose of the project and the data collection procedures. Teachers were instructed to proceed with their usual practices in the classroom. No additional specific mathematics curriculum was used in the comparison classrooms. Classrooms and children were assessed on the same assessment schedule; however, no professional development in mathematics was provided.



**Data Analysis Procedures.** Demographic data of the student and teacher samples was analyzed. Correlations were made between the two math measures. Independent samples t-tests and Chi Square Goodness of Fit tests were conducted to determine if there were any statistical differences between the control and experimental groups. Finally, two sequential multiple regression models regressed the various student and teacher variables on the mathematics outcome scores as measured by the posttest scores of the TEMA-3 and TEAM, respectively. Additionally, data collected from the *Weekly Math Logs* was analyzed qualitatively.

**Assumptions of Multiple Regression.** Multiple regressions were utilized due to three advantages (Keith, 2006). First, both categorical and continuous variables can be used with multiple regression statistics. Second, multiple independent variables can easily be incorporated. Third, it is appropriate for experimental research. In order for multiple regression results to be valid, a set of assumptions must be met. First, the dependent variable must be a linear function of the independent variables. Second, each observation must be drawn independently from the population. Third, the variance in errors is not a function of any of the independent variables (homoscedasticity), and fourth, the errors are distributed normally. Fifth, the dependent variable does not influence any of the independent variables and sixth, the independent variables are measured reliably and with validity. Lastly, the regression must include all assumed causes of the causes and effects.

## Chapter 4: Results

The yearlong investigation into the effectiveness of the *Mathematics: Creative Curriculum Approach* culminated in data analyses of demographic variables, student outcomes, and instructional quantity. A variety of analyses were performed including, independent samples t-tests and chi-square analyses; correlations; and sequential multiple regressions, as well as qualitative analysis of instruction. The following chapter provides the results of the analyses that were conducted in order to answer the following questions:

1. Did teachers in the experimental group modify their classroom mathematics instruction and activities at a more advanced or richer level when compared to the instruction in the control classrooms?
2. To what extent did the mathematics curriculum, *Mathematics – The Creative Curriculum Approach*, impact the early mathematics skills of children in Head Start classrooms?

### Reported Mathematics Instruction.

Teachers were requested to complete weekly logs of the daily mathematics instruction. Reported information included the type of mathematics content taught, difficulty level of content and perceived student engagement. Of the four teachers in the experimental group and the four teachers in the control group, only three teachers in each group completed the weekly math logs. Data collected from the six sets of math logs was analyzed qualitatively, and comparisons were made between the experimental and control groups rather than at the classroom level.

***Mathematics Content.*** Teachers between the two groups reported teaching varying types of mathematics content. On average, teachers in the experimental group reported that *Number and Operations* content was the majority of their instruction, at 35% of the total mathematics

instructional content. In contrast, teachers in the control group reported that 44% of math lessons were targeted to content in *Number and Operations*. Further, *Geometry and Spatial Sense* topics accounted for 22% of math lessons in the experimental group compared to 20% of math lessons in control group. Additionally, *Measurement* content was targeted in 10% of the math lessons in the experimental group while only eight percent in the control group. *Patterning and Algebra* was included in 25% of the math lessons in the experimental group, and 10% in the control group. Content in *Data Analysis* was included in eight percent of the experimental group compared to 18% in the control group.

Results indicate varying reports of math content taught during lessons. Teachers in the control and experimental groups reported teaching similar amounts of topics focusing on number sense and operations; geometry and spatial sense; and measurement. The two groups reported differences for patterning and algebra, as well as data analysis. This could be attributed to varying levels of awareness of mathematics content by teachers, and potentially as a result of the teacher's access and exposure to the intervention curriculum. Additionally, exposure to the intervention curriculum could also account for some confusion in how to report type of math content discussed. Take for example a common preschool activity, calendar time. During a general calendar lesson, teachers have the opportunity to incorporate numerous math content strands, including number and operations when discussing dates and days of the week; geometry and spatial sense when discussing the layout of a calendar; measurement when teaching the representation of dates for days, and length of time; patterns and algebra if teachers incorporate a color or shape scheme to associate with certain days of the week; and data analysis if conversations about weather tracking are included.

***Lesson difficulty.*** Teachers reported on each lesson's perceived difficulty level for their students. Thirty-two percent of experimental group lessons were rated as covering known material; 51% of lessons were reported as reviewing newer concepts; and 17% of lessons were focused on teaching new material. Teachers in the control group reported on average teaching known material for 38% of mathematics lessons; 48% of reviewing new concepts; and teaching new material for 14% of lessons. These reports appear to be relatively similar across groups.

***Engagement.*** Teachers rated the overall engagement of their students during each lesson on a scale which ranged from: not at all engaged; somewhat engaged; partially engaged; more engaged, but not fully; and fully engaged. No teachers reported any unengaged ratings. Teachers in the experimental group rated engagement as follows: somewhat engaged 4%; partially engaged 46%; more engaged, but not fully 39%; and fully engaged 11%. Control group teachers ratings were: somewhat engaged 2%; partially engaged 28%; more engaged, but not fully 57%; and fully engaged 13%. Both groups of teacher ratings indicated students were partially engaged or more engaged for the majority of lessons. However, when the teacher ratings for the two types of engagement (partially engaged and more engaged) were combined, teachers in the experimental group rated their students as engaged for 50% of lessons while teachers in the control group rated student engagement at 70% of lessons. Disregarding the extent of engaged (as determined by a teacher rating of partially or more engaged), teacher ratings in the experimental group indicated less engagement than the teacher ratings of engagement in the control group.

### **Statistical Analyses.**

***Analyses of Measures.*** Correlations were calculated to determine the relationship between the two mathematics dependent variables, the TEMA-3 and the TEAM. A Pearson

product-moment correlation coefficient was used to ensure that the measures were correlated at the two test administration time points. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. There was a strong, positive correlation between the pretest TEMA-3 and TEAM scores ( $r = .41, n = 43, p < .001$ ) with higher pretest scores on the TEMA-3 associated with higher pretest scores on the TEAM. The posttest forms of each measure were also strongly correlated ( $r = .59, n = 43, p < .001$ ). See Table 3 for the correlation matrix.

**Data manipulation.** Three variables were excluded from analyses, as there were no reported differences in each demographic category due to a homogenous sample (i.e., child ethnicity, teacher ethnicity, and primary language). The variable for teacher certification was excluded, as it was deemed analogous to the degree type and teaching experience variables. The variables for prior time taught in Head Start, as well as prior preschool teaching experiences were also excluded, as the variables were subsumed and best described by the total teaching experience variable.

