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Insert references in appendix A of this document. Insert tables and graphics in appendix B. Do not insert them into the body of the abstract.

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[*] Mosteller, F., Nave, B., & Miech, E. (2004). Why we need a structured abstract in education research. *Educational Researcher, 33(1),* 29–34.

Abstract Title Page

Not included in page count.

Title: The Role of Cognitive Strategy and Direct Instruction in Enhancing Kindergarten Students' Learning of Number Sense

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Abstract Body

Limit 5 pages single spaced.

Background/context:

Students with mathematics difficulties experience a wide range of problems related to learning and applying mathematics. Compared to typically achieving students, children with a mathematics learning disability, or those at risk for mathematic failure, are deficient in three areas of mathematical cognition: (1) the ability to retrieve number facts from long term memory, (2) the ability to solve word problems, and (3) the ability to organize, monitor, and evaluate information (e.g., Mercer, 1997; Paulos, 1990). These difficulties in mathematics usually emerge early and may persist throughout adulthood. Research indicates that at least 6.4% of American school-age children encounter some type of learning problem in mathematics (e.g., Bryant, 2005; Geary, 2004; Griffin &Case, 1997; Kroesbergen & Van Luit, 2003).

Mathematics competence is largely a function of appropriate and effective instruction (Berch &Mazzocco, 2007; Gersten, Jordan, Flojo, & Jonathan, 2005). Knowledge about the structure of number system is necessary for students to perform computations in flexible and creative ways and is a major component of the mathematics curriculum in elementary and middle school. Despite the importance, there is insufficient research to inform us about instructional approaches that best address the needs of students at risk for mathematics difficulties (Francis, Rivera, Lascaux, Kieffer, & Rivera, 2006). Traditionally, mathematics instruction in special education has emphasized mastery of algorithms and repeated practice (Gersten & Chard, 1999). As a result, children have a superficial and procedurally based understanding of mathematics, rather than a deep appreciation of its structure and knowledge (Hiebert, 1986; Resnick, 1987; Schoenfeld, 1987). Research indicates the importance of teacher-mediated explicit strategy instruction combined with open-ended problem solving to help students understand the big ideas of number sense (Kroesberger & Van Luit, 2003; National Research Council, 2001). Similarly, there is evidence that early intervention can prevent significant difficulties for many learners (Berch, Mazzocco, & Michele, 2007; Gersten, Jordan, Flojo, & Jonathan, 2005), and number sense is one of the most important skills necessary for students to succeed with basic mathematical computations in the early grades (e.g., Berch, 2005).

Purpose / objective / research question / focus of study:

Given that problems with number sense may have a causal influence on students' math learning difficulties and there is a lack of empirical studies that have examined the effectiveness of number sense interventions for kindergarten students with math difficulties, the purpose of the present study was to evaluate the effectiveness of number sense instruction on the acquisition and maintenance of mathematics competence by kindergarten students.

Setting:

This research took place in an elementary school, located in a suburban school district in northeast Pennsylvania, participated in this study.

Population / Participants / Subjects:
Kindergarten students from five classrooms in one elementary school, located in a suburban school district in northeast Pennsylvania, participated in this study. Consent forms were sent to all students in the five classrooms (N =107). Three students did not receive parental consent to participate in the study and three students moved to a different school in the middle of the study. Therefore, the final sample consisted of 101 students. Sixty-one students from three classrooms comprised the number sense + general classroom instruction (NS + GCI) group and 40 students from two classrooms were in the general classroom instruction (GCI) group. Students in the intervention group received instruction based on the number sense program; whereas, students in the comparison group continued to receive mathematics instruction from the district adopted curriculum.

Intervention / Program / Practice:
The number sense program designed for this study was based on the big ideas of number sense which included number relationships (spatial relationships, one more, one less, two more, and two less, benchmarks of five and ten, and part-part whole relationships) (Van de Walle, 2007). In addition, this program adopted a combination of explicit and cognitive instruction and followed the model, lead, guided practice, and independent practice instructional paradigm that allowed for the development of both procedural and conceptual knowledge (Gersten & Chard, 1999; Kame'enui & Carnine, 2002; Robison, Menchetti, & Torgesen, 2002; NCTM, 2000). The program consisted of four units and each unit focused on the four big ideas of number sense: (a) spatial relationships, (b) one more, one less, and two more, and two less, (c) benchmarks of five and ten, and (d) part-part whole relationships.

Instruction for students in the comparison group was derived from the district adopted commercially published reform based mathematics textbook, *Investigations in Number, Data, and Space (Investigations).* This curriculum is organized into six units that offer three to eight weeks of mathematical work in number, data analysis, and geometry. Some of the topics covered include pattern trains and hopscotch path; collecting, counting, and measuring; counting ourselves and others; making shapes and building blocks; benchmarks; addition and subtraction; how many in all; and data analysis.

Measures

All participants completed: (a) the Stanford Achievement Test -10 (SAT10) and a set of Early Numeracy-Curriculum Based Measures (EN-CBM) and Number Sense Measures prior to the intervention (pretest), (b) the EN-CBM and Number Sense Measures at posttest immediately following instruction, and (c) the EN-CBM and Number Sense Measures as the maintenance test three weeks after termination of the instruction.

The SAT 10 is a norm-referenced, group administered achievement test with adequate reliability and validity. The kindergarten test of the SAT 10 –Stanford Early Achievement Test (SESAT) was used in this study. The EN-CBMs consisted of: (a) Oral Counting Fluency, (b) Counting From, and (c) Number Identification. These measures were selected from commonly used early numeracy curriculum based measures. They were selected keeping in mind the age of students participating in this study. The Number Sense Measures employed in this study included (a)

Spatial Relationships; (b) Number Relationships; (c) Five and Ten Frames; and (d) Nonverbal Calculation.

