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Math peer tutoring intervention: the effect of place value training on addition and subtraction skills

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MATH PEER TUTORING INTERVENTION:
THE EFFECT OF PLACE VALUE
TRAINING ON ADDITION AND
SUBTRACTION SKILLS

Thesis

Submitted to

The School of Education and Allied Professions of the
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in Partial Fulfillment of the Requirements for

The Degree

Educational Specialist in School Psychology

by

Shauna Leigh Stabilio Gega

UNIVERSITY OF DAYTON

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SCHOOL PSYCHOLOGY PROGRAM
DEPARTMENT OF COUNSELOR EDUCATION AND HUMAN SERVICES
SCHOOL OF EDUCATION AND ALLIED PROFESSIONS

WE HEREBY APPROVE THE THESIS SUBMITTED

BY

Shauna L. S. Gega

ENTITLED:

Math Peer Tutoring Intervention: The Effect of Place Value Training
on Addition and Subtraction Skills

AS PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Educational Specialist in School Psychology

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ABSTRACT

MATH PEER TUTORING INTERVENTION: THE EFFECT OF PLACE VALUE TRAINING ON ADDITION AND SUBTRACTION SKILLS

Name: Gega, Shauna Leigh Stabilio
University of Dayton

Advisor: Dr. Julie Q. Morrison

The purpose of this thesis was to investigate the effectiveness of a math peer tutoring intervention involving place value training to increase addition and subtraction computation skills. The study utilized a pre-test post-test control group experimental design with repeated measurement. A single administration of the AIMSweb Math-CBM probe served as the pre-test measure. Eight second-grade students with low-average mathematical computation scores on the pretest and low-average performance in classroom math tasks were chosen to participate in the 7-week intervention. The students were randomly assigned to an experimental group and control group. The place value training and the use of base-ten blocks to solve addition and subtraction problems was the experimental condition. The four students in the experimental group were randomly paired before each session and tutors were provided with a script to guide them through the peer tutoring sessions. The intervention phase consisted of three sub-phases. Phase One of the intervention was place value training which involved base-ten blocks, digit cards, and place value arrows. Phases Two and Three focused on solving addition and subtraction problems using base-ten blocks and math worksheets. At the end of each week of the intervention phase, AIMSweb math probes with varying addition and subtraction problems were administered to the experimental and control groups for

progress monitoring. A post-test was also conducted to assess the effectiveness of the intervention and to compare the math fluency gains of the target students with their peers. Although the intervention proved effective for a few students in the experimental group, there were no significant differences between the performances of the experimental group compared to the comparison group. Considerations and future directions are discussed.

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CHAPTER I

Introduction

Although research studies on reading interventions are greater in number compared to mathematics interventions, the prevention of mathematics difficulties (MD) is equally important. Mathematics competence is important for success in both school and work. As Fuchs, Fuchs, Yazdian, and Powell (2002) state, “statistical analyses show that mathematics competence accounts for employment, income, and work productivity even after IQ and reading achievement have been explained” (p. 569). Various ways to address MD include helping teachers find effective strategies for instructing a diversity of students with varying abilities, identifying students who need assistance as early as possible, and providing these students with effective interventions to prevent further difficulties. Researchers have demonstrated the effectiveness of teaching foundational skills to assist students with learning the more difficult mathematical concepts later in life (Harniss, Stein, & Carnine, 2002). One alternative instruction strategy that has potential for assisting students with MD is peer tutoring. Given the importance of mathematics competence in students, it would be useful to have more research-based math interventions combining peer tutoring and the teaching of foundational skills.

Significance

As with other academic areas, proficiency in mathematics is important for a student’s success in school and work. However, with the increasing diversity of students, teachers need to search for alternative instructional strategies to employ in the classroom. Studies have shown that peer tutoring is a strategy that can address this diversity and also place less strain on teachers. The success of this study would provide educators with

another tool to utilize with students who are struggling with difficult addition and subtraction computation skills. The most significant contribution of this study would be the addition of an empirical basis for peer tutoring in these mathematical skills.

CHAPTER II

Literature Review

Introduction

Compared to other nations of similar wealth and status, the United States has consistently performed lower on mathematics achievement tests. According to Harniss et al. (2002), the results of the Third International Mathematics and Science Study (TIMSS) revealed that significant performance gaps existed between American students and students in other countries. Researchers suggest many reasons for this discrepancy including language and cultural differences and expectations, the type of mathematics curricula adopted by school districts, instructional strategies, and the pace of learning (Fuchs & Fuchs, 2001; Harniss et al., 2002; Ho & Cheng, 1997). It is important to “identify early signs and predictors of MD (mathematics difficulties) to ameliorate and perhaps prevent later MD” (Dowker, 2005, p. 324). Ho and Cheng (1997) found that the performance gap between high and low achievers in math will widen over time if no intervention assistance is given to the low achievers.

