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MATH BUILDING BLOCKS: NUMBER SENSE AND EARLY NUMERACY SKILL ACTIVITIES WITH KINDERGARTEN STUDENTS

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ABSTRACT

This qualitative action research study investigated the observed and reported experiences of early numeracy and number sense skills that were introduced to a group of 13 urban kindergarten students. The study participants attended an Extended Academic Program (EAP), whose focus was a literacy-based direct instruction reading program. The students were seen in a small group format two times a week during the tutorial portion of the school day. Students were monitored for skill development in the areas of counting, number recognition, and number and object-set correspondence. This study discusses the development and improvement of the monitored numeracy skills through the analysis of pre- and post achievement on a standardized academic measure. The text further discusses the subsequent development of a mathematical self-esteem, a mathematical language, and mathematical connections to areas outside of the small group environment.

ACKNOWLEDGEMENTS

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I would also like to thank the incredible administration, for their flexibility and encouragement while I completed the journey of my research study. Their support, along with that of my colleagues, gave me the energy to keep moving forward when the task seemed the most overwhelming.

My research support group and fellow graduate classmates also have my gratitude for challenging me to critically reflect and persevere. Their support on this journey was invaluable. It was an honor to take this journey with them.

My committee members further deserve my gratitude. I thank them for taking the time to read my study and offer the insightful comments that have made this document that final product it has become.

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That brings me to the most important support system through this journey- my family. I do not have the works to thank my husband Keith for believing in me and lifting me up when the journey seemed endless. He allowed me whatever time I needed to complete the assignments that were required. My daughters, Michaela and Elizabeth, were also a constant source of inspiration. I thank them for understanding when mommy had to go to class. I hope that I have modeled for them that learning is a life-long process.

Finally that brings me to my father. Although I lost him about half-way through this journey, I felt his love and support right until the very end. He completed this journey by my side. I dedicate this study to him.

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RESEARCHER STANCE

Becoming a teacher has been my one and only career passion. Playing school with my dolls and stuffed animals at home transitioned into actual experiences early in elementary school. As a fifth grade student, I stayed after school to help my former first grade teacher correct papers, file and record grades, change bulletin boards, and complete any other tasks that she directed my way.

My goal was focused and direct, leading to a major in Elementary Education from the moment that I entered college as a first semester freshmen. As I began course work, I enhanced my course of study by declaring a dual major in Special Education. *Inclusion* was becoming a key buzz word in the early 1990s and I felt that I owed myself and my future students the necessary background knowledge to allow me to meet the needs of all of the students who might find themselves in my classroom.

As I completed the classes that were required for my second major, I found that I enjoyed working with students who had challenges as much as I enjoyed the typical elementary students that I worked with in fieldwork and student teaching. It is that second declared major that has defined my teaching career to this point. Since graduating with my dual degrees, I worked as an Itinerant Learning Support teacher for 6th-8th graders for half a year, as the teacher in a Partial Hospitalization program for students in 6th -12th grade for a full school year as well as during two summer sessions, and as a Life Skills Support teacher

for K-2nd graders for a total of four and a half year. Each experience expanded my view of the teacher's role and taught me invaluable lessons that have been instrumental in each subsequent experience. Each teaching role has allowed me to problem solve situations that are typically not part of a typical elementary teaching experience. All of those roles have led and prepared me for my current position as the teacher who facilitates our school's *Instructional Support Team* (IST). This is the role that I have held for over six years.

The daily journey I take as the IST teacher can best be equated to working on an intricate jigsaw puzzle and connecting all the separate pieces into one overall image. With the help of a core team, my main role as the IST professional is to design, implement, monitor, and evaluate interventions for each student who is experiencing behavioral or academic difficulties. I provide this structured help any time of the school year to any grade level student. This support is considered the pre-referral process to special education that allows for interventions to be implemented prior to a formal psychological evaluation. From time to time, when my team notices that missing information is preventing students from meeting the necessary requirements, we create alternative intervention groups to supplement the district curriculum.

In this model, my role begins as the data collector. I not only examine educational records and current classroom or standardized testing results, but also generate new data. Through *Curriculum Based Assessments* (CBA) and

standardized testing procedures, I look to delve deeper into specific underlying skill sets that are areas of either strengths or weaknesses. It is that wide lens of information gathering on an individual child that is the critical foundation for the next steps of the IST process.

My school's IST approach and frame of reference for designing and implementing interventions is now beginning to be shaped by one of the new buzz phrases in the educational field--*Response to Intervention* (RTI). This notion of RTI leads to the possibility of earlier identification (K, 1st and 2nd grade) of a learning disability. One level my school is beginning to consider RTI in Kindergarten.

At this time, we have an *Extended Academic Program* (EAP) for kindergarten that services a maximum of 40 students in the half-day opposite their scheduled general curriculum time. The structure of this program aligns with the second tier of the RTI models that are currently being discussed and utilized. Most of the students included in this program are the most skill deficit of our kindergarten population. They are the most at risk for needing future intervention and support.

Reading is the main focus of both programs. Each is using research based direct reading instruction program that is generating very useful formative data. The data are showing many positive gains. It is the initial reading deficits that create the criteria for consideration for the tutoring services.

At this time, basic math instruction comprises a very small portion of the intervention block. Without a formal math program to follow, there are little data generated to show the math improvement that may be happening with the EAP kindergarten students.

For math, the progression of skills is more linear than in reading. Teachers assess a certain skill and remediate as needed toward that benchmark. The area of math skill need began to actively shape my inquiry process, particularly on the kindergarten level.

While quarterly progress is noted and overall gains are acknowledged, particularly for students in the EAP program, there is no plan of entry at this time to foster development in areas of math weaknesses. Since math is the second cornerstone of the educational system, I was beginning to view math intervention with our EAP kindergarten students as an area that warrants further investigation.

Arguably, I did well in my school math career, even taking two higher math classes in my senior year of high school. I am able to make connections within the mathematical tiers. However, those skills never came as easily as literacy based skills and application. I needed the formulas and some individual tutoring to clarify procedures and purposes of some of the activities and the concepts became more challenging. However, it is the comparison of data and mathematical relations that I find fascinating and a necessary component in

examining the profiles of the students that I work with in the IST process. I am not intimated by the mathematical world.

The math concepts that are introduced at the kindergarten level provide the foundation for all math teaching. Math concepts build upon one another. If the foundation is weak, the structure upon it will be shaky. For that reason, I believe that it is important to know what the effects of intervening at an early age have on building solid foundational math skills. It seems that many of the skills focused on in kindergarten (number identification and comparison, counting skills, tracking skills and the introduction of the concepts of addition and subtraction to name a just a few) are the underlying deficit areas for the IST math referrals that are generated by the classroom teacher. I also am curious to see if there is a place where intervening in the deficits in foundational math skills merges with the interventions that are being used to increase literacy skills and fluency.

As I began pondering how the students were responding to the full-day programming (which already included direct reading instruction), I also began wondering what impact early math skills would have on not only building math skills, but additionally impacting literacy skills. Was there a connection that could provide another avenue with which to intervene? Would strengthening those early skills help to foster continued growth in the literacy areas? From these wonderings the following question has developed: **What are the observed and reported experiences when number sense and early numeracy skill activities**

are introduced to Extended Academic Program (EAP) kindergarten students?

The earlier an intervention is started with a student, the easier it is to close the achievement gap that exists or has been developing in a particular area of weakness. When students respond positively, future school success becomes more attainable. With these notion firmly grounded in my belief system, I am energized to see what discoveries this journey will unfold.

LITERATURE REVIEW

Introduction

Children enter their school careers as bright and eager five-year-olds ready to explore the numerical world that is one of the backbones of every educational system. Each child brings with him or her vast arrays of home and preschool experiences that create a continuum of skills and readiness levels. In order to meet all of those needs and develop appropriate interventions to bring all students to proficiency, it is important to explore the literature that discusses the nature of the kindergarten student, early math skills, the connection of early math skills and literacy, and the notion of response to intervention for those students that need more intensive instruction in order to make sustained and adequate educational progress.

Kindergarten

With the exception of participation in preschool programs, Kindergarten can be a child's initiation into the educational world. Each child is unique and comes to school with a variety of life experiences. Those experiences become the foundation upon which the classroom teacher connects new learning, one of the key aspects of early mathematical teaching (Gifford, 2004; Murray, 2001).

Cognitive Ability

The Virginia State Department of Education (2003) notes in the overview of their early learning curriculum guide some important aspects related to the

cognitive ability of students entering into the kindergarten setting. Readiness skills in the area of mathematics are developed beginning from birth and continue through the early preschool years. Variations in the development of those skills place students along a continuum of proficiency. That placement on the continuum at any given time is not an absolute overall predictor of future skill proficiency.

Cognitive ability is not a static notion and is responsive to intervention at an early level. Malabonga and Pasnak (1995) found that a group of kindergarten students showed greater cognitive gains when instructed in seriation and classification when compared to a control group. Despite lagging cognitively when compared to their peers, the students in the intervention group showed that cognitive ability could be improved with instruction. Those students did not remain static on the skill continuum.

Similar results were found by Pasnak, Holt, Campbell, and McCutcheon's (1991) who worked with a group of disadvantaged kindergarten students, particularly minority children, who were not doing well in their first encounter with the public school system. The students who participated in the intervention group were instructed in a small group setting on the concrete operations of classification, seriation, and conservation. In contrast, their peers received the conventional mathematical instruction that was part of the regular curriculum. The small group of 5 children (whose instruction was 15 to 20 minutes a day, 3 to

4 times per week for 3 months) made significant gains on the Otis-Lennon School Ability test and the Stanford Early School Achievement Test. The mastery of key cognitive operations at a "stage shift in cognitive development" (p. 5) was a positive outcome for this early remediation.

Engaging young children cognitively in learning activities is an important aspect in mathematics instruction. Generalizing (assimilation), restructuring (accommodation), and representing (internal imitation) are key concepts that connect directly to addressing cognitive ability (Gifford, 2004). This is an area that needs to be addressed during instructional planning.

Developmental Ability

The developmental readiness of kindergarten students varies as much as the students' cognitive abilities. Because of this reality, it is important for teachers to be aware of how students construct personal knowledge, particularly if it differs from the teacher's perspective. Through direct observation of students manipulating objects and interacting with their peers, teachers have the power to recognize various stages of development in mathematical concepts and create subsequent meaningful activities (Louisiana State Department of Education, 1999). In addition, the teacher may also need to help students construct knowledge through a guided practice format (Seo, 2003).

This interactive child-watching approach will allow the teacher to reach each and every student at the level on which he or she is functioning. The

interactive nature will also need to extend to where the students interact with each other, creating memorable experiences that will help the learning transfer into long term memory (Murray, 2001).

Early Math Skills

Early math skills, such as number sense, are based on environmental experiences, interactions with adults, and daily observations of the surrounding environment. A child's mathematical learning is directly linked to an exploration of ideas about patterns and relationships (Virginia State Department of Education, 2003). Building on this base knowledge is the starting point for these early learners.

Number Sense

Number sense and numeracy have not been defined in the exact same fashion by any two researchers (Gersten, Jordan, & Flojo, 2005). However, Case (1998) describes some key areas that characterize good number sense. These areas include: the ability to be fluent and accurate when judging or estimating the magnitude of numbers, the ability to recognize unreasonable results when making mathematical judgments, the flexibility when working with mental computation, and the ability to use the most appropriate numerical representation while moving among different representations. Students with a grasp of number sense can be observed using numbers in multiple contexts in more than one way, while making mathematical based decisions (Gersten & Chard, 1999).

Number sense and numeracy are often included in the key ideas that emerge in the area of foundational math skills (Louisiana State Department of Education, 1999; Virginia State Department of Education, 2003; Wyoming State Department of Education, 2003). Daily activities need to occur in ways that allow for the potential of exploring comparisons and counting opportunities that are meaningful to the individual students (Virginia State Department of Education, 2003). By incorporating these purposeful activities into the daily routine (Armbruster, Lehr, & Osborn, 2002), reinforcement can occur in a very consistent manner.

In looking at developing programs, at either the Early Intervention or Kindergarten level, research has identified some key indicators for addressing early numeracy skills: using a research based curriculum, engaging in collaborative teaching and learning activities, and incorporating opportunities for some one-to-one tutoring for students who have fallen behind the general pace (Stobie, Boyle, Woolfson, Truswell, & Connaughton, 2004).

Early numeracy skills are an area that has been found to respond positively to intervention in the kindergarten setting. Van Luit (2000), when working with already identified special education students in the areas of language deficits and behaviors, found positive results in regard to specific instruction in learning to count. Using both discovery and direct instruction, all 62 students in the

intervention group performed better on post tests than those in the comparison group.

The potential for intervening with kindergarteners in the area of number sense are echoed in the findings of Jordan, Kaplan, Olah, and Locuniak's (2006) study. Through tracking the number sense development of 411 middle- and low-income kindergarteners over four time points, they found that both groups made progress at about the same rate of progress. Although the low-income group performed significantly worse than the middle-income group, the study seems to show that once formal teaching takes place, similar gains are noted regardless of the starting point.

In reviewing a vast body of research, Gersten et al. (2005) conclude that aspects of number sense development may be linked to the degree of informal teaching that students received at home prior to official school enrollment. If those students who are behind are then targeted, particularly in kindergarten and first grade, the potential exists for those students to quickly catch up with their peers who are more advanced in their skill development. That number sense development later becomes an essential tool for students to develop higher order insights when working on mathematical problems.

At this age, intervention should take place in a small-group format and include a pointed focus on building a more rapid retrieval of information and instruction in the under-developed areas of number sense. One option for

fostering gains in the intervention structure would be using the principle of "counting on" from the larger addend in activities to aid in increasing the accurate and efficient use of counting strategies (Gersten et al., 2005). A second possibility would be monitoring the acquisition of number-word sequence and numerical writing skills (Johansson, 2005).

Johansson (2005) concluded, through examining the results of three studies involving 650 children, that there was a positive correlation between the number of digits correctly written and the number of arithmetic problems solved. These results helped to support the conclusion that number-word sequence and numerical writing skills provide a foundation for the development of a mental number sequence that permits quality value solution procedures.

Foundational Skills

Foundational math skills need to be approached in a multidimensional (Murray, 2001), multi-sensory (Gifford, 2004) format where activities are carefully chosen and sequenced in such a matter that the students will be able to link the various skills to one another (Seo, 2003).

There has recently been a shift in the pedagological approach to the instruction of mathematics to three to five year olds. Gifford (2004) shares that rather than relying on little to no formal instruction to this age group, research is indicating that more direct teaching and adult interaction is best practice. With this recommendation in mind, she advocates designing instruction to include

building a child's mathematical self-esteem, connecting the home environment to the school context, and allowing the student to explore new ideas in groups and in pairs. By taking an active role in helping the students to construct and elaborate on the prior experiences, the teacher is "allowing them to 're-invent' mathematics for themselves" (Smith, 1998, p.5).