**Group comparisons.** Statistical analyses comparing the control and experimental groups were calculated in order to determine the similarities and differences that existed between the group of students in the control group and those in the experimental group. The continuous variables analyzed included child age, prior length of time in Head Start programming, teacher age, and total teaching experience. The categorical variables included sex of the child, degree of teacher, and child disability.

Independent samples t-tests were conducted to compare differences between the control and experimental groups for the following variables: Child age, prior time in Head Start programming, teacher age, and total teaching experience of teachers. Chi square tests for

independence were calculated between the control and experimental groups for child sex, degree of teacher, and child disability. A chi-square test for independence, using Yates Continuity Correction to correct for the overestimate of the chi-square value when used in a 2x2 table (Pallant, 2013), indicated no significant differences between the sex of child in each group or for presence of a disability. Results of the analyses indicated that the groups were statistically similar in terms of the child demographic variables: Age of the children, the prior amount of time that children spent in Head Start programming, sex of the children, and the numbers of students classified with disabilities.

In contrast, significant differences between the control and experimental groups were noted in the teacher variables. Differences were noted in teacher age, total teaching experience, and teacher degree. Specifically, independent samples t-tests indicated large significant differences in teacher age where teachers in the control group were significantly older than teachers in the experimental group (Control group  $M = 36.48$ ,  $SD = 8.83$ ; Experimental group  $M = 25.31$ ,  $SD = 2.44$ ;  $t(32.22) = 6.19$ ,  $p < .001$ , two-tailed; mean difference = 11.17; 95%  $CI$ : 1.80,  $\eta^2 = 0.48$ ). A large difference was also found between the groups for total teaching experience where teachers in the control had significantly greater experience than teachers in the experimental group (Control group  $M = 10.41$ ,  $SD = 5.42$ ; Experimental group  $M = 2.31$ ,  $SD = 1.08$ ;  $t(29.37) = 7.52$ ,  $p < .001$ , two-tailed; mean difference = 8.09; 95%  $CI$ : 1.08,  $\eta^2 = 0.59$ ). Additionally, a Pearson chi square analysis indicated significant differences in the degrees of teachers between the two groups ( $\chi^2(2, n = 43) = 22.03$ ,  $p < .001$ , Cramer's  $V = .72$ ). Teachers in the experimental group were significantly younger, but held a higher teaching degree, but had significantly less teaching experience than the teachers in the control group. See Table 4 for t-test statistics and Table 5 for chi square statistics.

**Mathematics Achievement.** Analyses were conducted to determine the extent of the differences between groups for measured mathematics achievement. Independent samples t-tests indicated that the groups scored significantly different on the TEAM at both the pretest, as well as posttest time points. There was a medium to large difference between the groups for the TEAM pretest scores, with higher scores measured in the control group (Control group  $M = 30.20$ ,  $SD = 17.64$ ; Experimental group  $M = 13.58$ ,  $SD = 15.84$ ;  $t(41) = 3.10$ ,  $p = .004$ , two-tailed; mean difference = 16.63; 95%  $CI: 5.37$  eta squared = .19). There was also a medium difference between the groups for the TEAM posttest scores, with higher scores measured in the control group (Control group  $M = 39.46$ ,  $SD = 10.43$ ; Experimental group  $M = 28.78$ ,  $SD = 17.29$ ;  $t(24.59) = 2.24$ ,  $p = .036$ , two-tailed; mean difference = 10.68, 95%  $CI: 4.77$ , eta squared = .11).

There were no significant differences found between the experimental group and the control group for TEMA-3 at pretest or posttest time waves.

**Sequential multiple regressions.** Sequential multiple regressions were then utilized to predict posttest student mathematics achievement after controlling for the child and teacher demographic variables and students' prior mathematics knowledge. Two regression models were created: One regressing the independent variables on the posttest TEMA-3 standard score, and the other regressing the independent variables on the posttest TEAM competency score. Each regression used the pretest score as a measure of prior mathematics knowledge. The child's age and sex were entered at stage one of the regression; the intervention condition, prior time spent in Head Start programming, presence of a disability, and pretest mathematics scores were entered at stage two; and at stage three the teacher variables were entered, which included teacher degree, teacher age, and teaching experience. Preliminary analyses were conducted to

ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity.

Correlations that were conducted as a component of the multiple regressions indicated that variables were somewhat correlated, but not too high to be considered problematic; a correlation of .80 would be problematic. Variables that were shown to be highly correlated in preliminary analyses were either eliminated or combined. However, multicollinearity was noted in the regression analysis for age of teacher and total teaching experience, indicating that these variables were very similar.

A three stage sequential multiple regression was conducted with mathematics achievement as measured by the TEMA-3 posttest scores as the dependent variable. The age and sex of the child were entered at stage one of the regression to control for innate child variables. The intervention condition, prior time spent in Head Start programming, presence of a disability, and pretest TEMA-3 standard scored were entered at stage two of the regression in order to reflect child education variables. Teacher variables including degree, age, and teachers' total teaching experience were entered into the third and final stage of the regression. The regression statistics for the TEMA-3 are reported in Table 6.

The sequential multiple regression with the TEMA-3 indicated that at stage one, only four percent of the variance in mathematics achievement was explained by the child's sex, and age,  $R^2=.04$ ,  $F(2,40)=.84$ ,  $p=.440$ . Introducing the child education variables to the regression model explained an additional 25% of the variation in mathematics achievement, with the amount of time children spent in Head Start programming prior to the study implementation as the only significant variable in the block,  $\Delta R^2=.25$ ,  $F(4,36)=3.16$ ,  $p=.03$ . Finally, the teacher variables in the third block added an additional 7% of variation in mathematics achievement,



$F(3,33)=1.18, p=.33$ . In the final model of the equation, no independent variables were significantly predictive of mathematics achievement.

The second regression model regressed the TEAM posttest score on the same independent variables. The age and sex of the child were entered at stage one of the regression to control for innate child variables. The intervention condition, prior time spent in Head Start programming, presence of a disability, and pretest TEAM competency scores were entered at stage two of the regression in order to reflect child education variables. Teacher variables including degree, age, and teachers' total teaching experience were entered into the third and final stage of the regression. The regression statistics for the TEAM are reported in Table 7.

The sequential multiple regression with the TEAM indicated that at stage one, only 6% of the variance in mathematics achievement was explained by the child's sex and age,  $R^2=.06$ ,  $F(2,40)=1.24, p=.301$ . Introducing the child education variables to regression model explained an additional 35.7% of the variation in mathematics achievement, with the pretest TEAM score as the only significant variable in the block,  $\Delta R^2 = .42, F(4,36)=5.5, p=.001$ . Finally, the teacher variables in the third block added an additional 7% of variation in mathematics achievement,  $\Delta R^2 = .48, F(3,33)=1.105, p=.259$ . In the final model of the equation, no independent variables were significant predictors of mathematics achievement.