Differences in Mathematical Performance between American and Asian Students

Cross-national comparisons of mathematics achievement have shown significant differences in favor of Asian students (Ho & Cheng, 1997). These differences are due in part to sociocultural factors such as parental expectations; however, language also has an impact on a child’s mathematics performance (Fuson & Briars, 1990; Ho & Cheng, 1997). For example, “the number ‘12’ corresponds directly to the underlying base-ten structure of the number system when it is spoken as ‘ten-two’ in Chinese but does not when it is spoken as ‘twelve’ in English” (Ho & Cheng, 1997, p. 496). Other Asian

languages, such as Japanese, Korean, Thai, and Vietnamese, also say multi-digit numbers in ways that are named-value (Fuson & Briars, 1990). These irregularities in language make it difficult for English-speaking children to construct named-value meaning for multi-digit numbers; therefore, Fuson and Briars (1990) argue that it is essential that support for constructing ten-structured conceptions (place value concepts) be provided in other ways to English-speaking children.

Importance of Place Value Training in Math Computational Skills

The task analyses of math computational skills typically include a strong knowledge base in place value concepts. According to Harniss et al. (2002), “place value is the understanding that in our number system, the ‘place’ a number holds in a sequence of numbers gives information about that number” (p. 579). Also, place value is one of the Big Ideas in Operations, meaning that it helps provide a foundation for learning other mathematic skills (e.g., addition, subtraction, regrouping) (Harniss et al., 2002). The Big Ideas in Operations are the mathematics equivalent of the Big Ideas in Early Literacy. Children need these foundational skills firmly established in order to be successful in learning the more difficult concepts. Fuson (1992) advised that instruction of multiunit concepts and multidigit addition and subtraction be postponed until the second grade (as cited in Baroody, 1990). Prior to the second grade, children should establish a firm base in learning unitary concepts, reading and writing two-digit numerals and single-digit sums to 18 first (Fuson, 1992 as cited in Baroody, 1990). Research articles utilized place value training with first graders with successful results (Fuson & Briars, 1990; Hiebert & Wearne, 1992) and one math objective school districts target is that second grade students should be able to demonstrate an understanding of place value through the hundreds

place (Schmidt, 1995). For example, the Ohio Department of Education (2001) requires that students learn place value concepts starting from first grade.

Research Studies Validating the Importance of Place Value Training

Many research studies have linked the importance of place value with early addition and subtraction skills. The study conducted by Ho and Cheng (1997) focused on training low achieving Chinese students in place value concepts in order to investigate the effect the training would have on children's addition and subtraction skills. The study yielded significant results with the low achieving students showing a great improvement in their addition skills compared with the high achieving students. Though there was an improvement in subtraction, the results were not statistically significant. The researchers proposed that the place value training had less effect on subtraction skills because emphasis was placed on addition.

Another study by Hiebert and Wearne (1992) used alternate instruction (as opposed to conventional textbook-based instruction) in four first-grade classrooms to teach place value and two-digit addition and subtraction without regrouping. Alternate instruction included more hands-on activities (i.e., manipulatives) to understand place value concepts. It was designed to enhance students' thinking processes by allowing them to devise their own strategies for figuring out problems. The researchers found that on the post-tests, the students receiving alternate instruction in place value concepts answered more regrouping problems correctly than those receiving text-book based instruction, even though neither of these groups of students had been instructed in calculating regrouping problems.

Use of Manipulatives to Teach Place Value Concepts

The use of base-ten blocks in teaching place value and multidigit addition and subtraction to first- and second-grade students is valuable in helping children to link the concrete representation of the blocks to the written marks of the problem (Fuson & Briars, 1990). This link aids students in applying the knowledge learned from the base-ten blocks to the actual written multidigit addition or subtraction problem. Physical and visual representations facilitate conceptual understanding and help children master and maintain mathematical competence (Fuchs & Fuchs, 2001). Concrete and pictorial models may also help encourage an understanding of abstraction (Baroody, 1990).

Schmidt (1995) conducted a classroom intervention to remediate second grade students' achievement of place value concepts. This intervention was implemented to help students reach the criterion of place value understanding through the hundreds place based on the state's mathematics objectives. A sample of 25 students was taught place value by using base-ten blocks and developmentally appropriate games and activities. Results showed that by using manipulatives, games, and activities, the students were able to reach criterion on the place value objective.

Research Studies on Peer Tutoring Strategies

Though these research studies provide evidence of the effectiveness of interventions targeting the place value concept, these studies were conducted with groups of children and involved teacher-directed instruction, demonstrations, games, and hands-on activities. None of these studies mentioned alternative styles of place value training, such as peer tutoring. How would peer tutoring strategies affect students' learning of place value concepts? Research has found that the advantages of peer tutoring include:

having the students actively engaged in academic behaviors and therefore less engaged in inappropriate behaviors; benefiting both the tutors and tutees academically; enhancing cooperative learning and social skills in the classroom (Greenwood, Carta, & Hall, 1988); helping to integrate students with disabilities into the general education classroom (Greenwood, Maheady, & Delquadri, 2002); and preventing academic failure among diverse students (Greenwood & Delquadri, 1995). Through the collaborative efforts of Kathleen Stretton and Joseph Delquadri, Classwide Peer Tutoring (CWPT) was developed as a viable instructional option for the regular classroom (Greenwood et al., 2002).