Another method for instruction that fits this teacher-guided approach is the use of play to explore some of the foundational skills. By providing the opportunity to allow students to play, the mathematical concepts of symmetry, comparison, sorting, position representation, patterning, counting, recognizing quantities, reading numbers, putting objects together, and taking them apart can be easily addressed (Seo, 2003). The use of blocks in a center format (Smith, 1998) is one of the essential tools for allowing the dramatic play for both the boys and the girls in the classroom setting. It is this experimental play with concrete objects that is an important prerequisite for understanding the meaning of measurement and estimation in the greater picture of the mathematical concepts that will follow in later years (Louisiana State Department of Education, 1999).

Early Math Skills and Literacy

There is natural convergence of early math skills and literacy. One way for a concrete connection of the two skills is through the use of big book stories or poems that have a mathematical base (Virginia State Department of Education, 2003). By additionally including number and counting books and physically

counting the objects on the page (Armbruster, et al., 2002), the student is able to see how the mathematical word and ideas merge in the literary format. In this way the two subjects start to be seen as interconnected, not separate notions.

Think alouds in math (Gifford, 2004), a strategy often used in reading, is another way that a positive math strategy for early learners can be used to dovetail the two curricula. The verbal discussion that is inherent to the think-aloud format enriches not only the student's math knowledge, but also general speaking skills. In addition, the discussion that occurs during teacher guided practice when students become stuck in developing their skills (Seo, 2003) is yet another example how verbal expression comes into play. Entering into mathematical conversation with these young kindergarten age children can enrich overall learning and help to reveal some unique and original ideas (Gross, 2003).

Mathematics also contains a language that needs to be taught and understood in order to develop meaning (Adams, 2003). Students read numbers, symbols, and words in order to communicate, and problem solve (Adams, 2003). Since much of the language is abstract, it needs to be learned prior to students being able to express their ideas (Gersten et al., 2005). There are many multiple meaning vocabulary terms, such as "count" and "ruler" for example, that are critical to the mathematical system. By identifying them and connecting them to currently understood definitions, the students are able to make connections and strengthen underlying mathematical understanding (Adams, 2003). Once the

insight is gained into their personal perspective, the math and literacy connection can be openly fostered.

Response to Intervention

As the students engage in their mathematical journey and exploration in a kindergarten setting, the question invariably arises as to what to do when very little progress is being noted. Most teachers would agree that some form of intervention needs to occur. It is here that the notion of "*Response to Intervention"* and its implications for future decision becomes a key concept.

Definition

Response to Intervention (RTI) is an alternative method for identifying students as having a specific learning disability (Bradley, Danielson, & Doolittle, 2005). This is an alternative to the discrepancy model (the difference between ability and achievement) that is used most often. Bradley et al. (2005) state that the current construct for RTI is generally a three- tiered model: primary intervention in the general curriculum, secondary intervention involving a "fixed-duration, targeted, evidenced based small group intervention" (p. 486), and a tertiary intervention providing intensive individualized services that may or may not be comparable to current special education services.

Vaughn and Fuchs (2003) also discuss the three-tier model of Response to Intervention, using similar descriptors, except more specifically equating the third tier of the structure as synonymous with special education. It is that failure to

respond to the fixed-duration intervention, at times 10-15 weeks, which would confirm the existence of a learning disability. They further note that the three-tiered prevention model is more of an umbrella term, with the implementation of the tiers possibly showing operational variations from individual program to individual program.

In looking at this model, there is the potential to not only help to identify students who may actually have a specific learning disability, but also to present an opportunity to intervene on the behalf of those students who may simply need instruction in a method that is alternate to the general curriculum. The promise this model holds is not only the promotion of effective practices that will help to close the achievement gap between identification and intervention, but also serve as a better way to integrate services between general and special education (Vaughn & Fuchs, 2003).

Progress Monitoring

In examining the RTI model, one aspect that is noted in the construct is the need for continued progress monitoring (Bradley et al., 2005). This progress monitoring increases in frequency as the level of intervention is increased. Naturally, the more aware a teacher is of student performance, the more readily changes to programming can be made. Because of this awareness, progress monitoring becomes an important key component in the process. Vaughn and Fuchs (2003) further underscore the importance of ongoing progress-monitoring

assessment procedures that could ultimately lead to a means for screening and tracking the progress of a large number of students.

Stecker and Fuchs (2000) found that the use of individual progress to design student programming in math resulted in positive improvements. For 20 weeks, special education teachers monitored the mathematical progress of 42 students with mild to moderate disabilities using curriculum based measurement (CBM). For those students, the results for their change in instruction were linked directly to individual performance. The students who had the benefit of these individual changes performed significantly better than their instructional partners whose instructional changes were not based on personal performance data. Although the progress monitoring was used on students already identified as having a disability, it shows how that careful attention to data leads to significant improvement.

Early Intervention

Research has shown that early intervention, in general, is one important key for early and on-going school success. Students who start behind in the multiple areas of school readiness tend to stay behind (Wyoming State Department of Education, 2003). This is particularly evident for students who are at risk due to family economics and backgrounds (Ramsey & Ramsey, 2004; Roth, Carter, Ariet, Resnick, & Crans, 2000; Yao & Hearn, 2003).

A regression study conducted by Roth et al. (2000) found that at-risk students who participated in Florida's statewide Pre-Kindergarten Early Intervention program had significantly lower odds of being retained or identified as compared to their nonparticipating peers and significantly higher odds of being in the highest test score outcome category for both math and reading when compared to their non-participating peers.

These results are very similar to findings from Yao and Hearn's (2003) longitudinal study in South Carolina. In this study, data showed participants in the South Carolina's four-year-old child development program scored higher on 1st grade school readiness tests, 2nd grade MAT7 tests, and 3rd grade PACT tests, when compared to those students in the school system for the same amount of time who did not attend the Early Intervention Program.

Ramsey and Ramsey (2004) also found that when children from economically poor and undereducated families are included in a high quality pre-school program, improved performance in reading and mathematics in the elementary level and secondary level are noted. There was also an additional reduction in special education placement and grade retention. They had the unique opportunity to track most of the 111 subjects of a study that began in the 70s over the course of 20 years. Their extensive work aimed at preventing school failure by promoting school readiness shows that "we can positively alter the development

of young disadvantaged children through the provision of early childhood education" (p. 489).

Summary

Kindergarten is an exciting first step in most children's school careers. Each child comes with a variety of experiences, readiness levels, and abilities. All are eager to learn. This time in schooling, coupled with other early intervention programs, has been found to be a key in positively affecting future school success. The mathematical numeracy and foundational skills addressed at this time allow the teacher to aid a student in making connections to past experiences as well as laying the foundation for connecting newly acquired skills. By fostering math self-esteem and exploration, numeracy skills can blossom. If progress happens to be stalled, there are opportunities and avenues for interventions that can positively affect continued growth. Interventions at this early foundational level have the potential for lasting positive impact. Mathematically capable minds are poised and ready for the exploration of all related topics. It is the educator's road to start them on the journey.

METHODOLOGY

Introduction

In order improve the development of foundational math skills in a group of Extended Academic Program (EAP) kindergarten students, I implemented number sense and numeracy activities in a small group (2-4 students) format twice a week for fifteen minutes over the course of thirteen school weeks.

Setting

The elementary school in which this study took place was a medium-sized school of 600 students located in a large urban school district in Eastern Pennsylvania. Educating students from Kindergarten through 5th grade, it also contained six self-contained education classes (Life Skills Support for grades K-5, Emotional Support for grades 3-5, Multiple Disabilities Support-- *Mental Retardation/Emotional Support* for grades K-5, and Multiple Disabilities Support *Severe/Profound, for grades* K -2) in addition to a pullout Learning Support program. The school is an identified Title I school with students who are 92% economically disadvantaged, and 67% Hispanic. Eleven percent of the student body is identified special education, and 22% receive bilingual education services. The school was also identified with a *No Child Left Behind* (NCLB) status of Making Improvement as of the 2006-2007 school year.

For the purpose of this study, instruction took place in a small group setting in the EAP classroom. The room houses four groups of EAP students (two

groups in the AM and two groups in the PM), with a maximum total of 20 students at a time. The students are divided into two groups, with each group having a teacher and one classroom assistant. All of the students identified as having second language learning needs were in one group.

The room has windows that were not clear to the outside. The entrance to the occupational therapist's room is in the back of the classroom. Occasionally she was escorting one or two students through the classroom to and from her office.

Small group instruction took place either at a rectangular table or on the carpet in the corner of the classroom.

Participants

All of the students who were participating in the AM and PM sessions of the kindergarten EAP program were invited to participate in the study. Students were chosen for this EAP program due to scores in the deficit range on the *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) screens for *Letter Naming Fluency* and *Phonemic Segmentation Fluency.* Second language learning needs were not an issue for these students. Math deficits were not a criterion for study consideration.

A total of 15 students received parental consent forms, eight males and seven females. One of the female students moved before the conclusion of the study, and the parent of another female participant declined to give consent. The

data were generated on eight male and five female students. Eight of the students were Hispanic, four Caucasian, and two African American.

The EAP program includes additional instruction time on the half-day opposite the students' scheduled kindergarten program. The students essentially attend a full-day program, receiving lunch and a snack as part of their instructional day. Free-play/recess is also part of the 40-minute lunch break between the regular half-day curriculum and the tutoring session. The math activities that comprised this study were conducted during this EAP portion of the day.

Procedures

Prior to beginning this action research study, permission was secured from the principal of the Elementary School (see Appendix A), Moravian College's Human Subjects Internal Review Board (HSIRB) (see Appendix B), the School District, the parents/guardians of the students involved in the study (see Appendix C), and the regular Kindergarten and EAP teachers (see Appendix D).

The following concepts and skills were the underlying goals for the small group activities:

- The students will be able to count from 1-30.
- The students will be able to demonstrate 1:1 correspondence when counting groups of objects.
- The students will be able to demonstrate a tracking system when counting.

- The students will be able to identify the numbers from 1-10.
- The students will be able to identify quantity arrays for the numbers from 1-10.
- The students will be able to identify the bigger number/quantity when given two different numbers or quantities.
- The student will be able to identify the smaller number/quantity when given two different numbers or quantities.
- The students will be able to use the terms “more than” and “less than” when talking about two different numbers.

Following each day of small group activity, observations were recorded on the observations log with notations made on the group as a whole and on students individually (see Appendix E).

Week 1

During the first week, all study participants were given the *Bracken Basic Concept Scale-Revised (*see Resources). All tests were scored and recorded. A range of scores for the whole group were noted. At this time, each student was assessed using three one-minute math probes--*Number Identification, Quantity Arrays, and Oral Counting (*see Resources). An initial teacher interview and individual student interviews (see Appendixes F and G) were given to gain impressions of math related skills prior to the intervention activities.

Each group of students (five in the morning and eight it the afternoon) were divided into two groups. The groups were different each time, based on student attendance and availability. Groups ranged in size from two to four students. All groups participated in the same activities, delivered in the same format. Each small group session lasted for approximately 15 minutes and occurred two times per week. Each session opened with the whole group counting to 30.

The focus of activities for this week was discrimination between numbers and letters. The first activity involved sorting letters and numbers into piles. The activity was done with the whole group and then individually. Teacher reinforcement and discussion were given individually as needed. The second activity was a letter/number hunt in the hallway, recording numbers and letters seen in various printed forms. Each student individually recorded the numbers and letters onto a sheet of paper (Appendix H).

Week 2

The focus of activities involved the numbers 1-5. The first activity involved matching like numbers to numbers, tracing numbers, and identifying the names of the numbers. The second activity was the game Concentration with the numbers 1-5.

Week 3

The focus of activities involved the numbers 1-5. The first activity involved using snap cubes and a hundreds chart to create the set of numbers 1-5. The second activity involved using bear counters to create sets of numbers 1-5.

Week 4

The focus of the group activities for this week was the numbers 1-5. The first activity involved creating matches between numbers and groups of objects. Sets were made with snap blocks and number tiles. The second activity involved creating number sentences using the numbers 1-5 with a picture prompt in the background.

Week 5

The focus of the group of activities for this week was the numbers 6-10. The first activity involved matching like numbers to numbers, tracing numbers, and identifying the names of the numbers. The second activity was concentration with the numbers 6-10.

Week 6

During this week, students were assessed using the *Number Identification Probe, Quantity Arrays Probe, and Oral Counting Probe (*see Resources). The second sheet of each of the probes was used as the starting point for this second monitoring. Scores were tallied and recorded. Testing was conducted at times alternative to scheduled group time.

The focus of the group of activities for this week was the numbers 6-10. The first activity involved using snap cubes and a hundreds chart to create sets of numbers 6-10. The second activity involved using bear counters to create sets of numbers 6-10.

Week 7

The focus of the group of activities for this week was the numbers 6-10. The first activity involved creating matches between numbers and groups of objects. Sets were made with snap blocks and number cards. The second activity involved creating number sentences using the numbers 6-10 with a picture prompt in the background.

Week 8

The focus of this group of activities for this week was the numbers 1-10. The first activity involved creating sets to match three different numbers and ordering the pairs of numbers. The second activity was playing the game of concentration using the numbers 1-10.

Week 9

The focus of the group activities this week were the numbers 1-10. In the first activity, the students picked number tiles and created sets to match the numbers using snap cubes. The second activity involved writing numbers randomly from 1-10 vertically down a 100 grid chart and then creating a matching group of quantities using small stickers.

Week 10 and 11

During these weeks, students were assessed using three one-minute math probes--*Number Identification, Quantity Arrays, and Oral Counting (*see Resources).The third sheet of each of the probes was used as the starting point for this final monitoring. Scores were tallied and recorded. Testing was conducted at times alternative to scheduled group time.

Outcome testing using the *Bracken Basic Concept Scale-Revised (*see Resources) was conducted this week. All tests were scored and recorded. A range of scores for the whole group were also noted. Final teacher interviews and individual student interviews (see Appendixes F and G) were given to gain impressions of math related skills following the intervention activities.

Data Sources

Observation Log

The observation log held the daily recordings of both individual and group observations during the intervention's small group activities. This included specific daily success of each student as well as teacher reflections on the observed behaviors. Using a two column log, my thoughts and comments were recorded separately from the student observations within the observation log (Appendix E).

Bracken-Basic Concept Scale-Revised

The *School Readiness* Component of the *Bracken Basic Concept Scale-Revised* was given at the start of the intervention as well as the conclusion of the intervention to objectively measure growth in skills (Resources).

Number Identification

The *Number Identification* is a one minute timed probe used to measure growth in number identification three times during the study: the beginning, middle, and end (Resources).

Quantity Arrays

The *Quantity Array* is a one minute timed probe used to measure growth in quantity identification three times during the study: the beginning, middle, and end (Resources).

Oral Counting

The *Oral Counting* is a one minute timed probe used to measure growth in oral counting skills three times during the study: the beginning, middle, and end (Resources).