### **Teacher Satisfaction.**

At the conclusion of the series of professional development, the teachers in the experimental group rated their overall satisfaction with the MCCA curriculum (see Appendix D). Overall, the teachers found the curriculum to be a positive tool; the curriculum was rated to be a very good program by three of the teachers, and rated acceptable by the fourth.

**Program Strengths.** The teachers in the experimental group noted numerous perceived strengths of the MCCA program. Many of the indicated strengths were focused on the variety of activities offered in the curriculum, as well as activities meant to support classroom lesson plans. Several teachers specifically noted that the program “describes each aspect of math and ... the age appropriate skills,” and “lists specific objectives for each activity that relate to GOLD objectives.” Additionally, one teacher felt that the program “gives several age-appropriate ideas and activities to bring into the classroom.”

**Program Weaknesses.** Only a few weaknesses were noted by teachers. Rather than focusing on weaknesses related specifically to the curriculum, the noted limitations were directed toward the logistics of program implementation and the need for professional development. Specifically, one teacher noted there was “not enough time to use in lesson plans,” indicating a need for planning time outside of the professional development sessions and within their typical work week. Another weakness noted was directed at the Head Start organization, noting a “lack of training about its [the program’s] existence and it’s...usefulness.”

**Future Implementation.** Teachers perceptions regarding the continued use of the curriculum was explored at the end of the school year. Positively, all teachers reported more benefits than limitations, noting the program’s usefulness for activities, the ability to enhance the classroom environment with math resources, and its explanation of the different math content strands. One teacher indicated that “this is a great resource and curriculum that offers excellent activity suggestions and a thorough explanation of each math content area.” When queried regarding future needs for successful implementation, teachers noted that training would continue to be needed, as well as follow-ups with staff to ensure that the curriculum was being implemented. Additional resources, including a computer, books, and mathematics-related

games were noted as being important for curriculum implementation. As an ending note, one teacher stated, “This was an excellent opportunity to grow professionally, and (the researcher) was a great help introducing and discussing the curriculum, its uses, and how valuable it was to student learning outcomes. She was supportive and helpful the entire time.”

## Chapter 5: Discussion

The purpose of this program evaluation was to determine the impact of the Mathematics: Creative Curriculum Approach (MCCA) on the mathematics achievement of preschool children in a rural Head Start program. Additionally, the intervention sought to identify differences in mathematics instruction as reported by teachers in the control group and teachers in the experimental group.

The results of the statistical analyses indicated that the mathematics curriculum did not significantly impact the outcome scores of the students in the experimental group. There were no statistical differences between the control and experimental groups for mathematics achievement as measured by the TEMA-3. Additionally, mathematics achievement as measured by the TEAM indicated that children in the control group demonstrated consistently significant higher mathematics scores than the children who did receive the intervention; however, these differences were found at pretest, prior to the implementation of the intervention.

The results of the regression analyses indicated that the intervention variable was not significant in either of the regressions, indicating that the mathematics curriculum did not significantly impact the outcome scores of the students in the experimental group. The only variables that impacted mathematics achievement varied by regression model. When regressing the TEMA-3 outcome scores on the independent variables, the amount of time spent in Head Start prior to the study was significantly predictive of a lower outcome score, indicating that the children who had spent more time in Head Start programming made fewer gains in mathematics skill demonstration than children with less time in Head Start programming. In the TEAM regression model, the only variable to predict mathematics achievement was the pretest TEAM score. Thus, the higher the TEAM score in the fall, the higher the outcome score in the spring.

This is generally expected, as one would assume that children would make growth between the fall and spring in academic knowledge. However, as there were no differences between groups for the TEMA scores, it is hypothesized that the curriculum-based measure (TEAM) is more sensitive to changes in mathematics skill than a standardized measure might be. This was a relatively unexpected finding of the study, in that the TEAM, a significantly newer measure than the TEMA-3, was potentially more sensitive to differences in student skills than the TEMA-3. Future research in this area of study might be suggested to use a measure like the TEAM.

It is imperative to note that while there were no significant differences between the control and experimental groups for the child demographic variables, there were significant differences between the groups for teacher demographic variables. Teachers in the experimental group had higher formal teaching degrees; however, they were also significantly younger and had significantly less teaching experience. Thus, the teacher variables potentially impacted the extent of mathematics achievement rather than the mathematics curriculum.

Qualitative analyses of the weekly math logs indicated minimal differences between reported mathematics instruction in the experimental and control groups in terms of content and difficulty level. Differences were found to be evident in terms of academic engagement. However, data was only collected by six of the eight teachers. Results indicated that teachers in both groups taught content focusing on number and operations for the majority of instruction, followed by geometry and spatial sense, and measurement. There were differences between the groups in reported content for patterning and algebra, and data analyses. Teachers in the experimental group reported teaching more patterning and algebra than the control teachers; however, they also reported teaching less data analyses. Teachers reported similar difficulty levels of content, although they reported engagement levels differently. Teachers in the control

group rated their students as more actively engaged than the teachers in the experimental group rated their students; students in the control group were rated to be more engaged for approximately 20% more of lessons than the experimental group. This data collection tool relied heavily on teacher engagement and buy-in, as well as support from system administration, both of which were found to be barriers to the study. Academic engaged time needs to be actively considered in this study findings, and should be considered as a component of future research.

Several barriers to the program implementation became apparent during the course of the study. The outside consultant status of the primary researcher was a barrier, in that there was a reliance on Head Start administration to relay news, updates, and provide information about general research processes. The organizational system and structure of the organization impacted the implementation of this study. There were gaps in perceived versus actual Head Start systemic processes, specifically in terms of collaboration with other staff, data distribution and interpretation, and the mentoring system. There was often a disconnect between the information provided by administration about routine procedures, and what was occurring at individual sites and centers. There were also differences in the perceived value of the study by several teachers who were in key roles to provide data. The study relied on experimental teachers to partake in trainings, collect data, and employ the strategies of the intervention curriculum. Whether due to a systemic lack of interest in group initiatives or lack of personal motivation, data collection proved to be a lengthy and time consuming process and data that was to be collected by classroom teachers was at times incomplete, making for either incomplete data sets (i.e., Weekly Math Logs), or the need for the investigator to collect information from Head Start administration after the completion of the study.

Variables of time, distance, and communication also impacted the ease of implementation of this study. Throughout the year-long study, with 6 months on either end for planning and study review, there were numerous staffing changes that occurred in the organizational structure. These changes occurred at the administrative end, mid-level administration, and teacher level. Often these changes occurred without prior notice to the researcher or Head Start staff. Due to these changes that occurred mid-year, the researcher and teachers needed to be flexible with teaching content and data collection.