Classwide Peer Tutoring (CWPT)

Classwide peer tutoring can be defined as “a class of instructional strategies wherein students are taught by their peers who have been *trained* and are *supervised* by the classroom teacher” (Greenwood et al., 2002, p. 613). Generally, in CWPT, students are paired randomly on a weekly basis to ensure that all students have the opportunity of being both the tutor and the tutee. Using the curricula, the teacher decides which topics and skills to cover. The tutors are given a script or checklist as a guide to prompt them in what to say or do while teaching the tutee. Curriculum-based measures (CBM) are administered to assess the progress of students using CWPT. This type of tutoring can be applied in different grade levels and to a wide range of academic subjects, such as reading, mathematics, and content areas.

Classwide peer tutoring has also been proven to provide positive long-term effects among students. In a longitudinal study by Greenwood, Delquadri, and Hall (1989), CWPT was implemented with one experimental low-SES group and was compared with

one control low-SES group and one comparison high-SES group that received teacher-designed instruction. All academic subjects were taught using classwide peer tutoring. This study examined changes in student performance over time from the first grade through the fourth grade. The results indicated that the experimental group and comparison group both produced significantly greater academic gains than did the control group. One limitation of CWPT implementation in the classrooms was that mathematics was one of the more difficult subjects to teach using this peer tutoring strategy. Although mathematical facts and simple computations were relatively easy to implement with CWPT, the more complex mathematical concepts were difficult to convey in a standard tutoring format.

Peer-Assisted Learning Strategies (PALS)

Another type of peer tutoring strategy is Peer-Assisted Learning Strategies (PALS) (Fuchs, Fuchs, Phillips, Hamlett, & Karns, 1995). This strategy can also be readily used to address the diversity of students in the classroom. PALS is a structured strategy that involves a schedule (Fuchs et al., 1995; Fuchs & Fuchs, 2001); once per week, teachers employ a CBM to monitor their students' progress. The students enter their responses into a computer program that scores and manages the data. This software summarizes the students' performance by graphing their data and displaying the total number of correct problems over time and by showing individual student's mastery status on each type of problem. Students are taught to read and interpret their own graphs as well as to set their own goals for improving their scores. Twice monthly, the teacher decides which students to pair and what skill to target. This decision is based on the results of the CBM assessment. PALS sessions are then implemented twice per week for

an average of 35 minutes each session. PALS borrows its basic structure from Classwide Peer Tutoring in which every child in the class is paired to work with another, however, PALS extends CWPT in the following ways:

(1) Mediated verbal rehearsal, in which the tutor models and gradually fades a verbal rehearsal routine delineating procedural steps for completing the problem type; (2) step-by-step feedback by the tutor to confirm and praise correct responses and to provide explicit explanations and model strategic behavior for incorrect answers; (3) frequent verbal and written interaction between tutors and tutees; (4) opportunities for tutees to apply explanations in subsequent problems; and (5) reciprocity, where both children serve in the roles of tutor and tutee within each session. (Fuchs & Fuchs, 2001, p. 89)

Using Peer Tutoring in Math Instruction

The combined CBM and PALS methods have been shown to improve mathematics achievement among a range of students and have been designated an “effective practice” by the Program Effectiveness Panel in the U.S. Department of Education (Fuchs & Fuchs, 2001). PALS can be implemented with a wide range of academic levels, including younger students. Two PALS studies were conducted with first grade and kindergarten children to enhance students’ mathematical development (Fuchs, Fuchs, & Karns, 2001; Fuchs et al., 2002). Using the school district’s curricula, the researchers created a PALS packet for each teacher in the experimental groups. Students in each group consisted of low, average, and high mathematics achievement levels. The PALS treatment was implemented in the classroom three times per week for 16 weeks, 30 minutes per session. Pre- and post-testing of the students revealed that all

students in the experimental group, regardless of achievement level, benefited from PALS. In addition to these positive results, the research also showed that PALS could be successfully implemented with a young population of kindergarteners and first graders, and that teachers found PALS to be an effective and feasible strategy to implement on their own (Fuchs et al., 2002; Fuchs et al., 2001).