Teacher Interview

The teacher interviews were conducted at the start and the conclusion of the study to acquire teacher impressions of emerging numeracy skills. Interviews were conducted with the EAP teacher and the classroom teachers (Appendix F).

Student Interview

This oral student interview was conducted at the start and the conclusion of the study to acquire student impressions and insight into developing numeracy skills (Appendix G).

Student Work

Student work from the number/letter scavenger hunt was collected and examined (Appendix H). The sticker grid from the last intervention activity was also collected and examined for evidence of skills.

Summary

In order to improve the development of foundational math skills in a group of EAP kindergarten students, number sense and numeracy activities were implemented in a small group (2-4 students) format twice a week for 15 minutes over the course of nine weeks. Daily observations and reflections were recorded and analyzed in order to identify common themes. Progress monitoring tools were used three times over the course of the study to provide levels of skills competency. An objective standardized assessment was used at the start and conclusion of the study to provide data on skills competency prior to and after intervention. Student and teacher interviews were given and examined to help gain insight into student and teacher feelings concerning the efficacy of the intervention.

TRUSTWORTHINESS STATEMENT

Trustworthiness is an integral part of any research study. After reviewing Arhar, Holly and Kasten (2001) I found that as a teacher action researcher, I needed to be trustworthy in many facets while I conduct my study. Through the use of principal, teacher, and parent consent forms, I openly secured those parties' acknowledgement of the work that I was conducting and their "blessing" in my pursuit of findings ways for improving early math skills for the children.

I involved my kindergarten student participants by explaining that I was also a student and needed their help in completing coursework. I let them know that they could tell me what activities were or were not helpful to them. I additionally assured them that my goal was for each student to learn more easily and not necessarily to complete each and every task with perfection.

I was diligent in ensuring confidentiality. I clearly expressed that what ideas they shared with me were private, unless it involved information that needed to be reported (such as abuse or neglect) to the principal, guidance counselor, or nurse.

I ensured student anonymity. Each student was given a pseudonym for use in my formal write-ups. If necessary, I also created a composite of a few students or a group of students if that would be a way of accurately portraying my data. My field log with identifiable information was kept private and locked away in a

secure location both during and after the school day. After the study analysis had been completed, the log was destroyed.

I clearly let my participants and their parents understand that they had the right to withdraw from the study at any time. The activities that I lead were still part of the *Extended Academic Program* (EAP) block, but I did include any no-participant information in the field log for the official study. By not participating, the students did not get more or less work than their classmates who do participate. If they did withdraw, there was no reflection in any way on the progress reports. The parents and students understood that my purpose was to improve early numeracy and number sense skills.

I made every effort to build a relationship of trust. I earnestly conveyed that although I was a researcher, I valued their input. I valued honest answers and assessments of how they felt about their learning. I let them know that I was not always looking for a right or wrong answer, but sometimes how they were thinking about a certain situation.

I was a self-reflective learner throughout the course of the study. I kept an active field log where I examined the data that I gathered regularly. By separating the field log into to columns in order to distinguish between observations and comments (Bogdan & Biklen, 2002), I was able code to my entries (Hubbard & Power, 2003) and gain new insights. Discussion with my researcher support group

members (McLean & Mohr, 1999) further challenged my insights and aided in honing my discoveries and observation techniques.

I made sure that my research did not get in the way of my classroom duties by carefully reflecting on that pointed question. I identified and labeled my biases (MacLean & Mohr, 1999) as they arose and made them known so that I did not misrepresent my findings. This included my own lack of confidence when working with mathematical concepts. I checked to see that all students were observed on an on-going and regular basis. Good, bad or indifferent, I made every effort to represent the true story of my experience, for the simple nature of trustworthiness.

I gathered multiple types of data (observations, achievement data, and interviews) that allowed me to examine my question from various points of view and in a variety of ways (Hubbard & Power, 2003). This variety allowed me to write a rich, three-dimensional description of what my experiences were like. Those multiple lenses allowed me to have a deeper understanding into my job as an educator.

Trustworthiness was the reminder to be an educator foremost, and a student second, as I continually stopped along the journey of the study to think—was I being fair to my student? Was this path making me a better learner? Were my students becoming better learners?

THIS YEAR'S STORY

The Journey Begins

Starting any new venture is scary. The fear of the unknown leaves just enough room for one to stop, reflect, and decide if the new step is worth the effort. The journey of this study was no different for me. The excitement of trying something new was coupled with the nervous anticipation about the logistics of creating a meaningful field log. As the IST teacher, I usually do not have the opportunity to work with a consistent group of students for an extended period of time. My role usually is to initially spend solid chunks of time with students on a one-to one basis, to determine levels of skill strengths and weaknesses. I may monitor the interventions that are created, as well as evaluate effectiveness and growth, but I am not usually the one to deliver the intervention so early in the school year. That typically comes later as the students struggle with the interventions already in place and need more intensive remediation. By that time students are excited to work with someone on a more individual basis.

Would it all be manageable? Would I be able to collect enough information to create a story worth telling? Would there be "big ideas" and patterns worth reporting? The only way to find out was to meet the students and initiate the relationship. Fears in check, I left my office, bravely walked down the stairs, making my way to the EAP Kindergarten classroom.

The Introduction

Would the students accept me as yet another positive addition to their school setting? The kindergarten students that I was about to meet were now part of the EAP program. Essentially attending a full day Kindergarten program, these students have had about two weeks to adjust to being in school for a full-day. For some I am sure the stamina necessary to complete the full day was a challenge unto itself. These students had already been identified at risk for reading development. Most were learners immersed in poverty; given the fact that our school is 93% free and reduced lunch, and lacked background knowledge.

Now here I come, asking them to make one more change. I had my parental consent forms ready to go home with them. *Would enough parents feel that my study was worth allowing their students to participate?* I allowed one last moment for myself to indulge in the fear before walking inside to meet the AM group.

I had a novel way to start my conversation with these students. Miss Honey, their EAP teacher is my sister. We also look a lot alike. This was my natural point of entry and how I began my conversation with the students once they were all seated on the carpet. Seated on the carpet with them, I let them know that I was going to be working with them two times a week doing math related activities. I further explained that I was also going to school and when I was working, I would be talking notes about what they were doing, but it was only for

me to know what they needed help in. I also explained that if any of these activities or the notes that I was taking was “making them crazy”, they needed to tell me so I could get Mrs. Bubbly (our guidance counselor) for them. I heard many giggles and saw many smiles. Those were heartwarming sounds and signs. None of the students asked any questions and all eagerly went to put my letter into their book bag for mom, dad or their guardian to sign.

Buoyed by the morning experience, I happily went for my grand introduction to the PM group. Using the same script for the afternoon, I highlighted the same key points, soliciting the same giggles when I mentioned possibly “making them crazy”. However, this time there were comments to be heard:

“Math is hard for me,” said Jared with a slight frown on his face.

“Math is easy for me,” countered Brian with Melanie echoing*, “Math is easy for me too.”*

Jared already seemed to view himself as struggling with concepts. I realized that I needed to be alert to see if he was craving attention or was really experiencing difficulty. It also made me wonder if this was just in math or in all areas. I filed that insight into my head and wrote it down the first opportunity that arose.

Both of the other two students seemed to have self-confidence in their abilities. At that time, I made a mental note to see if their confidence matched

their abilities. The development of everyone's overall math feelings was a notion that was just confirmed that I needed to track. The next order of business was to gather some baseline data to see exactly where the math abilities of this group fell.

Numeracy Foundations

Any building needs a solid foundation, and in education, Kindergarten is where the first blocks are often laid. Since the students were invited to the EAP program based on reading deficits, there were no pre-recorded indications of any math/numeracy deficits. In order to attain a baseline for a comparison, I gave all of the students the *School Readiness Component* of the *Bracken Basic Concept Scale-Revised.* Scores varied on the overall readiness scores, which included the areas of *Colors, Letters, Numbers/Counting, Sizes, Comparisons, and Shape,* as well as the *Numbers/Counting* subtest. It was that subset that I felt was a strong indication of the number sense/numeracy skills that I was going to be monitoring.

The readiness scores were varied. The overall *Bracken School Readiness Composite* scores of the group ranged from Standard Scores of 64 through 99. Only 4 of 13 students scored within the *Average Range* (85 through 115). The rest were in the *Delayed Range* (70 through 84) or *Very Delayed* (69 and below). (see Figure 1)

Figure 1. Bracken-School Readiness Composite Baseline Scores

In the *Numbers/Counting* subtest, the scores ranged from 2-19, out of a possible 19 (see Figure 2).

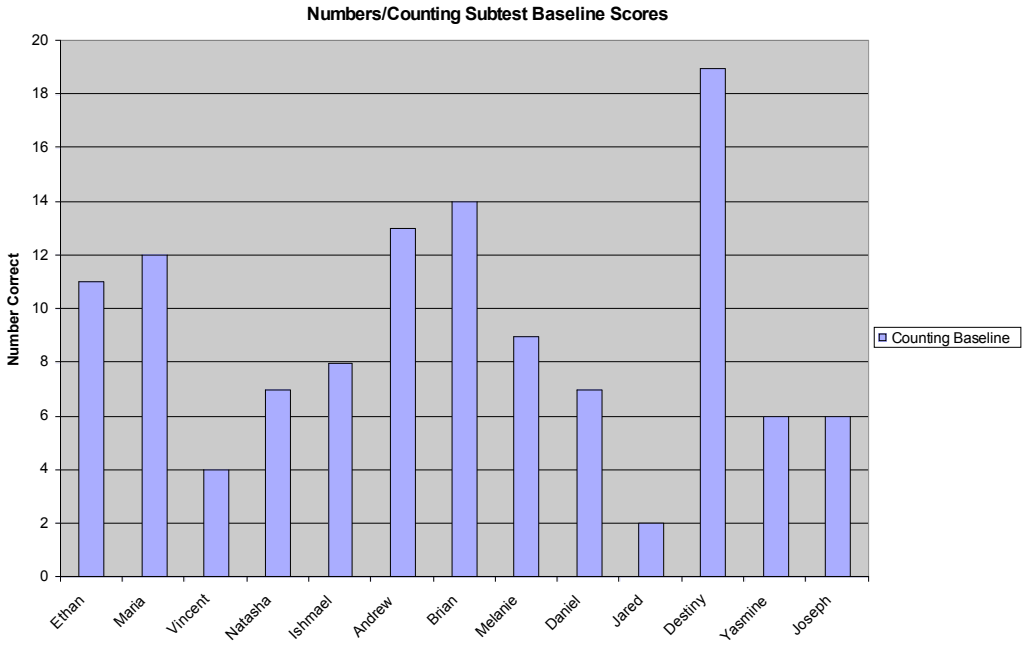

Figure 2. Numbers/Counting Subtest Baseline Scores

It was obvious that there was a wide range of abilities and skill sets throughout the two groups. There was the potential to measure growth. Each student represented a piece of the group math puzzle, showing an unclear picture of what would eventually evolve.

The Math Players

Although their stories will unfold in varying details, I would like to introduce the math players who began this journey with me one October day:

Ethan--eager and watchful, his articulation miscues and speech intervention do not hamper his eager mind. As the youngest of three brothers, he was always ready to jump in and try.

Maria--quiet and unassuming, this sweet African American girl seemed like a bud ready just ready to open.

Natasha--boisterous and eager to respond, she was always ready to offer a response and give the task a try.

Vincent--forever smiling and laughing, he was on the move and ready to share.

Ishmael--somewhat unsure and at times difficult to understand because of his articulation deficits, he was not afraid to ask for some help.

Yasmine--often absent because of severe asthma, she would smile and give it a try.

Jared--always a bright smile, but not sure of the answer, he was constantly in motion, not always sure of what the numbers were called.

Daniel--already six and missed prior school experience because there was no more room in the classes in the previous year in New York, he was the most math capable and a potential leader.

Brian--at times mischievous and susceptible to severe asthma attacks, he was looking for what was coming next.

Andrew--capable, but not always willing to show his skills, he was the unassuming and at times unmotivated participant who liked to follow the beat of his own drumer.

Joseph--finally five just after the start of school, he was looking to find his way in a group of more outgoing and confident peers.

Destiny--a ball of fire or a meek mouse, you were never quiet sure which student would be part of the group.

Melanie--confident and the eager helper, she struggled with any task that requires fine motor manipulation.

As much individuals as little groups working as one or following one lead, all of the players were poised and ready to begin building with the numeracy blocks already in place.

1, 2, 3s or ABCs

My baseline data showed me that my students have varying abilities in basic number recognition and counting a group of objects. Many abilities seem to be of a deficit nature. All of the kindergarten teachers had indicated that all of the students had been participating during math instruction and math centers. With the exception of some of the boys not always following teacher directions for the centers (Brian, Andrew, and Daniel), all had been willing to try. I was excited to have identified skill deficits in the students, since my intervention groups should be targeting known deficits.

With this information now known, I was satisfied with the first two activities that I chose for the children. Prior to even starting with number recognition, the basic difference between a number and a letter needed to be

investigated. Although both symbols, each really represents a different way of thinking. Numbers help us count and quantify objects; letters combine to allow us to make words and eventually read. This was where I was going to begin.

On the first day, I had the students gather on the carpet in groups of two or three. The carpet would be our initial working area. I told the group we were getting ready to "*do math*," a phrase I would regularly reinforce throughout the activities. That phrase was a conscious choice in light of Joseph's question of "*what is math?"* during his individual baseline interview.

We began by rote counting. Each child was given snap cubes arranged into 3 groups of 10. We counted as a group, each child pointing to the cubes as they counted. I also modeled the activity. That initial counting exercise was already an eye-opener for me. Not all of the students had a one-to-one correspondence when they counted. In addition, the rote counting sequence was jumbled for many of the students, particularly once we reached ten. I had already made a mental note that the daily opening counting exercise to 30 was a smart choice when designing the activities. I would be monitoring individual development closely.

The students worked with a partner to separate letters and numbers into two piles, with corrections being made as needed. I interjected often, "*Is it part of the ABCs or 123s?"* We adjusted the piles as a group, and then each child was given their own pile to sort. The differences were amazing.

Maria went right to work, quickly separating letters into one pile and numbers into the other. Her piles were flawless and she did not hesitate.

Ethan started out strong, but then his piles became random. When I asked him to hand me numbers from a mixed sampling, he was able to focus his attention and complete the task. Vincent followed the exact same path.

Destiny began her separation by pulling the numbers 1, 2, 3 and 5 into one pile. I thought she had understood. However, as she continued, the piles became hopelessly mixed. Even with direct teacher questioning, she was not able to pull just the numbers from one of her piles. There was obvious confusion.

Jared's two separate piles quickly became one long string of letters and numbers jumbled together. There were not even two discernible piles when he had finished. His answers appeared random and continued that way when I asked him to hand me the letters. He seemed hopelessly confused.