Teacher satisfaction ratings all indicated that the program was acceptable and that the materials were beneficial to classroom activities. Notes during the professional development sessions indicated otherwise; however, in that teachers were initially not utilizing the program, and instead relying on their own activities or those found on popular social networking sites (i.e., Facebook, Pinterest). Gaining the support of mid-level administrators to enforce implementation would have been necessary, and is recommended for future implementation. However, the structure of Head Start, as previously mentioned, was not conducive to generating full buy-in of all staff.

The weekly math logs were intended to provide a measure of the mathematics climate in the classroom. However, the logs were based on self-report and were not standardized. Additionally, self-report logs of instruction may not fit into a play-based classroom rather than a structured class with direct instruction in mathematics. Future research using a standardized observation or climate assessment tool in conjunction with standardized measures of mathematics achievement would be beneficial. This study utilized standardized mathematics achievement tests as the primary source of information regarding mathematics knowledge however there was no formal measure of the mathematics climate, other than the self-report logs.

A standardized observation tool would remove the error attributable to self-report measures, provide a stringent measure of active engagement of students, and provide a comparison to be used in tandem with mathematics achievement tests.

Although teachers report that they find mathematics to be important material for preschool education, research has indicated that the practice of mathematics instruction is minimal (Graham, Nash & Paul, 1997). This is potentially concerning in an educational setting such as Head Start, where instruction often occurs through play and interaction with the environment rather than in the traditional lecture format.

Suggestions for future research include a review of federal Head Start values and requirements, and a review of how those requirements are implemented at the organizational and site levels. Even within this specific Head Start program, teachers received varying levels of support for mentoring, preparation, and lesson planning collaboration depending on their immediate supervisors and sites.

A review of the local program's data collection and dissemination processes would also be pertinent. The current data collection systems (i.e., CLASS and GOLD) are based on observations of students and teacher-student interactions. In a system that is currently struggling with consistent implementation of procedures, it is potentially likely that teacher observations are not consistent, nor can the data then be interpreted reliably. The basis of this study was the GOLD data collected during the 2012-2013 academic year; if that data was based solely on observations, then it was potentially not the most standardized measure of true mathematics ability. Process notes during professional development indicated a need for a more structured data collection and progress monitoring tool that would measure specific pre-academic skills that could then provide the basis for explicit skill remediation.



**Limitations.**

The primary limitation of this study was participant attrition. At pretest data collection, there were 63 student cases with complete data. At the time of posttest data collection, there were only 43 complete cases. This created several issues with the study. First, the majority of cases were excluded from the study based on the interfering variable of Universal Prekindergarten attendance, where they received additional mathematics instruction and exposure. Second, children transitioned into different classrooms at various time points of the year based on their chronological age rather than academic growth or achievement. Students who transitioned into other classrooms of the same experimental group were kept in the study while those who transitioned between experimental and control groups were excluded.

A limitation attributed to the small sample size is the lack of generalizability to a larger Head Start population. The sample size required for optimal data analyses (i.e., multiple regressions) performed in this study is larger than that actually collected. Best practice guidelines for multiple regression statistics suggest 15 participants per predictor variable (Pallant, 2013). In this study, there were 9 variables, indicating a sample size of at least 135 participants; in the final data analyses, there were only 43 participants.

Other issues of statistical relevance were noted, including the assumption of multiple regression of observation independence. This often poses challenges for research conducted in school settings (Keith, 2006). Cases were treated in this study as if they were independent; however, as they are all students in one large organization and within classrooms these cases have more in common with each other than they would in comparison to students from a different school district or a different Head Start program. The most common corrective analysis for this concern is to use hierarchical linear modeling, which can take into account the clustering

of students in classes. Hierarchical linear modeling was not used due to the small sample size which has inherently weak power. On the other hand, the struggles encountered by this Head Start system are most likely similar to other organizations working with transient populations with generational poverty. This potentially indicates that the generalizability is limited to other preschool programs and not rural Head Start programs.

An additional limitation to the study was the intervention program utilized. Rather than being a mathematics curriculum, the *MCCA* is very much more a supplement for teachers who are already using the *Creative Curriculum* and are looking for general guidelines and activities with which to incorporate mathematics into their current curriculum. A true curriculum would instead provide a structure and format to lessons and lesson planning, rather than provision of activities. A study within this Head Start program that incorporates a true mathematics curriculum would be pertinent for future research.

### **Future Research.**

Small sample sizes, concerns regarding the generalizability of results, and practical assumptions of statistical procedures limited this study. The systemic barriers of the rural Head Start system as previously described also limited the study. To account for these concerns, future research with this program should consider several key considerations, including the focus of research and the type of the research.

The focus of the research of this study was very broad in terms of overall mathematics knowledge. A repeated theme of the results obtained via the weekly math logs was that mathematical concepts are often intertwined in activities. In the future, a research study designed to implement a specific math curriculum may produce greater student learning outcomes. Additionally, the play-based nature of the Head Start program is at odds with

evidence-based academic instruction that includes systematic direct instruction and progress monitoring of student learning. Currently, Head Start utilizes an observational tool to collect their information. However, this observational tool is reliant on staff for completion and fidelity of implementation. Explicit training on their current measurement processes, research of the implementation fidelity, and validity and reliability studies of the tool or a different tool would be future topics of research.

This study shows that longitudinal research is difficult in this type of Head Start system. Due to the high attrition rate of participants, it is not practical to expect repeated samples data collection. Staff attrition also was a difficulty and resulted in inconsistent data informants. Student and staff attrition; however, are essentially a component of a larger systemic issue. Future research that targeted the connection between federal Head Start values and processes and the local policies and management of the Happy Faces Head Start program would be beneficial for its staff, as well as an indirect influence for its students. A study that focused on mentoring and collaboration, and essential teaching processes and methodology, would have the potential to align the local systems with the expectations of the federal program, and could create a more positive academic climate in which staff are less likely to leave.

### **Practical Implications and Implications for the Field**

Head Start is an organization that is dedicated to the growth of the whole child, supporting health, nutrition, and physical well-being, in addition to academics. In the course of a day when there are many things to accomplish (i.e., snack, physical activity, rest time), teachers need to be creative in how they find ways to incorporate mathematics into the school day. Additionally, preschool children are often unable to sit and listen to a structured math lesson,

especially at the younger ages. Teachers need to be motivated and supported to implement natural opportunities for mathematics instruction during the preschool day.

### Summary

The results of this study indicated that the *Mathematics: Creative Curriculum Approach (MCCA)* did not improve the mathematics achievement of children within the Happy Faces Head Start program throughout the course of this study. Several limitations that were previously discussed might provide some insight into what needs to happen at the systems- and classroom-levels in order to promote greater mathematics achievement. Systemically, the organization's policies need to be evaluated in order to view its alignment with federal policies. Mentoring relationships within the Head Start program have recently been at the center of focus for the federal program. Within this smaller, Happy Face Head Start program, mentoring and general supervisory duties often differ greatly by location and supervisor. In a system that has a high change-over rate of staff at the administrative and teaching levels, an initiative like mentoring is more likely to fall by the wayside. At the teacher level, accountability for skill observation as well as teaching academic content within a play-based setting needs to occur. If teachers have neither the support from their administration in order to implement observations or academic programs with fidelity and motivation, then new initiatives, regardless of the content, are not likely to be successful.