Several studies provide evidence of the value and effectiveness of utilizing peer tutoring strategies in teaching mathematics. Fasko (1994) conducted a study to assess the effectiveness of a peer tutoring intervention for fluency in basic math facts and to see whether this led to an improvement and generalization to actual class work. The target students were fourth- and fifth-graders in a rural Appalachian elementary school with varying levels of ability. Tutors and tutees were chosen based on scores of multiplication math fact probes and teachers' decisions. Tutors were trained by the experimenter. Fasko (1994) used a multiple-baseline across subjects research design, dividing the students into three groups (one group with three non-identified students, the second group with students identified as LD, and the third group with two students identified as having educable mental disabilities, or EMD). After the baseline phase, the peer tutoring intervention was implemented two to three times per week, 20 minutes per day. The intervention included the use of flashcard drill sets with multiplication math facts. Multiplication math fact probes were administered weekly along with math worksheets given by the teachers to assess improvement and generalization to class work. The results indicated an improvement in fluency for all of the students as well as improvement on the math worksheets. After the intervention, the target students received multiplication math fact probes twice weekly to determine whether the students had

maintained the same performance level. Results revealed that the treatment promoted retention over several weeks' time, thereby demonstrating the positive long-term effect that peer tutoring instruction can have on students' academic performance.

The National Council of Teachers of Mathematics (NCTM) advocated for the use of manipulative materials and peer tutoring as an effective teaching method in mathematics (Barone & Taylor, 1996). The authors proposed ideas as to how to implement peer tutoring in the classroom and suggested that teachers select concrete, engaging activities that can be taught between students. Tutors should be adequately trained before the tutoring sessions through modeling, role reversal, and practicing explaining and carrying out the activities. Posters are also useful, serving as a guide throughout the peer tutoring session. Journals can be an effective part of the peer tutoring program. The use of journals by both tutors and tutees enhances mathematical communication by allowing tutors to organize and prepare the lessons they will teach, as well as allowing both the tutors and tutees to provide feedback of the lessons to one another and to take their own notes on what they feel are their strengths, weakness, likes, and dislikes. In contrast to other researchers, Barone and Taylor (1996) advise having at least a two-year age difference between tutors and tutees. They believe that this age difference promotes greater effectiveness due to the younger tutee regarding the older tutor as a role model, the higher skill level of the older tutor that results in a better teaching role, and less behavior problems from the tutee. As mentioned earlier, Barone and Taylor (1996) advocated for the use of manipulatives because it "encourages students to explore mathematics concretely and then to apply and transfer their understanding to the more abstract written form" (p. 9). They described a variety of concrete activities to

use in peer tutoring sessions, such as “Snap It,” “String Bean,” “Dominoes,” “Playground Mathematics,” and “Problem-Solving Puzzles.” Field studies of these activities have shown that the peer tutoring resulted in positive feelings towards mathematics by students, and that it promoted self-confidence, higher levels of thinking, positive interrelationships between students, and mathematical communication. However, these activities were directed mainly towards basic addition and subtraction skills.

Using Peer Tutoring Strategies to Teach Place Value Concepts

Although research studies have provided evidence of the effectiveness of place value training on future addition and subtraction skills, and the effectiveness of peer tutoring programs to teach mathematics, none of them have combined the two. The majority of the peer tutoring programs focused on teaching math facts and working on math worksheets. Yet the use of manipulatives is an effective technique in training students in place value concepts (Fuson & Briars, 1990; Hiebert & Wearne, 1992; Ho & Cheng, 1997; Schmidt, 1995). This place value training will, in turn, help students develop their addition and subtraction with regrouping skills. Harniss et al. (2002) recommend that educators should place an emphasis on teaching foundational skills rather than on focusing on formulas and exact procedural strategies. The Big Ideas in Operations include number sense; the distributive, commutative, and associative principles; equivalence; and of course, place value (Harniss et al., 2002). It is these Big Ideas that provide the foundation for learning the operations of addition, subtraction, multiplication, and division. Therefore, it would be valuable to assess the effectiveness of peer tutoring on place value training and the outcome that this training would have on students’ addition and subtraction skills.

CHAPTER III

Methods

Setting and Population

The setting for this study was a public elementary school in the suburbs of Dayton, Ohio. The school had an average daily student enrollment of 412 and served students from Kindergarten to Grade 4. The school's attendance rate was 95.4% and was performing above the state's requirement level of 75% in third grade reading (76.0%), but below the state's requirement in third grade mathematics (61.3%). For fourth grade, the school performed above the state's requirement level of 75% in writing (87.0%) and mathematics (79.4%). The fourth grade class performed below state standards in reading (71.0%). The school was composed of a predominantly White population with approximately 9.2% of the population being African-American and 6.3% Multi-racial. Additionally, 50.9% of the students came from economically disadvantaged homes and 6.0% of the student population consisted of students with disabilities. All descriptive data were based on the 2005-2006 academic school year.

Participants

One second grade classroom was administered AIMSweb Math Curriculum-Based Measurement (M-CBM) probes, which consisted of multiple-skill math facts (e.g., addition and subtraction without regrouping and addition and subtraction with regrouping). The M-CBM probes were used to determine baseline data as well as identify students in need of improvement on these skills. After pre-intervention testing, the results were shown to the teacher for input. With the results of the pre-intervention test and teacher's information on which students were the best candidates for the

intervention, eight students were identified to participate in the intervention. These students were chosen based on their scores (ranging from low to average) and their performance in classroom work and math tests. Prior to the intervention, four of the students were randomly assigned to an experimental group and the other four to a control group. In the experimental group, two of the students were male; two were female.