Daniel was the fastest of all. He not only easily separated the numbers and letters, but once the sorting was complete, he began placing his numbers in numerical sequence. When he realized that he did not have a 7, he scanned Joseph's pile and asked, "*Can I borrow your 7*?"

Joseph, who had his piles jumbled, not only gave him the 7, but when he realized he had a second number 7, he immediately gave him that one also. His number/letter sorting was not solid, but his matching skills seemed to be well developed.

After this first activity, I realized that I would need to include talk about finding numbers in the classroom to help the students solidify the difference between the symbols. With that connection clearly in mind, I got ready for the number/letter scavenger hunt for the next day.

Not only was recognizing the difference between numbers and letters important, but I wanted the children to recognize the numbers throughout the larger environment. We began the next group with a paper for noting letters and numbers (see Appendix H), a pencil, and a wipe board to lean on. Using the morning/afternoon message for modeling purposes, I showed the students how to locate letters and numbers and where to place them on the paper. Modeling complete, we set off to locate the numbers and letters in the larger school environment. The chatter was unbelievable as we went down the hall, up the stairs, and around the main entrance. The energy that I felt excited me. I heard the curiosity in their voices and saw the gleam in their eyes. This journey was amazing to them. It seemed that they had discovered that the numbers that they had started to learn could actually be found outside of the classroom environment.

Until that moment, I do not believe that I had stopped to ponder what had been the “mathematical experiences” these students had engaged in prior to entering school. I knew that numbers were everywhere, and now had been given the opportunity to watch these kindergarten students begin to make the same connection.

The following pastiche (see Figure 3) documents the number excitement that emerged:

Numbers, Numbers, Everywhere

I see that number!

Look at 2

OOOOH! (pointing the number 202)

I'm getting a lot!

On which side does it go?

Can I write the number 1?

There are a lot of numbers!

I found the letter 1.

Look, I write a 2

Found it!

Numbers (pointing to the word you)

There are numbers down there!

One goes here?

A 3 and a 2 and a 1

I can see a four.

I can see a one.

Figure 3. Pastiche of Number Talk

The numbers that were recorded and their placement were as varied as the chatter that was heard. Maria saw the “big picture”. Her numbers, as well as her letters, were viewed as whole units, not simply individual digits. She recorded multi-digit numbers like 204 and words like Nana (see Figure 4). She saw more than just a single unit. Where the others had dissected parts, she saw a larger whole. Her printing was legible and each representation was a separate entry. That was an exciting surprise.

Daniel had the categories separate and correct, but the numbers/letters he recorded were single digits/units (see Figure 5).

Melanie knew the difference and easily located both letters and numbers, but her fine motor deficits completely prevented any discernable characteristics in her written work (see Figure 6).

Writing numbers was not an area that I had chosen to really focus on in the course of the intervention activities. Seeing how some of the students struggled made me think that I would need to spend time modeling number formation when I had the students use the wipe boards.

Overall, this activity left me very excited. In all groups, the students generated a palpable energy. Numbers were interesting. Some of them even seemed amazed finding them all throughout the school. This just may have provided the first link to an environmental connection for them.

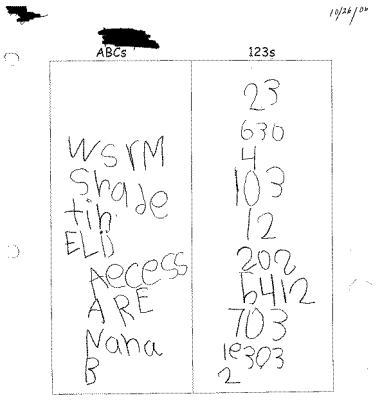

Figure 4. Maria's Work

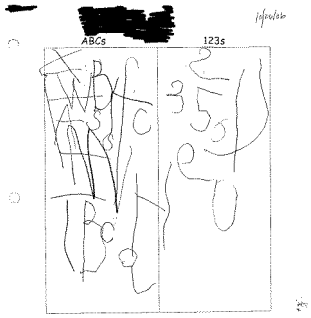

Figure 5. Daniel's Work

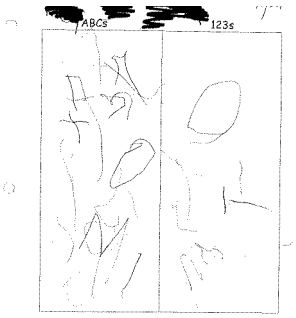

Figure 6. Melanie's Work

The Number Lady

"Mrs. Greczek, I see a number!" This is how Vincent greeted me when his group was first called over to the carpet. Unprovoked, he pointed to a number on the chart that was hanging on a portable easel behind my back. He had made a connection between me and needing to find numbers! That was exciting. Those personal connections are so important in building and retaining skills.

With the letter/number difference aside, it was now time to start focusing on number recognition for the numbers 0 through 5. Like the week before, we began counting objects, this time using bears. All of the students counted to 30 while I was taking the bears from the pile and placing them into rows of 10 as we counted. I took the time to ask them what I had done, drawing attention to the tracking strategy that I had been using. This explicit instruction would begin to take on an even greater role in lessons to come.

Each student was then armed with individual number tiles zero through five that they needed to match to my flash card. Some picked the number out as I said them, others needed to see the card before finding the appropriate tile. All were able to match independently. Matching was one successful underlying math skill for all. Good for them! Individual number identification varied from identifying all the numbers through 5, to simply being able to identify the number 1. There was work to be done, but that was the purpose of the intervention. I was anxious to see the skills evolve.

"Let Me Show You"

Peers can play an important part in skill development. Interaction was something that I made sure was part of the activity design of this study. I was amazed to see that become so important early in the study. The group had just moved to writing the numbers 1 through 5 individually on wipe boards. I had just called out the number five and was watching the small group get to work. After a pause, Ishmael said, *"I don't know how to make a five."*

Before I could interject by showing him a model or demonstration, Maria jumped right in! *"Here let me show you."* She took his wipe board, and angled her body so he could watch. Once she noted that she had his attention, she wrote the five. Once completed, she immediately handed the board back to him and waited for him to write a five. He complied without any interjection from me.

This natural interaction impressed me in two ways. First, I was delighted with the self-confidence that led Maria to help Ishmael without a second thought. She knew she could help and managed to convey the help in a very teacher-like manner. Her style was so unassuming that Ishmael naturally followed her directions without hesitation. The second way I was impressed was the notion that Ishmael had the insight to realize that he was unsure how to make the number five and had the courage to ask for assistance.

Although not occurring in such a structured manner, Ethan displayed the same model role. As Vincent was counting a stack of blocks aloud, Ethan noticed that

his sequence was out of order, and he interjected, "*No, 1, 2, 3, 4, 5*" (recounting the blocks for him) and then continued to hand Vincent the blocks one at a time until he finished his sequence. Both Vincent and Ishmael were participating and moving within the "zone of proximal development" that Vygotsky speaks about in his educational theory. In this instant, I saw Vygotsky's words come to life right before my eyes: "Learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers" (Vygotsky, 1978, p. 90). *Will the peer dynamic continue to be such a positive influenc*e? Only time would tell. I was hoping that this initial spark would continue as the weeks progressed.

The Concentration Game. . . Not Really

In order to work with the numbers from zero to five in what I felt would be an engaging format, I had the students play a game of concentration. This same format would be repeated again in a few weeks with the numbers six to ten and eventually the numbers zero through ten, using small number tiles. There were four tiles of each number. By having a student identify the number as the tile was turned, I elicited individual responses from the student that allowed the opportunity for correction. That high level of repetition would be a positive intervention for number recall. What actually transpired was a mix of true concentration and impulsivity. Impulsivity became the name of the game for most

of the group interaction. In fact, verbal and physical redirections abounded amid flashes of focus.

In some ways the nature of the game proved too much for some of the students. The frequent individual responses were lost on some of the students who could not wait their turn and had to be continually reminded to wait their turn and watch the others. Concentration was tough all the way around. I needed to realize that inattention will be part of the game plan and called for more specific directions and longer modeling in the future.

The poem that follows (see Figure 7) captured some of the juxtaposed behaviors that the students engaged in during the first try at this activity.

Concentration

Match the numbers as you go

Tell the name of the ones you know

Watch and remember to go far

Collect a pile and be a star

I am rolling can't you see

Where is that number three?

Whose turn is it supposed to be?

Hey, she has a bigger pile than me!

Match the numbers as you go

Tell the name of the ones you know

Watch and remember to go far

Collect a pile and be a star

Figure 7. Concentration poem

Give it a Name

We all count and need to count various times during the day. That is one of the basic math skills. It dawned on me early that some of the students did not have vast experience counting. When they counted, the sequence was random, and one-to-one correspondence between numbers and objects of numbers was inconsistent at best. With that observation in mind, I began to not only model counting objects with the group, but also I began to have the students talk about what I was doing to keep track of the objects that I had already counted. I lined up objects in a row, pushed them aside and snapped cubes together. I kept asking "*what did I do to remember which objects I had counted?"* until they could identify verbally what I was doing. Within a few lessons, I was hearing a description of the strategies:

Vincent: *"You put them togethe*r"

Maria: *"You pushed it out", "You put them in order"*

Destiny: *"You can stick them together"*

This verbalization was followed by student initiation of one of the strategies when counting. It was exciting to see students using the strategies in combination with the verbal explanation. Some students were using tracking strategies prior to the lesson discussions, but it was gratifying to see them used in such a deliberate manner.

Math has its own language. The students needed to be able to talk about what they are doing and verbalize their thinking. The discussion of the strategies led to other math strategy talk that was cultivated in the same way. When the students were asked to qualify their thinking and name the process, the words began to flow in many forms:

Strategy Lingo

You need to get one out

You take that off

Add one more to get five

Nothing in the zero

Put one more

1, 2, 3, 4… put one back

Figure 8. Math strategy talk

It was important to honor and validate the words that the students were choosing to use, while allowing them to practice. It does not matter that the terms are technically correct at this time, but that the discussion had begun. As Dowdy (2002) tells us: "The issue is about having enough opportunity to practice that language in 'legitimate' communications" (p. 12). "Math speak" in math activities is about as legitimate as it gets!

Connecting the Numbers

Numbers and counting are more than signs and activities that are reserved for school day activities. They are part of our everyday life. The more I saw the students in group, the more I saw connections spark between numbers and self-reflection. The numbers began to have personal meaning and representation.

One day, seeing the numbers five and two sparked interesting comments from Destiny: "*I'm this many*" (showing me five fingers) as soon as she saw the number five. When the number two came up later in the activity, she stated to the group, "*I gave Joseph two of my stickers.*" The relationship between numbers and quantities was expanding.

Natasha also made a number connection, a family connection. One day, the number seven sparked the response, "*Seven, my sister is 7."* Once the number symbols had personal meaning, the likelihood of longer term connections were bound to increase.

Excited about these connections, I also realized that besides these few comments, there was little talk about math and the outside world. As I pondered what I was hearing, I realized that I possibly needed to start the explicit discussion about how math connects outside of the classroom to home activities.

With the success in modeling the prior math talk, I decided to take it one step further. One day I opened the activities with a question, "*What do we do when Mrs. Greczek comes to work with you?*" Jared chimed in immediately,

"*NUMBERS.*" That one connection for Jared made my heart smile. He usually struggled so that I was glad that he was able to name the realm of our work. From that I said, "*Mrs. Greczek used math at home this morning. I was making eggs for breakfast and I had to count out two eggs. Did you use any math at home recently?"*

Ishmael, another one reluctant to answer, stated: "*I saw numbers at home."* and "*I was counting my fingers.*" The connections were very basic and somewhat stretched, but I brought back the question throughout some of the sessions. Answers were still hard to elicit with occasional answers like Melanie's, "*I don't do math at home.*" Once Brian was able to tell me, "*I have numbers under my bed [magnetic]."* and Joseph was able to say, "*I have numbers on my refrigerator."* This was not an easy connection for many of the students to make and would obviously take some more time to develop.

Numbers + Sets = Math Talk

Recognizing numbers is important, but realizing the value they represent is also a key concept. In order to develop this numeracy skill, the students engaged in many activities that required them to count objects in order to make sets. Bears or cubes or stickers, the goal was the same--link numbers to the same number of objects. At times, I gave the group a number requiring everyone to make the same set. Other times, the students picked their own numbers, and each made a different set. The structure of these activities allowed me the opportunity

to engage in individual conversations to offer support for many skills (counting, tracking, and one-to-one correspondence).

During one activity of creating sets of numbers, Melanie had made a set of four cubes instead of a set of five cubes. She had noted that mistake after she visually compared her set of numbers to the sets of the other group members. The following was the conversation that ensued as the two of us corrected that mistake.

Getting to a Set of Five

Melanie: *"Am I right?"*

Mrs. Greczek: *"Let's check."*

Melanie: *"Let me count again."*

Mrs. Greczek: *"Go ahead."*

Melanie: (She counted the group and realized that there was a mistake) "Take one away."

Mrs. Greczek: *"Go ahead."*

Melanie: (She compared her group to the other groups in the middle and realized there still was difference) *"Take one away."*

Mrs. Greczek: *"Go ahead."*

Melanie: (Comparing again after removing one more). *"Put bigger, more."*

Mrs. Greczek: *"Yes, you're right! Let's count."*

Melanie: *"1, 2, 3* . . . (reaching for another cube) . . . *4 (*reaching for yet another cube)*...5."*

I let Melanie make her own mistakes and helped her work through the situation with her own strategies. It was hard not to interject with the solutions, but this interaction proved more valuable. It allowed Melanie to exercise her own thinking and problem solve the solution. She now had a base experience to recall if she experienced a similar situation.

Playtime!

Concrete manipulatives are an essential component for teaching early numeracy skills. Little hands need to interact with concepts on a hands-on basis. It is often the physical interaction that leads to connections and understanding. For this group of individuals, this positive tool proved to be a negative influence. The site of the manipulatives signaled playtime and distraction on more than one occasion.

Instead of counting objects to make a predetermined set, the students had other focuses. At any given time, students could be found lining the bears into circles, like Andrew, or sorting bears into colored sets like Destiny and Jared. The different colors themselves sparked verbal wars and kidnapping of others' objects because "*I want the blue bears*!" Snap blocks were fashioned into designed figures, like numbers and squares. Brian and Andrew were famous for these constructions and often led some of the others to copy their behavior. The wipe

boards were used as scribble boards--lines, letters and shapes, but not numbers. Despite repeated redirection, some of the students were lost for a portion of the activities. Some of the distraction rose out of boredom and other times out of frustration. Either way, the focus was no longer math based.

The time on task was lost most frequently when I gave one-to-one assistance to students who struggled with the counting sequence, needed help tracking objects when counting, or needed to be challenged with teacher questioning. The individual guided practice and teacher dialogue was essential to skill development, but a source of frustration. It was not a component that I wanted to give up. That was the challenge that I needed to manage with having a group of students with such a wide range of skills.