Many of those barriers were also related to the feasibility of conducting applied research in Head Start programming. While a program evaluation of a mathematics curriculum might have been a major undertaking, it is sorely needed. Program evaluations in school-type systems consistently need undertaking, and school psychologists are often in a best place to perform those evaluations (Keith, 2008). A core definition or question of the primary need could also

best address and advise applied research. Rather than looking at the program as a whole and conducting the evaluation, there are many other variables to consider, including but not limited to, the relationship between teacher capacity and child outcomes, the specific mathematics content taught in classrooms as opposed to a whole curriculum, or even working with under advantaged youth within a system of generational poverty. Clearly defining a question while also considering the type of setting in which the research will take place could alleviate or even remedy the concerns that were encountered by this study.

The final question that needs to be addressed is: Should the Happy Faces Head Start program continue to use the *MCCA*? Empirical research indicated no significant differences in mathematics achievement test scores between the control and experimental groups, and multiple regression analyses indicated that the intervention variable was not found to predict mathematics achievement. Rather, differences in the groups were potentially attributable to differences in teacher demographic variables. Thus, the immediate answer is no, the program should not continue to be utilized. The fidelity of intervention implementation, teacher buy-in and personal motivation, and the capacity for the organization to support such an endeavor must also be considered when answering such a question. In its current state, the Head Start program could not expect to produce different results if it implemented the *MCCA* again next year.

Qualitative results taken from teacher input about the program indicate that they felt they learned useful information about the early mathematical skills of young children. However, other than the weekly math logs and child mathematics achievement, there was no research-based means of checking to ensure that the teachers actually taught the content or used the strategies. This issue continues to be relevant in settings where face and empirical validity are

pitted against each other; on the surface a program might appear to be wonderful and help students, but scientific processes produce contradicting results.

If teachers have bought into a system, and are willing to create change, the change process may be able to take hold. If they have not, then change is a struggle. Additionally, teachers need to be supported by their organizational system. Support in this situation would include not only the material resources, such as toys, games, and instructional materials, but human resources, including trainings, guidance, data analysis, and self-evaluations. The guidance to take a mathematics-based program and implement it in a preschool setting with minimal structured classroom teaching would be necessary for this program to work. At this point, the current system in place at the Happy Faces Head Start would not support such an endeavor. However, if substantial changes in the systemic structure and system climate were to be made, then a program like the *MCCA* might have a better chance of demonstrating academic gains.

## References

- Aikens, N., Kopack Klein, A., Tarullo, L., and West, J. (2013). *Getting ready for kindergarten: Children's progress during Head Start*. FACES 2009 Report. OPRE Report 2013-21a. Washington, DC: Office of Planning, Research and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services.
- Anderson, A., Anderson, J., & Thauberger, C. (2008). Mathematics learning and teaching in the early years. In O.N. Saracho & B. Spodek (Eds), *Contemporary perspectives on mathematics in early childhood education* (pp. 95-132). Charlotte, NC: Information Age Publishing.
- Aratani, Y., Wight, V.R., & Cooper, J.L. (2011). Racial gaps in early childhood: Socio-emotional health, developmental, and educational outcomes among African-American boys. National Center for Children in Poverty: Mailman School of Public Health, Columbia University.
- Arnold, D.H., Fisher, P.H., Doctoroff, G.L., & Dobbs, J. (2002). Accelerating math development in head start classrooms. *Journal of Educational Psychology*, 94(4), 762-770.  
doi:10.1037//0022-0663.94.4.762
- Aunola, K., Leskinen, E., Lerkkanen, M.K., & Nurmi, J.E. (2004). Developmental dynamics of math performance from preschool to grade 2. *Journal of Educational Psychology*, 96, 699-713.
- Balfanz, R. (1999). Why do we teach young children so little mathematics? Some historical considerations. In J.V. Copley (Ed.), *Mathematics in the early years* (pp. 3-10). Reston, VA: National Council of Teachers of Mathematics.

- Bliss, S. (2006). Test review: Test of early mathematics ability, third edition. *Journal of Psychoeducational Assessment*, 24(1), 85-91.
- Bond, T.G., & Fox, C.M. (2007). *Applying the Rasch model: Fundamental measurement in the human sciences*, 2<sup>nd</sup> Edition. Psychology Press.
- Brown, E.T., Molfese, V.J., & Molfese, P. (2008). *Preschool student learning in literacy and mathematics: Impact of teacher experience, qualifications, and beliefs on an at-risk sample*. *Journal of Education for Students Placed at Risk*, 13(1), 106-126.
- Brualdi, A.C. (1996, rev. 1999). Multiple intelligences: Gardner's theory. *Practical Assessment, Research, & Evaluation*, 5.
- Bull, R., Espy, K.A., Wiebe, S.A., Sheffield, T.D., & Nelson, J.M. (2011). Using confirmatory factor analysis to understand executive control in preschool children: Sources of variation in emergent mathematic achievement. *Developmental Science*, 14(4), 679-692. DOI: 10.1111/j.1467-7687.2010.01012.x
- Chambers, B., Cheung, A., Slavin, R.E., Smith, D., & Laurenzano, M. (2010). Effective early childhood education programs: A systematic review. *Best Evidence Encyclopedia*. Johns Hopkins University School of Education. Retrieved from <http://www.bestevidence.org/>.
- Clements, D.H. (2004). Major themes and recommendations. In D.H. Clements, J. Sarama, & A. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 7-72). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.
- Clements, D.H., & Sarama, J. (2008). Experimental evaluation of the effects of a research-based preschool mathematics curriculum. *American Educational Research Journal*, 45(2), 443-494.