Data Collection

After determining the eight target students, informed consent forms were sent home to their parents (see Appendix A). Agreement to participate in the intervention was voluntary. Participants were informed that they could withdraw at any time during the study. All but one informed consent form was accepted and signed by the parents. Due to this decline, another student was recruited based on the results of the M-CBM probes. Parental consent was obtained for this student.

On the first day of each phase of the intervention, the researcher devoted time to demonstrating and modeling how each intervention session would be implemented. All data retrieved before, during, and after the intervention was saved in a password-protected computer file that only the researcher was able to access.

During the time the target students were engaged in the intervention, the students in the control group participated in silent reading. Occasionally, students were selected from the control group to participate in additional math instruction based on the needs of the student. This supplemental instruction consisted of working with skills that were being instructed during the week, such as regrouping, money, etc.

Intervention

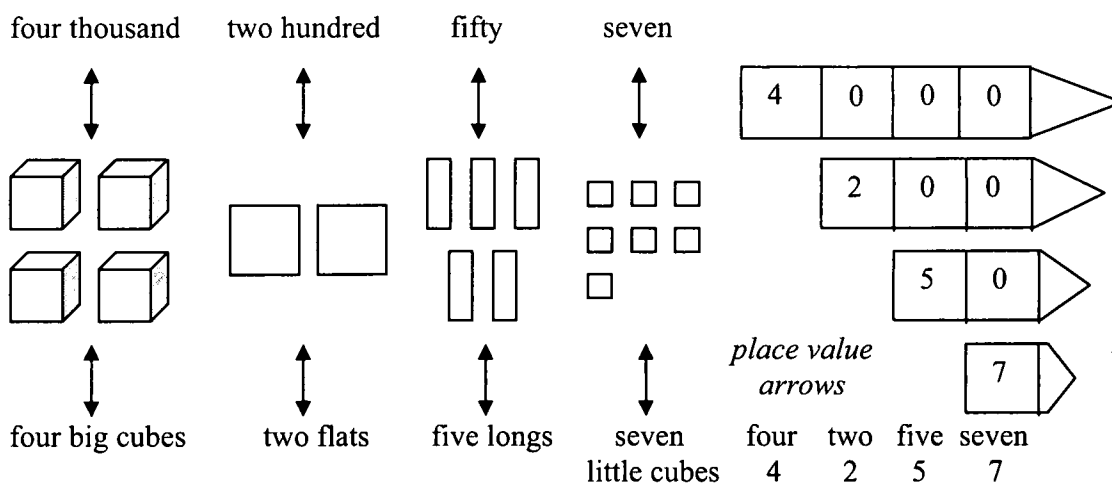
The intervention was implemented during the second half of the school year. Due to difficulty in recruiting a second grade teacher in the study, the intervention took place after addition skills with regrouping were already introduced. However, subtraction skills with regrouping were instructed in the classroom during the intervention phase. PALS studies mentioned that interventions should take place at the same time that the chosen skill will be instructed in the classroom (Fuchs & Fuchs, 2001; Fuchs et al., 2001; Fuchs et al., 1995; Fuchs et al., 2002). Furthermore, the place value training and the use of manipulatives were adapted from the studies conducted by Fuson and Briars (1990). Certain topics to cover and strategies involving place value, addition, and subtraction are referenced to Fuson and Briars (1990).

The intervention took place over a 7-week period, three times per week for 20 minutes per session across three different phases. Manipulatives (i.e., base-ten blocks), place value arrows, and addition and subtraction math worksheets were used to train the students in place value concepts. At the beginning of each session, tutors and the tutees were randomly identified. This was to ensure that each student had a chance to be a tutor during the intervention period. Tutors were provided with a guide to aid them through the peer tutoring sessions (see Appendix B). Each guide was tailored to each phase's objectives. During each session, the researcher was present to offer assistance and to ensure that the tutors were implementing the intervention accurately.

Phase One (Week 1): Place Value Training. The first week was place value training and focused on familiarizing the students with the base-ten blocks, and place value arrows. The tutor showed what each of the base-ten blocks represented. For

example, the little cubes (units) represented *ones*, the bars of 10 connected little cubes (rods) represented *tens*, the flats represented *hundreds*, and the big cubes represented *thousands*. The tutor then showed adjacent places trades (1 for 10, 10 for 1). Tutees were asked to demonstrate these trades on their own. Tutors also demonstrated how to show a number in its expanded form (i.e., $135 = 100 + 30 + 5$), and had the tutees demonstrate this as well. The tutors constructed 3- and 4-digit numbers with the blocks and placed the place value arrows next to the numbers to show the base-ten version of the numbers beside the blocks. Tutees were then asked to construct 3- and 4-digit numbers with the blocks and place value arrows (see Figure 1).