A Really Big Number

The wide range of skills that the students possessed sometimes led to positive activity extension and number exploration. During one activity, the students had been given a bag of the number tiles six through nine, with the numbers one and zero included. The students matched one of their tiles to the number that I called. After the group matching activity, I conducted individual student checks while all the students practiced writing the numbers on the wipe boards.

On their own, Daniel and Brian started exploring multi-digit numbers. Daniel called out, "*Want to see a really big number*?" He had written the number-

90823 on his wipe board. He asked what that number was, made more "*really big numbers,*" and used the word million in his dialogue.

Brian arranged his numbers into two-digit combinations: 79, 81, 88, and a 27, which he declared as a, *"two-seven."* He made a 91 stating, "*A whole new number!"* and finished with 100 "*A big number.*" In that one instance, both boys transformed the activity to one that they found challenging.

The boys continued a similar extension during another set construction activity. Daniel took his individual sets and numbers and made then into a multi-digit numbers. He wrote 502 and called it *"Fifty two."* His second try resulted in the number 5012041. Not to be outdone, Brian went to work and stated, *"I made a whole new number, 1003."*

This time after watching and listening to Daniel and Brian, Destiny arranged her numbers in a multi-digit format. She offered no dialogue as to her actions, but arranged strings of numbers before her that she treated as a whole unit. I felt that she was not really ready for the talk that the boys engaged in. However, through peer modeling she gained new insights.

Building Skills Together, Once Again

The spirit of community that developed early in the group dynamics expanded over the course of the weekly group interactions. Peers continued to recognize when others needed assistance along the way. They also monitored their own learning on a more regular basis. Teacher questions, posed to one

student became the catalyst for other students' personal reflections and an opportunity for providing peer support. The assistance was accepted readily and easily.

Although some students filled the leadership role more naturally (such as Maria and Ethan), there were no defined boundaries, many students having been on both sides of the assistance exchange. Negative comments, such as Daniel's, "*Only Brian and I know how to count,"* were uttered far and few between and often ignored by fellow group-mates who were hard at work. The dialogue allowed both partners to grow in numeracy understanding and development.

Each day, I was more amazed as I witnessed the math self-esteem grow in each individual. Whether it was the confidence to take a risk in answering a question or admitting to confusion, the peer support brought each child to a new level of skill development and comfort level when working in the realm of early numeracy skills. The following pastiche (see Figure 9), captured some of the many positive interactions that occurred on a daily basis.

You Help Me and I'll Help You

"No 1, 2, 3, 4, 5, 6, 7. It's seven here, two out to make five." "That's right!" (Maria to Natasha)

"No, you need one more." (Nashalise to Vincent)

"You need to take two off" (Ethan to Ishmael)

"You need that one- put it back." "Thanks Ethan." (Ethan to Vincent)

"I'll do it for you." (Joseph to Melanie)

"Need a little help with the six?"(Brian to Jared)

"You need a zero and a one." (Vincent to Ishmael)

Figure 9. Pastiche of Peer Support Dialogue

What's a 9?

Prior to beginning the study, I would have guessed that number recognition was one of the easiest numeracy skills to develop. As it turned out, lack of number recognition was one of the struggles for many of the students. The struggle was most apparent once the activities involved the use of numbers larger than four. Questions like Yasmine's, "*How is a nine?*" and Vincent's, "*How do you make a six?*" surfaced every time I verbally asked a number without showing a model.

Without being able to identify the symbol, the students were unable to complete the task of creating sets. Myself or a peer with a more developed number sense offered assistance to help those students move forward in the task. As the weeks progressed, strategies were developed to aid in figuring out the number names. Students used the number line on the classroom wall and counted forward until the number was reached, counted while seeing a mental number in their head, or wrote numbers on a wipe board until the number was reached. Although not always efficient, these strategies led to independent task completion and closer to a solid independent skill.

Bigger, Smaller, and Equal

Comparison of sizes is another of the important numeracy foundational skills. When planning my methodology, I had decided that I would also be tracking the development of the skill of number comparison with regard to bigger, smaller, more than, and less than when comparing two numbers.

The initial student attempts at comparison were general guesses, like Joseph's justification, "*The four is bigger, it's a big number.*" In that instance, he had no other basis for his statement other than his beginning concept of size and his assumption that four was a large number. He made no attempt to examine the size of the stack of cubes in front of him. He had no experiences in comparing numbers upon which to expand on his statement.

Once the students had practice in making sets to match numbers, I inquired as to the relative size of two numbers. My questions were posed once the students had two sets of objects in front of them. The concrete sets of objects allowed a visual reference for the students and also a discussion reference for me if I needed the students to explain or rethink an answer. In the early questioning, the students relied on those visual representations as the basis for their answers. For example, Vincent gave the reply, "*because it's taller*" when asked why four was bigger than two. Ethan also gave similar answers when he stated, *"It's bigger because it has the biggest line*" and "*It has the shortest line,*" when he compared two sets that he had just created.

As the questioning continued, the answers evolved to the point where students used the terms, more than and less than when comparing the two numbers. Most students consistently picked the correct answer, but all continued to rely on the visual and physical measures of the two groups, particularly when the manipulatives were snap cubes. None of the students, even the ones with the most developed sense of number sense, made the jump to verbalizing that one set had a certain amount of objects more than or less than the other set. When specifically questioned, some could give the answer, but never transferred the knowledge into independent use. At the end of the study, these students needed more direct instruction and modeling of that concept before it could be transferred to the level of an independent skill.

Specific number differences between groups started to become part of the dialogue when students noticed remaining blocks that had not been used to create specific sets of numbers. "*I only have one left,*" and "*I have two more,"* Andrew shared, when he had leftover cubes from putting his number sets into the middle for a teacher check.

The vocabulary term of "equal", although not tracked as a skill, also emerged in the math dialogue of the students. Early on, the students began comparisons with statements like "*It's the same"* from Vincent and Jared's observation of "*They match."* Those statements evolved to teacher prompted terms of equal and eventually individual identification without prompting. Many of the students could even initiate the classification of equal when asked which number was bigger, like Daniel, "*four/ four they're equal.*" They were not tricked by needing to give an answer that did not agree. Numeracy development is underway in another area!

1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and Beyond

It seemed that before I could blink, the last week of activities had arrived. It was the first week of January and the students had just completed a week and one day of holiday break. I hesitantly arrived for the first of the last two intervention days. I was amazed to find that many of the students had not missed a beat. They remembered that we worked with numbers and math. They counted

and identified numbers in my warm-up beautifully! Reassured, I presented the last formal activity prior to post testing.

Individually, I dictated numbers from one to ten for the students to write. Each student was given a separate, random order. I provided models of the numbers if they were unsure since I had not made writing the numbers a frequently practiced activity. It was also not an evaluation point. When all were ready, I gave each child a set of stickers to create object sets to match the numbers. Of the 13 students, 4 of the group had 100% accuracy on the sets (Brian, Daniel, Ethan, and Andrew). I suspect that Maria would also have had a perfect paper if she had not been absent for this activity. My field log had noted that she had many of those practice activities correct in short order! All of the students had at least a few of the numbers correct. Jared had the most difficult time, only getting 2 out of the 10 numbers correct (one and three). His statement of "*Math is hard for me*" from the introduction day had proven to be a prophetic statement. He made gains and his counting skills and tracking were strong, but overall he had the most difficulty (see Table 1 for the complete list of student scores).

It is here the story ends. Challenges had arisen, but only provided another opportunity for instruction. I saw numeracy development and growth on almost a daily basis. The journey was insightful, invigorating and reaffirming as a teacher. It is a journey that I would take again.

Final Activity Results

Student Names	Number Correct out of 10
Ethan	10/10
Brian	10/10
Andrew	10/10
Daniel	10/10
Natasha	9/10
Joseph	8/10
Ishmael	8/10
Melanie	7/10
Yasmine	6/10
Vincent	6/10
Destiny	6/10
Jared	2/10
Maria	Absent

Table 1. Student accuracy for creating sets of objects to matching numbers

DATA ANALYSIS

Data analysis is "the process of bringing order, structure, and meaning to the data, to discover what is underneath the surface of the classroom" (Hubbard & Power, 2003, p. 88). This quote summarizes the underlying purpose of the journey that I have recently completed with the EAP kindergarten students. Since qualitative research is a "recursive process" (Hubbard & Power, 2003, p. 90), my data analysis occurred during the study, through comparisons to educational philosophers, and after the completion of the study. Throughout the process, my question remained the central focus of the inquiry.

Analysis During the Study

Field Log

In order to collect data in a systematic manner, I kept a field log where the specifics of the inquiry process were kept following a day's activities. In addition to the recording of the happenings of the day, I also included reflections or personal insights based on what I had seen. In order to make sense of the observations, I distinguished between my observations and reflections (Bogdan & Biklen, 2002). I read and re-read the data contained in the log to continually gain new sights and allow me to structure my next step while being cognizant of exactly where I was and had been. This allowed me to add more explicit teacher dialogue into the instruction of the activities as well as aid the students in making overt connections to the how numbers related to their everyday life.

Student Work

One of the ways that I gathered multiple points of view during the process (Hubbard & Power, 2003) was to collect student work. At the start of the study I gave all participants the *School Readiness* portion of the *Bracken Basic Concept Scale-Revised (BBCS-R).* This test assesses the basic concept development of children who are in the age range of 2 years 6 months through 7 years 11 months. The test was administered individually, with the concepts presented orally and visually in a multiple choice format. The *School Readiness Composite* is designed to assess many of the concepts that parents, preschool, and kindergarten teachers focus on in the preparation for formal school education (Bracken, 1998). That Composite included the subtest of *Colors, Letters, Numbers/Counting, Sizes, Comparisons, and Shapes.*

Once the protocols were scored, I ranked all the students from highest to lowest with both the overall score as well as the number correct on the *Number/Counting* subtest. That subtest is designed to measure a child's recognition of the single and double digit numerals numbers, as well as sampling a child's ability to count. These scores became the baseline pre-intervention skill set that I would use as a comparison for the end of intervention skill set data.

In addition to the *Bracken,* I gave the students three one-minute math probes--*Number Counting, Number Identification, and Quantity Arrays*--at the start and at the mid-point of the study. Scores on the probes were recorded for

each student as a measuring tool of continuing progress for both group and individual gains.

Finally I collected student recordings of numbers/letters during our school number scavenger hunt as well as a number/quantity association activity completed on the last day of the intervention groups. I examined these pieces for levels of proficiency as well as inter-student trends of mistakes.

Interviews

At the onset of the study, I conducted individual interviews with all of the participants to gain insight into their perceptions about math. These interviews were examined for individual as well as group attitudes.

In addition to the students, I also conducted interviews with the two regular kindergarten teachers as well as the EAP teacher. The purpose of these interviews was to gain third-party perceptions of the students' attitudes and engagement in math activities. This would serve as a pre-intervention perception of math attitudes.

Methodological Memos

At the mi-point of my study, I wrote a methodological memo (Arhar, Holly, & Kasten, 2001) to examine the data and note the progress until that time. This focused examination of my field log allowed me to generate sub-questions for my study, which in turn highlighted new areas of focus for observations. It allowed me to make informed decisions as to the course of the final weeks of the

study and to begin to gain insight into how the data collection was interacting with analysis and interpretation.

Coding

Classifying the data in a continuous cycle was another important analysis tool I utilized. I coded my log (Ely, Vinz, Anzul, & Downing, 1997), creating phrases that identified topics that were emerging in the data. Once the coding was underway, I began indexing the observations (Hubbard & Power, 2003). I created a table of contents that listed the category and the page number of the code, so I would be able to easily access that information at another time. The codes evolved during the study as I was able to refine my thinking and observation skills.

Research Support Group

Teacher-researchers "do not collect data for very long without stopping to reflect, analyze, and reset their insights (MacLean & Mohr, 1999). I regularly engaged in dialogue with my teacher support group to challenge my thinking and help me to refine my coding process and identify my emerging themes.

Analysis Through Comparisons to Educational Philosophers

In order to analyze my study with a wider educational lens, I wrote several analytical memos that connected my study to the works of some of the educational philosophers. Through the reading and digestion of the works of John Dewey, Paolo Freire, Lisa Delpit, et al., and Lev Vygotsky, I was able to connect quotes underlying their educational view to occurrences in my intervention

groups. That serious reflection allowed me gain further insights to the happenings in my study.

Analysis After the Study

Student Work

At the conclusion of formal intervention activities, I gave all participants the *School Readiness* portion of the *Bracken Basic Concept Scale-Revised.* Once the protocols were scored, I ranked the students from highest to lowest with both the overall score as well as the number correct on the *Number/Counting* subtest. These scores became the outcome intervention skill set that I used as a comparison to the scores achieved during the pre-intervention testing. I created a graph comparing each student's pre- and post scores.

In addition to the *Bracken,* I gave the students three one-minute math probes--*Number Counting, Number Identification, and Quantity Arrays*. Scores on the probes were recorded for each student and were added to the data from the pre-and mid intervention points and used to make statements as to the overall level of student progress.

Interviews

At the end of the study, I conducted individual interviews with all of the participants to gain insight into their perceptions about math. These interviews were examined for individual as well as group attitudes and compared to the

comments that had been made prior to the intervention activities. The comments were examined for changes in attitude, both positive and negative.

In addition to the students, I also conducted post-interviews with the two regular kindergarten teachers as well as the EAP teacher. There comments were compared to their pre-interview questions and examined for changes in student attitude and engagement, both positive and negative.

Literacy Devices Analysis

In telling the story of my study, I utilized the literary devices of three pastiches, one drama, and one poem to allow me to undercover underlying meanings in the pages of my field log. The devices afforded me the opportunity to see beyond the surface language of the words that I had recorded and reflected upon during the course of the study.

Bins and Themes

Once I had completed all of the above on-going data analysis, I created a system of bins to group my codes into overarching areas to organize recurring patterns within the data (Ely, Vinz, Anzul, & Downing, 1997). In order to arrange the bins I used a graphic organizer to visually layout how I see all of the areas connecting (see Figure 10).

After ongoing reflection, themes emerged from my data collection that will be discussed in the findings section.