- Clements, D.H., Sarama, J.H., & Liu, X.H. (2008). Development of a measure of early mathematics achievement using the Rasch model: The research-based early maths assessment. *Educational Psychology, 28*(4), 457-482. doi:10.1080/01443410701777272
- Copley, J.V., Jones, C., & Dighe, J. (2007). *Mathematics: The creative curriculum approach*. Washington, DC: Teaching Strategies, Inc.
- Crehan, K.D. (2012). *Test of early mathematics ability, third edition*. Mental Measurements Yearbook.
- Davis-Kean, P.E. (2005). The influence of parent education and family income on child achievement: The indirect role of parental expectations and the home environment. *Journal of Family Psychology, 19*(2), 294-304.
- Denton, K., & West, J. (2002). *Children's reading and mathematics achievement in kindergarten and first grade*. Washington, DC: National Center for Education Statistics.
- Dobbs, J., Doctoroff, G.L., Fisher, P.H., & Arnold, D.H. (2006). The association between preschool children's socio-emotional functioning and their mathematical skills. *Applied Developmental Psychology, 27*, 97-108. doi:10.1016/j.appdev.2005.12.008
- Dodge, D.T., Colker, L.J., & Heroman, C. (2002). *The creative curriculum for preschool, fourth edition*. Washington, D.C.: Teaching Strategies, Inc.
- Duncan, G.J., Dowsett, C.J., Claessens, A., Magnuson, K., Huston, A.C., Klebanov, P., et al. (2007). School readiness and later achievement. *Developmental Psychology, 43*, 1428-1446.
- Erikson, E.H. (1994). *Identity and the life cycle*. New York: W.W. Norton and Company.
- Ertle, B.B., Ginsburg, H.P., Cordero, M.I., Curran, T.M., Manlapig, L., & Morgenlander, M. (2008). The essence of early childhood mathematics education and the professional

- development needed to support it. In A. Dowker (Ed.), *Mathematical difficulties: Psychology and intervention* (pp. 60-84). San Diego, CA: Elsevier Inc.
- Gelman, S.A. (1998). *Concept development in preschool children*. Paper presented at the Forum on Early Childhood Science, Mathematics, and Technology Education, Washington DC.
- Ginsburg, H.P., & Baroody, A.J.(2003). *Test of Early Mathematics Ability*, Third Edition. Austin, TX: ProEd.
- Ginsburg, H.P., & Pappas, S. (2004). SES, ethnic, and gender differences in young children's informal addition and subtraction: A clinical interview investigation. *Applied Developmental Psychology*, 25, 171-192. doi:10.1016/j.appdev.2004.02.003
- Graham, T.A., Nash, C., & Paul, K. (1997). Young children's exposure to mathematics: The childcare context. *Early Childhood Education Journal*, 25, 31-38.
- Greenes, C., Ginsburg, H.P., & Balfanz, R. (2004). Big Math for Little Kids. *Early Childhood Research Quarterly*, 19(1), 159-166.
- Happy Faces Head Start. (2012). *Community Assessment*. Allegany County, NY: Author.
- Happy Faces Head Start and Early Head Start. (2012). *Grantee Number 02CH0280 Continuation Application, Cycle 3: March 1, 2013 – February 28, 2014*. Allegany County, NY: Author.
- Happy Faces Head Start. (2012). *Aggregate Assessment Data*. Allegany County, NY: Author.
- Hindman, A.H., Skibbe, L.E., Miller, A., & Zimmerman, M. (2010). Ecological contexts and early learning: Contributions of child, family, and classroom growth factors during Head Start, to literacy and mathematics growth through first grade. *Early Childhood Research Quarterly*, 25, 235-250.

- Hulsey, L. K., Aikens, N., Kopack, A., West, J., Moiduddin, E., and Tarullo, L. (2011). *Head Start children, families, and programs: Present and past data from FACES*. OPRE Report 2011-33a. Washington, DC: Office of Planning, Research and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services.
- Keith, T.Z. (2006). *Multiple regression and beyond*. Boston: Pearson.
- Keith, T.Z. (2008). Best practices in using and conducting research in applied settings. In A. Thomas & J. Grimes (Eds.), *Best practices in school psychology, 5<sup>th</sup> edition* (pp. 2165-2176). Bethesda, MD: NASP.
- Kenney-Benson, G.A., Pomerantz, E.M., Ryan, A.M., & Patrick, H. (2006). Sex differences in math performance: The role of children's approach to schoolwork. *Developmental Psychology*, 42(1), 11-26. DOI: 10.1037/0012-1649.42.1.11
- Magnuson, K.A., Ruhm, C., & Waldfogel, J. (2007). Does prekindergarten improve school preparation and performance? *Economics of Education Review*, 26, 33-51.  
doi:10.1016/j.econedurev.2005.09.008
- Maslow, A.H. (1999). *Toward a psychology of being, third edition*. New York: J.Wiley & Sons.
- McGraw-Hill. (2013). Program correlations list. Retrieved from  
<https://www.mheonline.com/program/view/4/7/335/007TEAM/>.
- Moiduddin, E., Aikens, N., Tarullo, L., West, J., & Xue, Y. (2012). *Child Outcomes and Classroom Quality in FACES 2009*. OPRE Report 2012-37a. Washington, DC: Office of Planning, Research and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services.

- Mulligan, G.M., Hastedt, S., and McCarroll, J.C. (2012). *First-Time Kindergartners in 2010-11: First Findings From the Kindergarten Rounds of the Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011)* (NCES 2012-049). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved from <http://nces.ed.gov/pubsearch>.
- National Association for the Education of Young Children (NAEYC). (2002). *Executive Statement. Early Childhood Mathematics: Promoting Good Beginnings*. Retrieved from <http://www.naeyc.org/positionstatements/mathematics>.
- National Council for Teachers of Mathematics. (2002). *Executive Summary: Principles and Standards for School Mathematics*. Retrieved from <http://www.nctm.org/standards/content.aspx?id=16909>
- National Council for Teachers of Mathematics. (2006). Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics. Author.
- New York State Early Childhood Advisory Council and the New York State Council on Children and Families. (2012). *New York State early learning guidelines*. Author.
- New York State Department of Education. (2011). *New York State P-12 Common Core learning standards for mathematics*. Author.
- Office of Head Start. (n.d.). *Head Start Services*. Retrieved from <http://www.acf.hhs.gov/programs/ohs/about/head-start>.
- Office of Head Start. (n.d.). *History of Head Start*. Retrieved from <http://www.acf.hhs.gov/programs/ohs/about/history-of-head-start>.
- Pallant, J. (2013). SPSS survival manual, 5<sup>th</sup> edition. McGraw Hill.

- Pappas, S., Ginsburg, H.P., & Jiang, M. (2003). SES differences in young children's metacognition in the context of mathematical problem solving. *Cognitive Development*, 18, 431-450. doi:10.1016/S0885-2014(03)00043-1
- Persell, P. (2012). *New York State Early Learning Alignment Crosswalk*. New York State Head Start Collaboration Project.
- Piaget, J. (1972). *The psychology of intelligence* (M. Perry & D.E. Berlyne, Trans.). Totowa, NJ: Littlefield, Adams, & Co. (Original work published in 1947).
- Piaget, J., Inhelder, B., & Weaver, H. (Trans.). (2000). *The psychology of the child*. New York: Basic Books.
- Pianta, R.C., Howes, C., Burchinal, M., Bryant, D., Clifford, R., Early, C., et al. (2005). Features of prekindergarten programs, classrooms, and teachers: Do they predict observed classroom quality and child-teacher interactions? *Applied Developmental Science*, 9(3), 144-159.
- Presser, A.L., Clements, M., Ginsburg, H., & Ertle, B. (2012). *Effects of a preschool and kindergarten mathematics curriculum: Big math for little kids*. Center for Children and Technology. Retrieved from <http://cct.edc.org/publications/effects-preschool-and-kindergarten-mathematics-curriculum-big-math-little-kids-final>.
- Puma, M., Bell, S., Cook, R., Heid, C., Broene, P., Jenkins, F., Mashburn, A., & Downer, J. (2012). *Third Grade Follow-up to the Head Start Impact Study Final Report, Executive Summary*. OPRE Report # 2012-45b. Washington, DC: Office of Planning, Research and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services.