Figure 1. Base-ten blocks and place value arrows



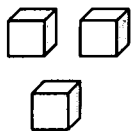
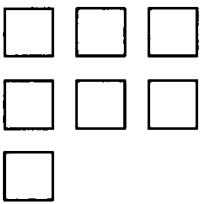

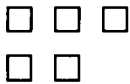

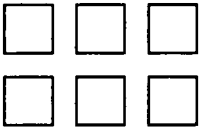
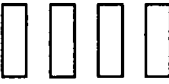
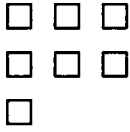
Example: (from Fuson & Briars, 1990, p. 182)

The place value arrows were also used to help the students understand base-ten concepts. For example, tutors placed single-digit arrows over decade numbers (e.g., 10, 20, 30, etc.). To demonstrate the number 42, the tutor placed the single digit 2 on top of the decade number 40 to promote the understanding that 42 means 40 and 2. The tutees

then demonstrated their understanding of this base-ten concept by performing the same procedure with different numbers.

Phase Two (3 weeks): Addition. Three weeks were devoted to using the base-ten blocks to solve addition problems with regrouping. Tutees were given a large calculating sheet (see Figure 2) and a worksheet of varying digit addition, with regrouping. Tutors demonstrated two strategies for solving the addition problems (adding left to right or right to left). Tutors ensured that tutees solved the problems by adding column by column. The results were recorded with place value arrows and on the worksheet. Tutors were instructed to give feedback and praise for each problem. The base-ten blocks were used as long as the tutee needed them. When the tutees no longer needed the base-ten blocks and chose to solve the problems on the worksheets only, the tutors checked their written procedure before allowing them to leave the blocks.

Figure 2. Calculating board for addition and subtraction problems

Thousands	Hundreds	Tens	Ones	
				3 7 2 5
				1 6 4 7

Phase Three (3 weeks): Subtraction. The last three weeks of the intervention focused on using the base-ten blocks to solve subtraction problems with regrouping. The large calculating sheet was also used to solve the subtraction problems. Different strategies were also used to solve the subtraction problems. The tutors demonstrated a couple of strategies, such as to solve column by column like the addition problems and make any trades when necessary, or another strategy that involved checking the top number of each column to ensure it was larger than the bottom number in the same column. For the latter, if the top digit was not as large, a 1 for 10 trade from the column on the left was made to demonstrate borrowing/regrouping. After all trades were complete so that the top number was larger than each bottom number, the tutor showed how to subtract column by column. This procedure of doing all the trades and making all the top numbers larger *first* is easier than doing problems column by column and avoids common mistakes. After demonstrating the procedures, the tutees were asked to solve the problems on their own using the base-ten blocks and answers were recorded with place value arrows and on the worksheets. The tutor provided the tutee with feedback and praise.

As with the addition phase, the base-ten blocks were utilized as long as the tutee needed them. When the tutees no longer needed the base-ten blocks and chose to solve the problems on the worksheets only, the tutors checked their written procedure before allowing them to leave the blocks.

Instruments

Multiple-skill math worksheets (i.e., addition and subtraction with regrouping) were used during each session to practice computation skills. These math worksheets

were generated through InterventionCentral.org. With the exception of the first week that involved place value training, the students in the experimental and control groups were given a timed, progress monitoring M-CBM probe from AIMSweb at the end of each week. These probes consisted of multiple-skill math facts, with and without regrouping. Although the control group was not receiving the intervention, they were also given weekly tests for comparison. According to the AIMSweb math computation manual (Shinn, 2004), the AIMSweb Math-CBM probes have good reliability (internal consistency = .93; interscorer agreement = .93; test-retest = .93; alternate form = .91). Curriculum-based measurement is a research-based approach; however, specific information regarding the validity of the Math-CBM probes could not be found in the research literature.

After the 7-week intervention period, the entire class was reassessed and administered alternate forms of the AIMSweb M-CBM math probes that they were given to establish the baseline and determine the eight participating students. These math fact probes contain multiple-skill math facts, with and without regrouping. This reassessment provided an opportunity to compare the gains of the target students with their peers.

The researcher was responsible for scoring the probes used for weekly monitoring and the probes used for time-series analysis of the data. To ensure confidentiality, these probes and results were contained in a locked filing cabinet to which only the researcher had access.

Inter-Scorer Agreement. To increase reliability, two scorers scored the AIMSweb math probes (pre-intervention and post-intervention benchmarks) and AIMSweb progress monitoring probes to ensure reliable results. Inter-scorer agreement was calculated by

dividing the total number of math probes scored by the number of disagreements (differently scored probes) and then multiplying that number by 100. For the three pre-intervention math probes, inter-scorer agreement was 87%, 83%, and 95%, respectively. For the three post-intervention math probes, inter-scorer agreement was 83%, 95%, and 95%, respectively. Math probes with disagreements were scored a third time to ensure accurate scoring.