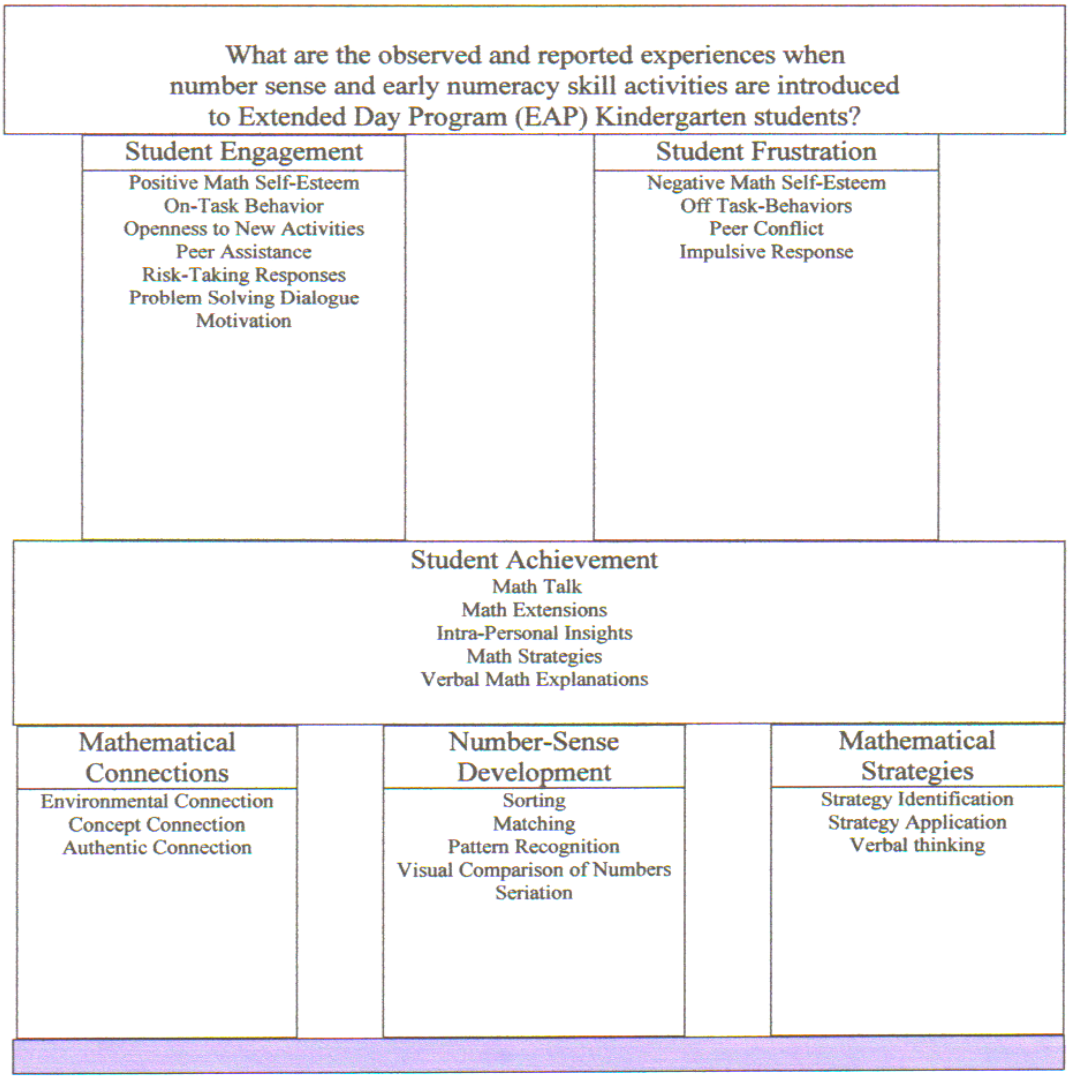

Figure 10. Graphic Organizer of Bins and Themes

FINDINGS

Introduction

In teaching students of poverty, educators must first begin with the basic belief that all students are learners. If achievement is lacking, an examination of the method of instruction must be investigated and questioned. The answer to the lack of success is not the notion that there is an incapability to learn. There may be a lack of experiences and a lack of background knowledge and language that make the learning more difficult, but learning will still occur. It becomes the school's job to provide the experiences necessary to bridge the gap between what is already known and the pieces necessary for progress to continue. As Purcell-Gates (2002) states: "First, and most obvious, teachers and schools must accept, believe, and act upon the belief that *children of poverty are learners, have been learning since birth, are ready to learn at anytime, and will learn*" (pg.135).

It is with this notion firmly planted that the journey on the road of exploration in early numeracy and number sense skills comes full circle back to the beginning and the question: **What are the observed and reported experiences when number sense and early numeracy skill activities are introduced to Extended Academic Program (EAP) kindergarten students?**

The Data Tells the Story

Using the *Bracken Basic Concept Scale-Revised* as an independent measure, 12 out of 13 students showed an increase on the overall *School*

Readiness Composite (see Figure 11). Melanie was the only student whose overall score dropped five points; however, both of her scores fell within the *Average Range (85-114)*.

One student, Jared, slightly improved his score within the *Very Delayed Range* (69 and below). One student, Yasmine, improved her score from the *Very Delayed Range (69 and below)* into the *Delayed Range (70-84)*. Two students, Maria and Daniel, improved their scores within the *Delayed Range (70-84).* Five students--Vincent, Natasha, Ishmael, Destiny, Joseph--moved from within the *Delayed Range (70-84)* into the *Average Range (85-114).* Two students, Andrew and Brian, improved their scores within the *Average Range* (85-114). Finally, one student, Ethan, moved from within the *Delayed Range (70-84)* into the *Advanced Range* (116 and above).

In addition to the individual changes noted above, there are also some positive improvements that can be discussed in relation to the group as a whole. Prior to the start of the intervention, the group average on the *School Readiness Composite* of the *Bracken Basic Concept Scale-Revised* was a standard score of 81.2 with a median score of 81. At the conclusion of the intervention, the group average was a standard score of 92.3 with a median score of 92. These scores resulted in a positive change of an average of 11.1 points per student.

The above described positive responses to the early intervention that these at-risk kindergarten students received throughout the EAP portion of the school

day are similar to the beginning gains that have been noted in the long-term work of Ramsey and Ramsey (2004), the regression study of Roth et al. (2000) and the longitudinal study of Yao and Hearn (2003).

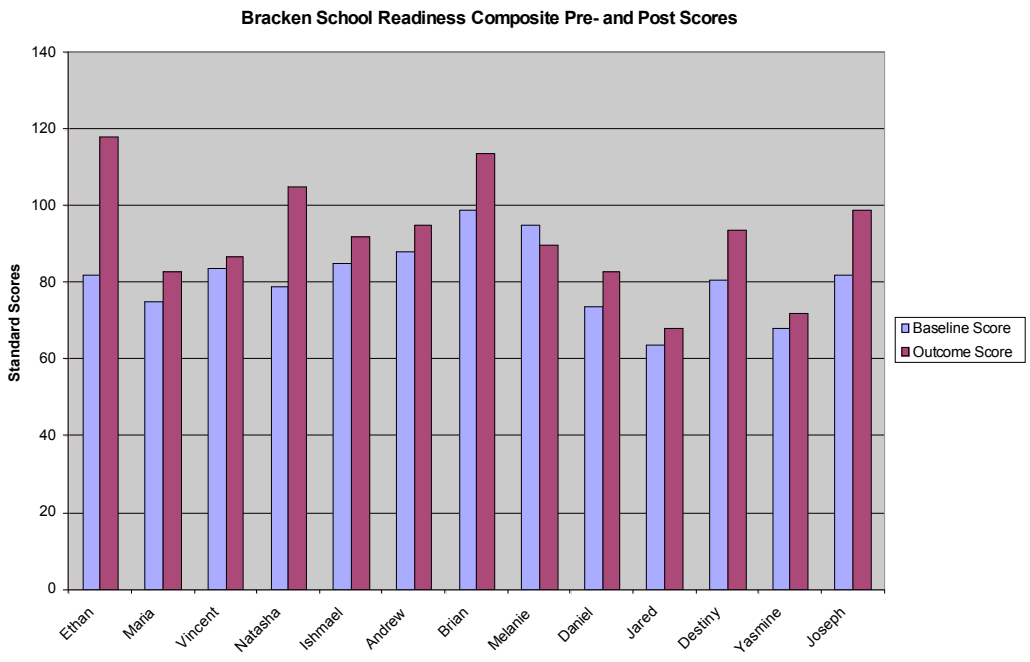

Figure 11. Bracken School Readiness Composite Pre- and Post Scores

The student scores on the *Numbers/Counting Subtest* of the *Bracken Basic Concept Scale-Revised* are a further measure of the positive response to the number sense and early numeracy skill activities utilized within this study. Twelve out of the thirteen students showed an increase in the number of correct

responses on that specific subtest (see Figure 12).

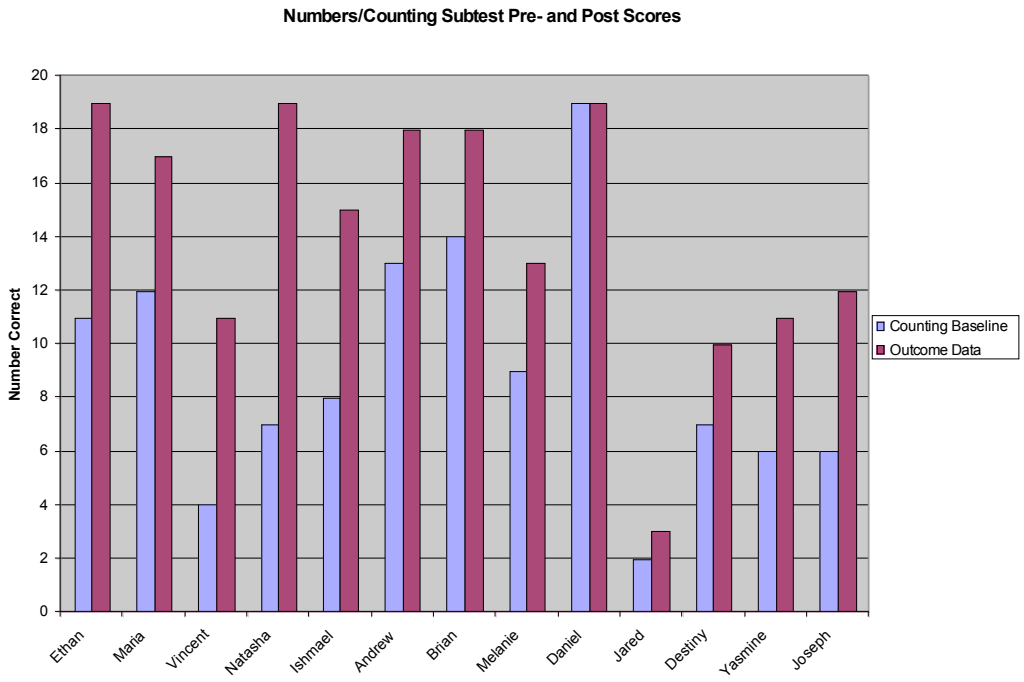

Figure 12. Numbers/Counting Subtest Pre- and Post Scores

Daniel was the only exception to showing an increase and that was due to the fact that he had all 19 responses correct during the baseline testing. Student responses increased between 0 and 13 more correct responses, and reflected both improvement in number recognition and the counting objects.

In addition to the individual changes noted above, there are also some positive improvements that can be discussed in relation to the group as a whole. Prior to the start of the intervention, the group average on the *Numbers/Counting Subtest* of the *Bracken Basic Concept Scale-Revised* was a score of 9.1 correct out

of 19 correct with a median score of 8. At the conclusion of the intervention, the group average was a score of 14.2 out of 19 correct with a median score of 15. These scores resulted in a positive change of an average of 5.1 more questions correct per student. Six students had two or less incorrect, which was a change from only one student in that range prior to the intervention.

The improvements noted in overall ability are similar to Jordan et al.'s (2006) findings of number sense improvements when working with low income Kindergartners, and Pasnak et al.'s (1991) positive response with small group kindergarten intervention in the areas of classification, seriation, and conservation. Students this age, regardless of previous background knowledge, have been found to be responsive to direct instruction and intervention. My findings were not surprising in the light of these other two studies.

In addition to the underlying improvement in number sense and numeracy development in the tracked areas--oral counting, number recognition and object counting--a variety of themes emerged throughout my field log.

Number Sense Development

Kindergarten students build foundational mathematical knowledge through the continuous development of the skills of sorting, matching, pattern recognition, number recognition, and seriation.

Number sense development does not happen in a linear fashion. Each underlying skill--rote counting, tracking, one-to-one correspondence, number

recognition, more than, less than, bigger, smaller, and number-object correspondence--develops on its own accord and separate to one another. Each student has a unique set of individual strengths and weaknesses that grows at its own rate through new experiences and reinforcement of current skills.

The varying rates of improvement among the 13 participants gave evidence to underscore this point. Individual student progress on the *Number Identification Probe* (see Figure 13), the *Oral Counting Probe* (see Figure 14), and the *Quantity Arrays Probe* (see Figure 15) showed that each student had different area of strengths and weaknesses, while still generally showing an upward trend of progress in each area.