- Reid, E.E. (2010). *Promoting early numeracy skill growth in head start children* (Unpublished doctoral dissertation). The Pennsylvania State University, The Graduate School, College of Education, Pennsylvania.
- Robinson, J.P., & Lubienski, S.T. (2011). The development of gender achievement gaps in mathematics and reading during elementary and middle school: Examining direct cognitive assessments and teacher ratings. *American Educational Research Journal*, 48(2), 268-302.
- Sarama, J. (2004). Technology in early childhood mathematics: Building Blocks as an innovative technology-based curriculum. In D.H. Clements, J. Sarama, & A. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 361-376). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.
- Sarama, J., & Clements, D.H. (2009). *Manual for Classroom Observation (COEMET)*. Authors.
- Sarama, J., & Clements, D.H. (2008). Mathematics in early childhood. In O.N. Saracho & B. Spodek (Eds), *Contemporary perspectives on mathematics in early childhood education* (pp. 67-94). Charlotte, NC: Information Age Publishing.
- Smilansky, S., & Shefatya, L. (1990). *Facilitating play: A medium for promoting cognitive, socio-emotional, and academic development in young children*. Gaithersburg, MD: Psychological & Educational Publications.
- Sophian, C. (2008). Rethinking the starting point for mathematics learning. In O.N. Saracho & B. Spodek (Eds), *Contemporary perspectives on mathematics in early childhood education* (pp. 21-44). Charlotte, NC: Information Age Publishing.
- Spelke, E.S. (2005). Sex differences in intrinsic aptitude for mathematics and science? A critical review. *American Psychologist*, 60(9), 950-958. DOI: 10.1037/0003-066X.60.9.950

- Starkey, P., Klein, A., & Wakeley, A. (2004). Enhancing young children's mathematical knowledge through a pre-kindergarten mathematics intervention. *Early Childhood Research Quarterly, 19*, 99-120. doi:10.1016/j.ecresq.2004.01.002
- Teaching Strategies, Inc. (2010). *Research Foundation: Teaching Strategies GOLD Assessment System*. Author.
- Tudge, J.R.H., & Doucet, F. (2004). Early mathematical experiences: Observing young black and white children's everyday activities. *Early Childhood Research Quarterly, 19*, 21-39.
- United States Department of Health and Human Services. (2011). *The head start child development and early learning framework*. Author.
- Vygotsky, L. (1978). Interaction between learning and development. In M. Cole, V. John-Steiner, S. Scribner & E. Souberman (Eds.), *Mind in society: The development of higher psychological processes* (pp. 79-91). Cambridge, MA: Harvard University Press.
- Vygotsky, L.S., Robert W. Rieber (Ed.), & Marie J. Hall (Trans.). (1999). *The collected works of L.S. Vygotsky: Scientific legacy* (Cognition and language: A series in psycholinguistics, volume 6). London: Kluwer Academic/Plenum Publishers.
- What Works Clearinghouse. (2013). *The Creative Curriculum® for Preschool, Fourth Edition*. A report prepared by Mathematica Policy Research under contract ED-IES-13-C-0010. Retrieved from <http://ies.ed.gov/ncee/wwc/interventionreport.aspx?sid=512>.

Table 1

*Student Demographic Information*

	Control Group		Experimental Group	
	M	SD	M	SD
Age of Child <sup>a</sup>	46.04	4.83	45.50	5.91
Prior time in Head Start	16.15	15.74	19.88	16.66
	Frequency	%	Frequency	%
Sex of Child				
<i>Male</i>	13	48.1	8	50
<i>Female</i>	14	51.9	8	50
Disability				
<i>No</i>	23	85.2	15	93.8
<i>Yes</i>	4	14.8	1	6.3

*Note.* M=Mean, SD=Standard Deviation.

<sup>a</sup>Age of child and prior time in Head Start are measured in months.



Table 2

*Teacher Demographic Information*

	Control Group		Experimental Group	
	M	SD	M	SD
Age of Teacher <sup>a</sup>	36.48	8.82	25.31	2.44
Total Teaching Experience	10.41	5.42	2.31	1.08
	Frequency	%	Frequency	%
Teacher Degree				
<i>Associates</i>	1	25	1	25
<i>Bachelors</i>	0	0	2	50
<i>Masters</i>	3	75	1	25

*Note.* M=Mean, SD=Standard Deviation.

<sup>a</sup>Age of teacher and teaching experience are measured in years.

Table 3

*Correlations Between TEMA-3 and TEAM*

Variable	1	2	3	4
1. Pretest TEMA-3	-			
2. Posttest TEMA-3	.42**	-		
3. Pretest TEAM	.41**	.43**	-	
4. Posttest TEAM	.52**	.59**	.60**	-

*Note.* \*\*Correlation is significant at the 0.01 level (2-tailed)

Table 4

*Summary of Independent Samples T-Test Results*

	Control		Experimental		t-test	eta <sup>2</sup>
	M	SD	M	SD		
Age of Child <sup>a</sup>	46.04	4.83	45.50	5.91	NS	-
Prior time in Head Start	16.15	15.74	19.88	16.66	NS	-
Age of Teacher <sup>b</sup>	36.48	8.82	25.31	2.44	6.19*	.48
Teaching Experience	10.41	5.42	2.31	1.08	7.52*	.59
Pretest TEMA score	85.67	9.59	81.63	8.36	NS	-
Posttest TEMA score	87.81	17.46	82.13	8.66	NS	-
Pretest TEAM score	30.20	17.64	13.58	15.84	3.10*	.19
Posttest TEAM score	39.46	10.43	28.78	17.29	2.24*	.11

*Note:* M=Mean. SD=Standard Deviation. NS=Not Significant.

\*Significant at the  $p < .01$  level.

<sup>a</sup>Age of child and prior time in Head Start are measured in months.

<sup>b</sup>Age of teacher and teaching experience are measured in years.