Research Design:

This study adopted a quasi-experimental design where classrooms were randomly assigned to intervention and comparison groups. Repeated measures design was adopted and students completed the test at pretest, posttest, and delayed posttest.

Data Collection and Analysis:

Pretreatment group equivalency was tested by conducting a one-way analysis of variance (ANOVA) on the two groups' scores on the SAT 10, EN-CBM, and the Number Sense Measures at pretest.T-tests and Chi-square tests were also conducted to determine treatment group equivalency on key demographic variables (e.g., age, ethnicity, SES, disability, and gender). In addition, means, standard deviations, skewness, kurtosis and effect sizes were calculated.

To determine the reliability of SAT-10, EN-CBM, and Number Sense Measures, internal consistency estimates using Cronbach's alpha were calculated separately for each measure. In addition to address the relation between students' scores on the CBM mathematics measures (i.e., EN-CBM, and Number Sense) and SAT-10, multivariate regression was conducted to determine how much variance in the EN-CBM and Number Sense Measures was explained by SAT-10. Further scores from the EN-CBM and Number Sense Measures were correlated separately at pretest, posttest, and delayed posttest measures using Listwise Pearson Product Moment Correlation to determine the relation between EN-CBM and Number Sense Measures.

To determine if there was a differential effect between the two groups a Repeated Measures ANOVA -2 Group (NS + GCI and GCI) x 3 Time (pretest, posttest, and delayed posttest) was conducted. In addition, simple effects analyses with Bonferroni correction were conducted to determine if there were group differences at each time of testing. Further, paired samples tests were conducted to analyze the extent to which EN-CBM and Number Sense Measures scores were maintained between pretest to posttest, and posttest to delayed posttest.

Findings / Results:

Results of Pearson Chi-Square analysis indicated that there were no statistically significant differences on gender, ethnicity, and SES. There was a significant difference in the NS + GCI and GCI group on disability category and IEP. Given that from the overall sample only 3 students, all in the GCI group had a documented disability and an accompanying IEP, these results should be interpreted with caution. In addition results of independent t-tests indicated a statistically significant difference for age between the two groups. The mean age in months of students in the GCI was higher than the mean age of students in the NS + GCI group.

Pretreatment group equivalency was tested by conducting a one-way analysis of variance (ANOVA) for group (NS + GCI vs. GCI) on students' performance on the SAT10, EN-CBM, and the number sense measures. Results indicated no statistically significant differences between the two groups on all measures.

Descriptive Statistics were calculated for all EN-CBM and Number Sense Measures. In general at pretest the mean scores for both the NS+GCI group and GCI group were comparable. At posttest the mean scores of the NS+ GCI group was higher than the mean scores of the GCI group on all measures. Similarly, at delayed posttest the mean scores of the NS + GCI group was higher than the mean scores of the GCI group on all but the number identification measure.

Results of the Cronbach's alpha coefficient indicated moderate to high levels of reliability for all measures at pretest, posttest, and delayed posttest. In addition, results of multivariate regression indicated that the SAT 10 a commonly used standardized achievement test was significantly correlated to the EN-CBM and Number Sense Measures used in this study. Results of Pearson's correlations indicated a strong direct correlation between almost all measures at pretest and all measures at posttest. These results not only strengthened the perceived quality of the investigator designed measures but also indicated the reliability of the measures used.

EN-CBM. Results for all three EN-CBMs indicated statistically significant main effects for group and time of testing. The simple effect for time was also examined post hoc, using a Bonferonni adjustment. Results indicated statistically significant differences from pretest to posttest but no significant differences from posttest to delayed posttest for Oral Counting Fluency and Counting From. Results for Number Identification indicated significant difference from pretest to posttest and from posttest to delayed posttest. In addition, a statistically significant group by time of testing interaction effect was found for Oral Counting Fluency but not for Counting From and Number Identification. Results of post hoc paired samples tests for each of the two groups separately indicated improved performance for students in both groups. However, students in the NS+ GCI group outperformed students in the GCI group on all measures at posttest and all but one measure (Number Identification) at delayed posttest.

Number Sense Measures. Results for all Number Sense Measures indicated statistically significant main effects for group and time of testing. The simple effect for time was also examined post hoc, using a Bonferonni adjustment. Results indicated statistically significant differences from pretest to posttest but no significant differences from posttest to delayed posttest for all measures. In addition, a statistically significant group by time of testing interaction effect was found for all Number Sense Measures. Results of post hoc paired samples tests for each of the two groups separately indicated improved performance for students in both groups. However, students in the NS+ GCI group outperformed students in the GCI group on all Number Sense Measures at posttest and delayed posttest.

Conclusions:

Overall results of this study support previous research in that carefully sequenced activities focusing on the big ideas of number sense (e.g., spatial relationship; one more, one less, two more, and two less; benchmarks of five and ten; part-part whole relationship) (Van de Walle, 2007) as well as the use of explicit instruction (e.g., following the model, lead, guided practice, and independent practice paradigm) (Gersten & Chard, 1999; Kame'enui & Carnine, 2002) when combined with opportunities for practice, lead to significant improvements in number sense skills of kindergarten students (Carnine,1997, Van de Walle, 2004). The present study shows preliminary evidence that instruction combining big ideas of number sense and explicit instruction can enhance mathematics competence of kindergarten students. Although further replication of these preliminary findings is necessary, the findings of this study can shed some light on current instructional practices for kindergarten students that are foundational for later mathematical learning.

Appendices

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Appendix A. References

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Appendix B. Tables and Figures

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