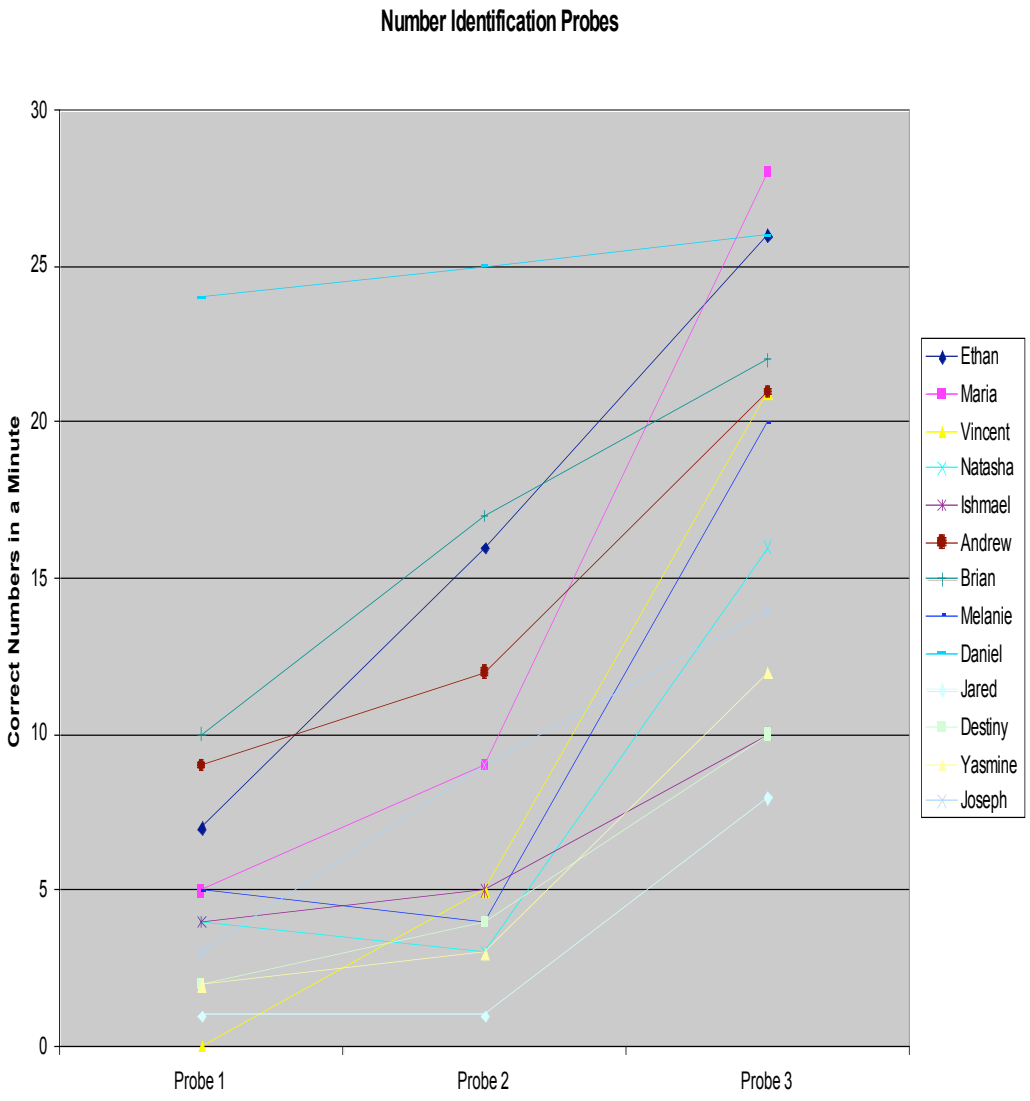

Figure 13. Number Identification Probe Progress

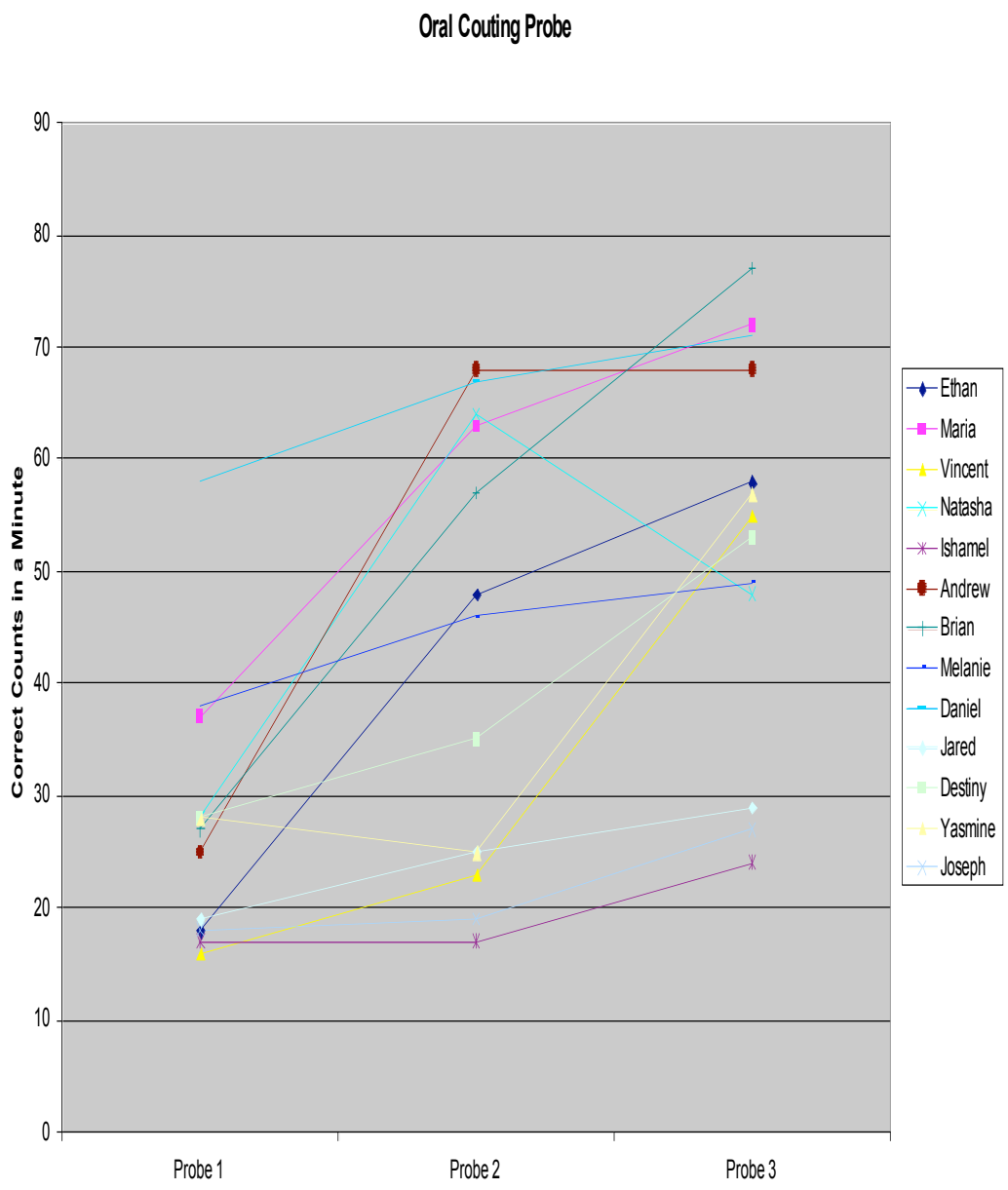

Figure 14. Oral Counting Probe Progress

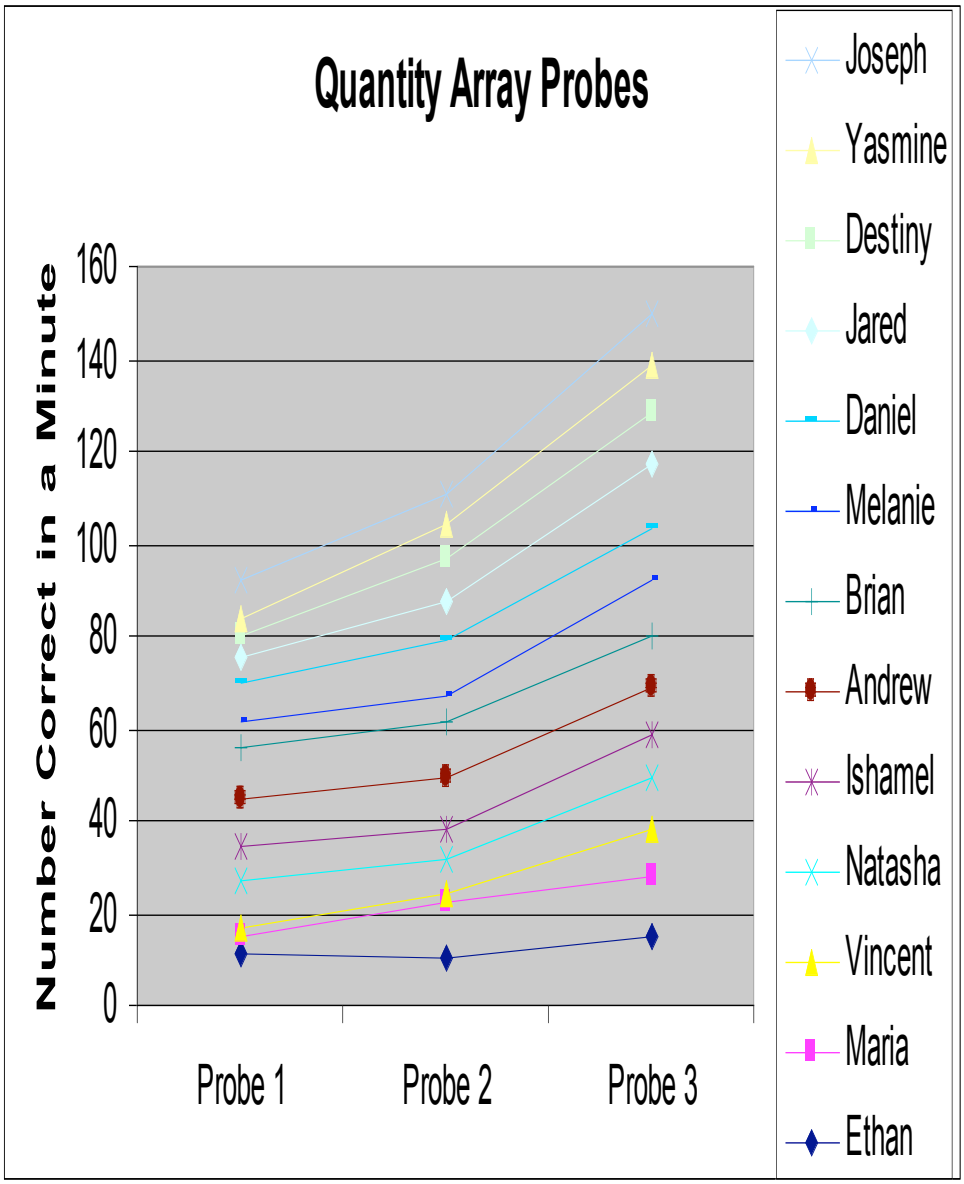

Figure. 15 Quantity Arrays Probe Progress

Jared is the best example of the wide range of individual skills. Of all the students, he experienced the least overall growth, as measured by the *Bracken Basic Concept Scale-Revised* on both the *School Readiness Composite* and the *Number/Counting Skills Subtest.* His overall rate of growth, particularly with number recognition, was almost nonexistent. He started the intervention knowing the number one and ended the intervention solidly knowing only the number one. However, his rote counting skills and tracking skills far surpassed Melanie's when counting sets of objects. At the end of the intervention she still regularly counted objects more than once despite the fact that her scores on the *School Readiness Composite* of the *Bracken Basic Concept Scale-Revised* began and ended in the average range.

It is the continual working within this range of skills that allows each area to develop and build connections between the other skill subsets. For example, increasing number recognition led the students to spontaneously take the number tiles they worked with and arrange them in sequential order. Matching numbers that look the same like Daniel's, "*four/ four they're equal*" led to the understanding of more the complex numeracy skill of equality.

Student Achievement

Kindergarten students demonstrate the ability to engage in math-based conversations, verbalize mathematical strategies, and extend the base activity while cognitively monitoring their learning.

Freire (2006) tells us that **"**Without dialogue there is no communication, and without communication there can be no true education**"** (p. 93). His notion of dialogue was a cornerstone of our early numeracy and number skills activities. That on-going dialogue led to numerous math-based conversations that were critical in facilitating skill advancement.

Math has its own language and vocabulary that needs to be taught (Adams, 2003). In order for that language to be verified, there needed to be open dialogue occurring regularly between myself and the students. It was the dialogue that allowed me to check for understanding and see if the teacher-student interaction was leading towards educational growth.

One clear illustration of this power of dialogue in action was a one-to-one conversation in which Melanie and I took a set of four objects and turned it into a set of five. Melanie used the math talk and strategy of *"take one away"* twice before she realized that she needed *"to put bigger, more"* and add more bears to the set. The think aloud format within this math-based activity (Gifford, 2004) was a critical component to the teacher dialogue.

The students cognitively monitored their learning, advancing from the stage of recognizing when they did not know an answer to the point where they checked their own work before looking to the teacher for assistance.

Mathematical Connections

Kindergarten students are able to make mathematical connections between different math concepts, their environment, and their everyday life.

Vygotsky (1978) tells us that "learning and development are interrelated from the child's very first day of life" (p. 84). It was crucial to have acknowledged the learning that had already occurred prior to beginning the intervention and use that information as the connection point to teach the new information that was being introduced. By working with kindergarten students on the early numeracy and number sense activities, the students began to mold the ideas that already existed into a format that was congruent with the activities that occurred during the math portion of the school day.

Connections to other math concepts served as the stepping stones for skill development. The students were able to use their math experiences to build bridges from one activity to the next. The concepts of sorting often by color and seriation were a comforting way for the students to have begun working with manipulatives in front of them as they completed the tasks for the day, often building number sets. By relying on their previous knowledge, they created their own concept bridges and solidified some of the developing numeracy concepts.

Personal life connections also served a similar purpose. As the study progressed, references to their own age and the age of siblings surfaced in reference to numbers being discussed during the group activities. Those

discussions led to the use of fingers to represent the number. Once the symbol of the number had personal significance, a powerful anchor for remembering the name of the numeral was in place.

Throughout the intervention time frame, the students' awareness of numbers and their place in their larger environment became keener. Connections began in the classroom environment with exclamations such as Vincent's, *"Mrs. Greczek, I see a number!"* His familiarity with numbers grew stronger simply by recognizing a number on the chart that was hanging on a portable easel in his classroom. By the end of the intervention time frame, all of the students, during the post intervention interviews, could tell me that they were able to locate numbers in school (on the walls in the classroom, the doors, in the hallways just to name a few). For some the students, the recognition was even extended to the larger environment. Number locations outside of the school walls included Daniel's *"on the phone"* and "*on my mailbox",* Brian's, *"on the bus"*, Andrew's, *"in the back of the truck* (meaning the license plate), and Maria's, *"on the cards".* This recognition was very different from the wall pointing and shoulder shrugs that I generally received during the initial pre-intervention interviews.

Mathematical Strategies

Kindergarten students strengthen early numeracy skills through the internalization and frequent practice of mathematical strategies that aid in counting, numerical comparison, and number identification.

Repetition and repeated practice is one way that strengthens the internalization and true understanding of new concepts. The small group intervention and repeated nature of the activities allowed the students to improve on many of the underlying numeracy skills.

Specific tracking strategies that could be verbalized allowed the students to improve their one-to-one correspondence. Recognizing tracking strategies and giving them names, such as Vincent's, *"You put them together"*; Maria's, *"You pushed it out" and "You put them in order";* and Destiny's *"You can stick them together"* allowed the students to focus more intently on the seemingly easy task of counting. Double counting one object haphazardly eventually evolved to the point where some of the students monitored their counting by stopping along the way and recounting the sets that they were building. Whether checking their point in the rote counting sequence or which object was last counted, they continually built upon the complexity of their mastered skills.

The visual aspect of measurement became the cornerstone for the development of the numerical comparisons. In the early questioning, the students relied on those visual representations for the basis of their answers. For example, Ethan stated, *"It's bigger because it has the biggest line*" and "*It has the shortest line*", when he compared two sets that he had just created.

As the questioning continued from day to day, the answers evolved to the point where students used the terms, more than and less than when comparing the

two numbers. All continued to rely on the visual and physical measures of the two groups, particularly when the manipulatives were snap cubes. None of the students, even the ones with the most developed sense of number sense, made the jump to verbalizing that one set had a certain number of objects more than or less than the other set.

This realization that the students needed the physical/visual representation of two numbers came as no surprise given, Vgotsky's (1978) observations that "experiments and day-to-day observations clearly show that *it is impossible for very young children to separate the filed of meaning from the visual field* because there is such intimate fusion between meaning and what is seen" (p. 97).