The accuracy with which the intervention was implemented was monitored by using treatment integrity checklists (see Appendix C). Treatment integrity checklists were completed by the researcher after each intervention session.

Intervention Rating Profile. At the end of the intervention, the teacher was asked to complete the Intervention Rating Profile (Martens, Witt, Elliott, & Darveaux, 1985; see Appendix D). This measure of social validity is comprised of 10 items structured as a 6-point Likert rating scale, where 1 was “Strongly disagree” and 6 was “Strongly agree.” The Intervention Rating Profile is a research-based instrument for measuring a parent’s (or teacher’s) perceptions of the acceptability of the procedures and outcomes involved in an intervention.

The purpose of the scale was to obtain input about the math peer tutoring intervention that was implemented with the teacher’s students. A higher rate of acceptability of the intervention would make it more feasible for teachers to utilize in the classroom with their students.

Research Design

A pre-test post-test control group experimental design with repeated measurement was utilized. A single administration of the AIMSweb Math-CBM probe served as the

pre-test measure. The place value training and the use of base-ten blocks to solve addition and subtraction problems was the experimental condition. This research design was used in order to assess the effectiveness of the intervention on both addition and subtraction skills (with and without regrouping). In order to assess whether the intervention was effective in increasing the students' learning, the math fluency gains for the intervention group was expected to be significantly larger than that of the control group.

Data Analysis

The performances of the intervention group and the control group were compared using visual analysis to determine the effects of the intervention. Visual analysis focuses interpretive attention on characteristics common to all behavioral data; these are (1) the extent and type of variability in the data, (2) the level of the data, and (3) trends in the data (Cooper, Heron, & Heward, 1987). Differences in the rate of skill acquisition for each group was also determined by calculating the percentage of non-overlapping data points (PND) as described by Scruggs, Mastropieri, and Castro (1987). This descriptive statistic quantifies treatment outcomes by assessing the percentage of data points in the intervention phase that exceed the highest baseline data point.

CHAPTER IV

Results

Compared to the baseline median score, three out of four students in the experimental group had an increase in Correct Digits (CD) per two minutes. Figure 3 shows the results of each student over the intervention period. Progress monitoring M-CBM scores fluctuated significantly with E1; however student E1 ended the intervention period with a score of 26 CD (increase of 8 CD per two minutes compared to his baseline score). E2 initially increased his CD per two minutes rate, then gradually decreased to a final score of 19 CD (decrease of 2 CD per two minutes compared to his baseline score). Both E3 and E4 generally increased their CD per two minutes rate (with one decrease during Week 4) to give them a final score of 33 CD and 19 CD per two minutes, respectively.

Students in the control group yielded similar results. Three out of four of the students experienced an increase in CD over the intervention phase. Figure 4 shows the results of each student in the control group over the intervention period. C1's progress monitoring M-CBM scores were constantly lower than his baseline median score; therefore, there was no increase in his CD per two minutes rate (decrease of 4 CD). Both C2 and C3 fluctuated weekly in their scores, but ended the intervention phase with an increase of 7 CD per two minutes compared to their baseline scores. C4 experienced an increase over the first five weeks of the intervention period, then slowly decreased his CD per two minutes rate for a final score of 27 CD per two minutes (11 CD increase compared to his baseline score).

Figure 3. Progress monitoring M-CBM scores for the experimental group.