Table 5

*Summary of Chi Square Tests for Independence Results*

	Chi-square value	DF	<i>p</i>	Cramer's V
Sex of child	1.00	1	NS*	.02
Degree of teacher	22.03	2	.000**	.72
Classified with disability	.717	1	NS**	.13

*Note:* M=Mean. SD=Standard Deviation.

\*Yates Continuity Correction

\*\*Pearson Chi-Square

Table 6

*Summary of Sequential Multiple Regression Analyses for Variables Predicting Mathematics Achievement – TEMA-3*

	$\beta$	$t$	$R$	$R^2$	$\Delta R^2$
Step 1			.20	.04	.04
Age of Child	.200	.992			
Sex of Child	.002	.206			
Step 2			.54	.29	.25
Assigned Condition	-.086	.560			
Prior time in Head Start	-.312	.047*			
Disability	-.050	.750			
Pretest math score	.294	.081			
Step 3			.60	.36	.07
Degree of Teacher	-.098	.720			
Age of Teacher	-.538	.351			
Total Experience	.810	.198			

*Note.* N=43; \* $p < .05$

Table 7

*Summary of Sequential Multiple Regression Analyses for Variables Predicting Mathematics Achievement – TEAM*

	$\beta$	$t$	$R$	$R^2$	$\Delta R^2$
Step 1			.24	.06	.06
Age of Child	.240	.128			
Sex of Child	.013	.933			
Step 2			.64	.42	.36
Assigned Condition	-.174	.253			
Prior time in Head Start	-.160	.254			
Disability	-.179	.237			
Pretest math score	.445	.020*			
Step 3			.69	.48	.07
Degree of Teacher	.176	.457			
Age of Teacher	-.338	.515			
Total Experience	.887	.120			

*Note.* N=43; \* $p < .05$

Appendix A

Child Information Form

Please complete this form to the best of your knowledge for each of your students. Names will be kept confidential and used only for office purposes.

---

Student's name \_\_\_\_\_

Age (years, months) \_\_\_\_\_ Gender \_\_\_\_\_

Race/Ethnicity \_\_\_\_\_ Primary language \_\_\_\_\_

Prior length of time in Head Start & Early Head Start (years, months) \_\_\_\_\_

## Appendix B

### Teacher Information Form

Please complete this form to the best of your knowledge. Names will be kept confidential and used only for office purposes.

---

#### Demographic Information

Name\_\_\_\_\_

Age\_\_\_\_\_ Race/Ethnicity\_\_\_\_\_ Gender\_\_\_\_\_

Degree\_\_\_\_\_ Teaching certification\_\_\_\_\_

#### Teaching Experience

Years of teaching experience with pre-kindergarten\_\_\_\_\_

Years of teaching experience with Head Start\_\_\_\_\_

Total years of teaching experience\_\_\_\_\_



## Appendix C

## Weekly Math Activity Log

Please complete this log each week in order to give the researcher a brief picture of the math content taught each week, as well as how engaged and challenged your students were with the lessons. Names will be kept confidential, and will only be used for office purposes.

<b>Teacher:</b> _____	<b>Week of:</b> _____				
	Monday	Tuesday	Wednesday	Thursday	Friday
Approximate Duration of Math (in minutes)					
Math Content Strands Utilized*					
Child Engagement**					
Difficulty Level***					

\*Math Content Strands

Insert the following notations for the different content strands as needed (more than one might be applicable):

NO=Number & Operations GSS=Geometry & Spatial Sense M=Measurement PA=Patterns & Algebra DA=Data Analysis

\*\*Child Engagement

Based on your professional experience, rate the average engagement of children according to the below scale:

0=Not engaged; 1= Somewhat engaged; 2 =Partially engaged; 3=More engaged but not fully; 4=Completely engaged

\*\*\*Difficulty Level

Based on your professional experience, rate the average difficulty experienced by children according to the below scale:

1=Known material 2=Review of newer concepts 3=New material introduced

Appendix D

MCCA – Teacher Satisfaction & Curriculum Review

Please rate your overall satisfaction with this curriculum:

Not a good program at all

Acceptable

Very good program

Strengths	Weaknesses

Would you recommend Head Start continue this program for next year? Please explain.

If Head Start were to utilize this program in the future, do any particular changes need to be made in order for this program to be successfully implemented?

Please provide any additional feedback you might have. Your feedback will be considered in conjunction with the student data collected.

## Appendix E

## Professional Development Outline for MCCA

	<b>Topic</b>	<b>Data Review</b>	<b>Discussion Points</b>	<b>Application</b>
Training 1 (Full day)	Overview of Program -Content Strands -Process Skills -Classroom Materials	-Head Start National standards -Prior Head Start performance data	-General experiences -Education in early childhood mathematics -Process for professional development	-What are your strengths and weaknesses? -How can we support this initiative together?
Training 2 (Half day)	- Number Concepts - Counting & Identifying Sets	- Head Start fall Teaching Strategies GOLD - TEMA and TEAM fall outcomes	- How have you been incorporating the program into your instruction? - Have you been incorporating the new math materials into your instruction?	Application to: - Self Assessment - Large group instruction - Small centers - Interest areas
Training 3 (Half day)	-Geometry & Spatial Sense -Patterning	-GOLD, TEAM, TEMA data related to topic strands	-What would an observer note about my instruction? -Evaluating our own teaching strategies	Instructional Analyses -Pros and Cons -What do I need to change?
Training 4 (Half day)	-Measurement -Data Analysis -Program Evaluation	-GOLD, TEAM, TEMA data related to topic strands	-How do these strands relate to others in the MCCA program? - What am I teaching well, and what areas do I need to strengthen?	-How can my organization support my teaching? -What tools will I need in the future to successfully teach this content?

Appendix F

Professional Development Rating Form

**Overall Impressions:**

*(Please place a mark along the line)*

---

Not Informative At all

Generally Informative

Very Informative

**Were there specific topics covered that were overall not helpful to your teaching?**

**Were the data review and instructional discussions helpful and engaging?**

**Is there anything different you would like to see for the next meeting?**

**Additional comments, concerns, etc.**

**Your constructive feedback for this presentation is much appreciated, and will help me to create effective and useful future professional development sessions. Thank you!**

## Appendix G

### Self-Assessment

<b>Data Analysis &amp; Measurement</b>	<b>I am not skilled in this area</b>		<b>I am somewhat skilled in this area</b>		<b>I am highly skilled in this area</b>
I understand what to expect children ages 3-5 to know and be able to do related to measuring, collecting, and analyzing data.	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
I use and write teaching plans that engage preschoolers in developmentally appropriate data analysis and measurement experiences.	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
I find the data analysis and measurement activities in preschooler's daily routines and interactions.	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
I recognize and support emerging skills as children measure objects, collect appropriate data, and analyze that data	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
I use, and encourage children to use, language to discover what data is, methods to measure data, and language to describe analysis results.	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>