As number recognition skills increased throughout the intervention time frame, so did strategies for naming the still unknown. Rather than simply looking at an unknown number, shrugging a shoulder, saying *"I don't know",* or looking to a peer for assistance, the students had begun to use their environment and the knowledge that had been learned. Students used the number line on the classroom wall and counted forward until the number was reached, counted while seeing a mental number in their head, or wrote numbers on a wipe board until the number was reached. Although not always efficient, it led to independent task completion and closer to a solid independent skill.

Student Engagement

Teacher-to-student and student-to-student interactions in small group format allows kindergarten students to engage actively in hands-on-activities, offer and accept peer assistance, engage in risk-taking responses and problem solving, and remain open to new experiences while acquiring a positive math self-esteem.

Teacher-to-student and student-to-student interaction was an essential component of the intervention activities. Dewey (1997) shared that "the essential point is that the purpose grow and take shape through the process of social intelligence" (p. 72). It is that dialogue that fostered the engagement in the hands-on-activities and the social benefits that arose from the on-going interactions.

The safe and non-judgmental tone of the group allowed the students to actively offer and accept peer assistance. Ishmael's statement of, *"I don't know how to make a 5",* and Maria's response of *"Here let me show you"* during the second week of the study, were frequently mirrored in similar exchanges. I heard the students use expressions like *"No, you need one more"* (Natasha to Vincent); *"You need to take two off"* (Ethan to Ishmael); *"You need that one- put it back." "Thanks Ethan."* (Ethan to Vincent); ***"****I'll do it for you"* (Joseph to Melanie). These exchanges demonstrated that the students were willing to take a risk with the mathematical language in a format that was helping all engaged in the conversation to expand his or her working knowledge of numbers.

The daily exchanges also enabled the students to gain a positive math self esteem. In the post-intervention interviews, 10 of the 13 students reported that they liked math and 12 out of 13 students reported that they could count. Daniel even went so far as to say that he could count *"to 10, 000."* Every student could identify one math activity that was their favorite, whether it was writing numbers, counting, or using blocks to count. Even the three students who indicated that they did not like math were able to share a favorite math activity. The frustration over a lack of skills had not yet reached a paralyzing point. Fostering positive experiences at this early age allowed the students to see numbers and the number world in a positive light. Each had found some success that made the journey worth taking.

Student Frustration

Participation in small group number sense and early numeracy skills activities may lead to impulsiveness, peer conflicts, and off-task behaviors when there is too great of an instructional mismatch between group participants.

With the positive aspects of any intervention, there is also a negative side. Since the students that comprised the intervention group were not chosen based on math deficits, but rather reading deficits, there was a wide range of skills prior to beginning the early numeracy and number sense activities. This wide range of

competencies at times led to frustration, impulsiveness, and boredom by some of the group members.

The manipulatives that were an important part of creating the multi-sensory input (Seo, 2003) during the learning activities, at times became one source of the off-task behavior. Instead of counting objects to make a predetermined set, the students had other focuses. At any given time, students could be found engaged in play using the manipulatives. Some conducted conversations between the bear counters, while others turned the snap cubes into works of art that included more parts than the number of cubes that the students were directed to have used.

Arguments, although rare, broke out from time to time. Students argued over the colors of the manipulatives, "*I want the blue bears*!", and engaged in side conversations and interactions that led to hurt feelings, such as Melanie saying, *"He made a mean face!"*

The gap in skills also led to an overt recognition of competency differences by those who were making the slowest progress. Two of the most heart-wrenching acknowledgments were Jared's intermittent statements of "*Math is hard for me*" and Joseph's final interview statement that he doesn't like math "'*cause it's too hard, a little bit for me*." Although the higher-skilled peers provided a role model and helped to facilitate learning, they also served as the example of what has not been learned.

Delimitations

This study was conducted on a small group of students (13) who were seen in a tutorial format by an instructor other than the classroom teacher. These students were not chosen because of their math deficits, but were already part of a tutorial program for their reading deficits. Due to invitation criteria, the range of math skills varied at the start of the intervention. All students received the same activities, subsequently resulting in students working at their frustrational level, instructional level, and independent level concurrently. Any missed activities from absences were not made up, with the exception of baseline and outcome testing.

Because of these limitations, generalization of these findings to both small group intervention and whole group interventions should be made with caution.

Conclusion

Through the introduction of number sense and early numeracy activities to EAP kindergarten students, the students realized an increase in skills of rote counting, number recognition, and number-object set correspondence as evidenced by scores on the *Bracken Basic Concept Scale-Revised* , *Number Identification Probe, Quantity Arrays Probe, and Oral Counting Probe*. Field log analysis showed that students engaged in math dialogue and risk-taking behaviors when answering questions. It further showed that the students positively gave and accepted peer assistance while making mathematical connections to their

environment, personal lives and other math activities. The students generally showed ever-increasing positive math self-esteem, as evidenced by individual post-interview responses.

Most importantly, the students seemed to have developed an attitude that the mathematical world is one they are willing to enter and actively participate when supported through social interaction. Joseph summed it up best when he qualified his answer to not liking math as, *"I don't like it, but I will do it."* These kindergarteners are beginning their mathematical journeys with, in Dewey's (1997) words, "the most important attitude . . . the desire to go on learning" (p. 48).

NEXT STEPS

The driving force for conducting this study was to determine the place of early numeracy interventions in the *Response to Intervention* (RTI) model that my school is beginning to put in place through our *Instructional Support Team* (IST). It is with that feeling in mind that I have made my first reflections.

The first immediate result was placing Jared into the formal IST process. His instruction in the EAP portion of the school day, coupled with the numeracy activities of this study, matched the Tier II intervention intensity that have been described in the current literature (Bradley, et al., 2005). His progress had compared to those of his fellow group mates and warranted more intense support. At this time he is receiving an additional math intervention in a one-to-one format for 15 minutes a day, five days a week in our math lab. His progress is being monitored and he will be coming to our team shortly for a check on his progress. Ishmael and Yasmine, after further monitoring, are also about to begin the IST process because of their continuing inconsistent skill acquisition. For all three of these students, this study was one of the catalysts for documenting intervention and the need for more intensive intervention at this early age.

In examining the structure of the study, there were some areas that warrant change. The varying levels of mathematical ability, at times became a source of frustration and boredom for some of the participants. In a subsequent study, I

would gather baseline data and then group students according to type and degree of need. That format may better address the needs of more of the participants.

Another area to change would include a switch to a number recognition protocol strictly for the numbers 1-10 for use during the first part of the study. I found that the *Number Recognition Probe* protocol that I used was distracting for many of the students during the first two administration points. Numbers greater than ten were far beyond the skill level for many of them given the extent of their deficits.

The implications of the progress monitoring tools would also be addressed in a more productive format. This study did not allow for instructional changes to be made based on the monitoring results. Alternatives for more intense remediation would be part of the methodology since changes based on personal growth have been found to be an effective tool for change (Stecker and Fuchs, 2000).

Another possible avenue to research would be to investigate the effects of using progress monitoring instruments such as *Number Identification Probe, Quantity Arrays Probe,* and *Oral Counting Probe* or others, as a screener for those students who may need more intense intervention. The students with the most deficit scores could be targeted for intervention in small group format similar to the one used in this qualitative study.

Kindergarten is the gateway into the formal school experience for many students. Those crucial first experiences lay the foundation for all future interactions within the mathematical world. By helping the children to make overt connections to the skills they are learning from one activity to another, early numeracy activities aid in the development of the multiple specialized abilities that develop the overall number sense knowledge that is crucial to higher level mathematical skills. A difference can be made through the targeted early intervention in this area.

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Number Identification Probe. Research Institute on Progress Monitoring.

Quantity Arrays Probe. Research Institute on Progress Monitoring.

Appendix A

May 18, 2006

Dear[redacted]

During this school year (2006-2007), I will be taking classes towards the completion of a Masters degree in Curriculum and Instruction at Moravian College. These classes are the conclusion of many classes that have been helping me stay in touch with the most effective methods of teaching in order to provide best the learning experiences for students at [redacted].

Moravian's program requires that I learn to conduct a systematic study of my own teaching practices and complete an action research study prior to degree completion. During this action research study I will be focusing on developing early numeracy skills in Kindergarten students. Creating a solid foundation upon which future math skills can be connected is one of the key goals of the Kindergarten math curriculum. By building excitement and a sense of mathematical confidence, I hope to foster positive mathematical experiences.

As part of my study, I will be observing and reflecting on the mathematical skills that the children will be gaining. I will be monitoring academic progress closely and keeping some work samples. The students will also be interviewed at the beginning and the end of the study to gain insight into any positive changes that may be occurring.

All the children will be participating in a 15-minute math intervention group during the EAP portion of the day, two times per week. These activities will become part of the weekly curriculum in which all students will be participating. However, participation in my study is voluntary and will not affect any child's assessment on the quarterly progress reports. Any child may withdraw at any time. If any child is withdrawn, I will not use any information pertaining to that child.

All of the children's names will be kept confidential. Neither the children's names, nor the names of any faculty member, teacher, or the school will appear in any written report or publication. All research material will be secured in my home.

My professor is Dr. Charlotte Zales. She can be reached at Moravian College by phone (610) 625- 7958 or e-mail at crzales@moravian.edu

If you have any questions or concerns about my study, please feel free to contact me at school by phone [redacted] or email at [redacted] If not, please sign and return the bottom portion of this letter. Thank you for your help.

Sincerely,

Stephanie M. Greczek

Stephanie M. Greczek

I attest that I am the principal of the teacher participating in this study, and that I read and understand this consent form, and received a copy. Stephanie M. Greczek has my permission to conduct this study at [redacted]

Signature:_____

Date:_____

Appendix B

1 7 4 2

MORAVIAN COLLEGE

October 19, 2006

Stephanie Greczek
520 Meadow Lane
Pennsburg, PA 18073

Dear Stephanie Greczek:

The Moravian College Human Subjects Internal Review Board has accepted your proposal: "The Effects of Number Sense and Early Numeracy Skill Activities in Extended Day Kindergarten Students." Given the materials submitted, your proposal received an expedited review. A copy of your proposal will remain with the HSIRB Chair.

Please note that if you intend on venturing into other topics than the ones indicated in your proposal, you must inform the HSIRB about what those topics will be.

Should any other aspect of your research change or extend past one year of the date of this letter, you must file those changes or extensions with the HSIRB before implementation.

This letter has been sent to you through U.S. Mail and e-mail. Please do not hesitate to contact me by telephone (610-861-1415) or through e-mail (medwh02@moravian.edu) should you have any questions about the committee's requests.

Debra Wetcher-Hendricks
Chair, Human Subjects Internal Review Board
Moravian College
610-861-1415

Appendix C

October 23, 2006

Dear Parents,

During this school year (2006-2007), I will be taking classes towards the completion of a Masters degree in Curriculum and Instruction at Moravian College. These classes are the conclusion of many classes that have been helping me stay in touch with the most effective methods of teaching in order to provide best the learning experiences for students at [redacted]

Moravian's program requires that I learn to conduct a systematic study of my own teaching practices and complete an action research study prior to degree completion. During this action research study I will be focusing on developing early numeracy skills in Kindergarten students. Creating a solid foundation upon which future math skills can be connected is one of the key goals of the Kindergarten math curriculum. By building excitement and a sense of mathematical confidence, I hope to foster positive mathematical experiences.

As part of my study, I will be observing and reflecting on the mathematical skills that your child is gaining. I will be monitoring academic progress closely and keeping some work samples. The students will also be interviewed at the beginning and the end of the study to gain insight into any positive changes that may be occurring.

All the children will be participating in a 15-minute math intervention group during the EAP day, two times per week. These activities will become part of the weekly curriculum in which all students will be participating. However, participation in my study is voluntary and will not affect your child's assessment on the quarterly progress reports. Your child may withdraw from the study at any time. If your child is withdrawn, I will not use any information pertaining to your child.

All of the children's names will be kept confidential. Neither your child's name, nor the name of any student, faculty member, teacher, or public school will appear in any written report or publication. All research material will be secured in my home.

My professor is Dr. Charlotte Zales. She can be reached at Moravian College by phone (610) 625- 7958 or e-mail at crzales@moravian.edu.

Our principal, [redacted], supports my coursework and may be contacted at [redacted].

If you have any questions or concerns about my study, please feel free to contact me at school by phone [redacted] or email at [redacted] If not, please sign and return the bottom portion of this letter. Thank you for your help.

Sincerely,

Stephanie M Greczek

Stephanie M. Greczek

I attest that I am the student's legally authorized representative and that I read and understand this consent form and received a copy.

Legal representative signature:_____

Child's name:_____

Date:_____

Appendix D

October 23, 2006

Dear Colleague,

During this school year (2006-2007), I will be taking classes towards the completion of a Masters degree in Curriculum and Instruction at Moravian College. These classes are the conclusion of many classes that have been helping me stay in touch with the most effective methods of teaching in order to provide best the learning experiences for students at [redacted].

Moravian's program requires that I learn to conduct a systematic study of my own teaching practices and complete an action research study prior to degree completion. During this action research study I will be focusing on developing early numeracy skills in Kindergarten students. Creating a solid foundation upon which future math skills can be connected is one of the key goals of the Kindergarten math curriculum. By building excitement and a sense of mathematical confidence, I hope to foster positive mathematical experiences.

As part of my study, I will be observing and reflecting on the mathematical skills that your EAP students are gaining. I will be monitoring academic progress closely and keeping some work samples. The Kindergarten teachers will also be interviewed at the beginning and the end of the study to gain insight into any positive changes that may be occurring.

Participation in my study is voluntary. Your may withdraw from the study at any time. If you are withdrawn, I will not use any information pertaining to your comments and sights that were drawn from the teacher interviews.

Your name will be kept confidential. Neither your name, nor the name of any student or other faculty member, or our school will appear in any written report or publication. All research material will be secured in my home.

My professor is Dr. Charlotte Zales. She can be reached at Moravian College by phone (610) 625- 7958 or e-mail at crzales@moravian.edu.

Our principal, [redacted] supports my coursework and may be contacted at [redacted]).

If you have any questions or concerns about my study, please feel free to contact me at school by phone [redacted] or email at [redacted] if not, please sign and return the bottom portion of this letter. Thank you for your help.

Sincerely,

Stephanie M Greczek

Stephanie M. Greczek

I attest that I am one of the Kindergarten teachers participating in this study, and that I read and understand this consent form, and have received a copy.

Signature:_____

Date:_____

Appendix E

October 24, 2006 page_____

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92

Appendix F

Teacher Interview Form

1. **Students actively participate in the following types of math activities**

2. **Students do not actively participate in the following types of math activities:**

3. **Students engage in the following math-based conversations during the school day:**

4. **Students use the following math based strategies :**

5. **Students help each other during math based activities by:**

Appendix G

Individual Interview Form

1. **Do you like math? Why or why not?:**

2. **My favorite thing to do in math is:**

3. **My least favorite thing to do in math is (what I don't like):**

4. **I count things when:**

5. **I can find numbers in the following places:**

6. **I can count:**

7. **I like to do math:**

Appendix H

ABCs	123s