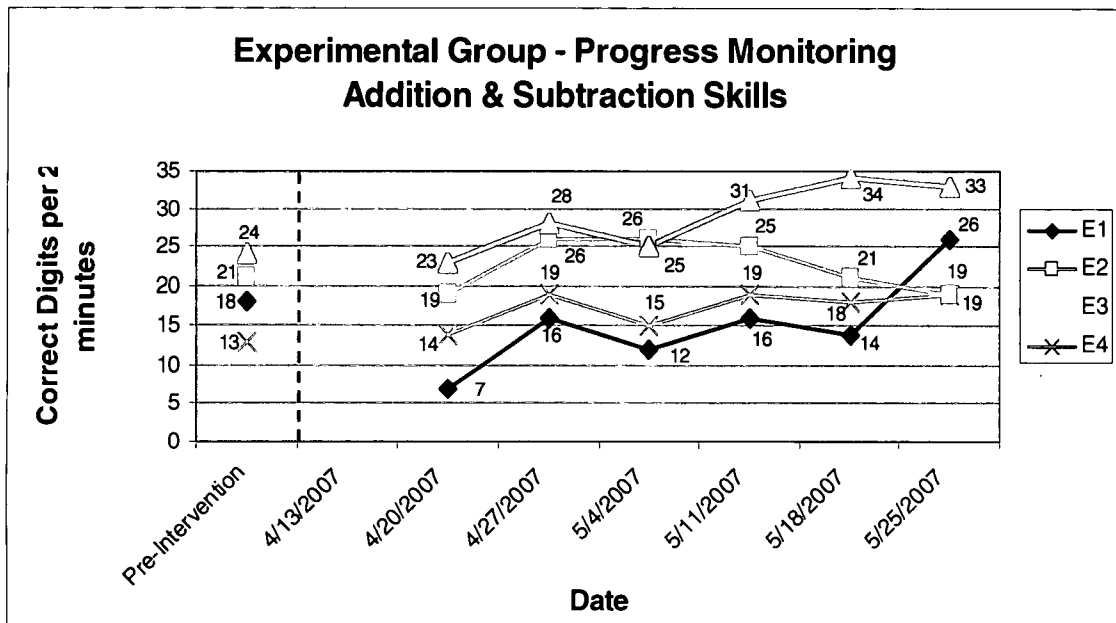
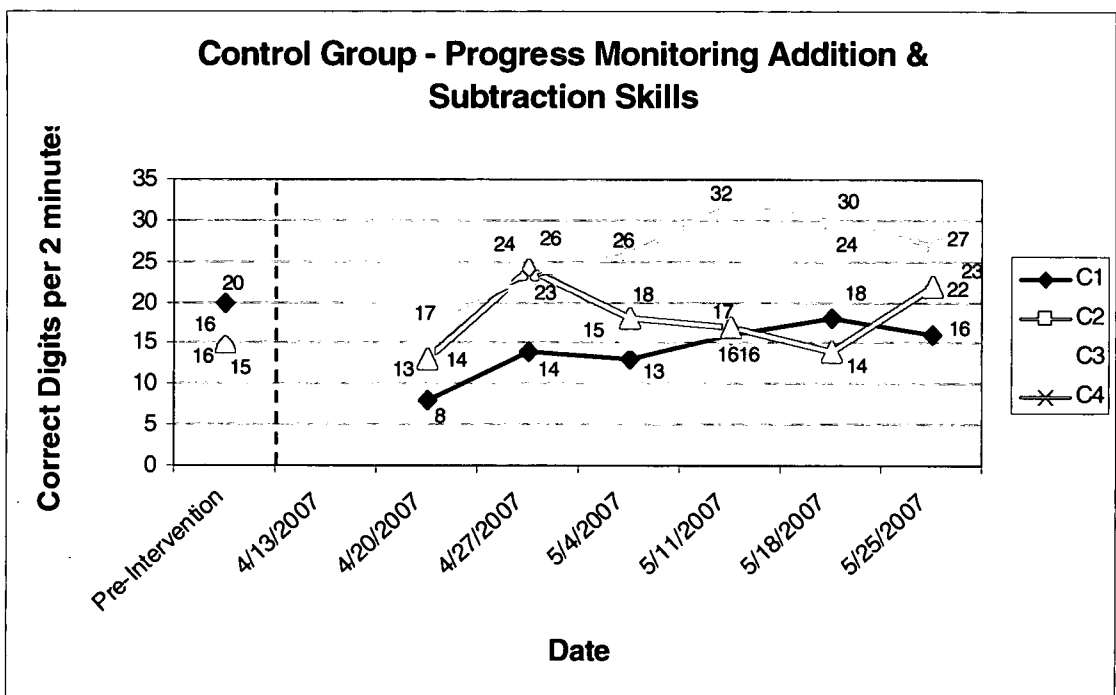


Figure 4. Progress monitoring M-CBM scores for the control group.



Percent of Non-Overlapping Data Points (PND)

PND was calculated by determining the percentage of the intervention data points that fell above the baseline data point. Compared to the baseline score, the PND for E1 was 16%, E2 was 50%, E3 was 83%, and E4 was 100%. In contrast, the students in the control group received the following PND: C1 = 0%, C2 = 50%, C3 = 66%, and C4 = 100% (see Table 1).

The results of the PND indicate minimal effectiveness of the intervention when comparing the scores of the experimental group with those of the control group.

Table 1

Percentage of Non-Overlapping Data Points (PND)

	Baseline Data Point	CD Gain at Final Data Point	PND
Experimental Group			
E1	18	+8	16%
E2	21	-2	50%
E3	24	+9	83%
E4	13	+6	100%
<i>Mean for the Experimental Group</i>	<i>19</i>	<i>5.25</i>	<i>62.3%</i>
Control Group			
C1	20	-4	0%
C2	16	+7	50%
C3	15	+6	66%
C4	16	+12	100%
<i>Mean for the Control Group</i>	<i>16.8</i>	<i>5.25</i>	<i>54.0%</i>

Post-Intervention Testing

The results of the post-intervention AIMSweb Math-CBM probes showed that all students in the experimental and control groups increased their CD per two minutes rate in comparison to their pre-intervention scores. However, two of the students in the

experimental group (E1 and E2) received the lowest increase compared to the other students. E1 did not show a significant improvement (1 CD increase) and stayed below the 25th percentile. E2 had an increase of 6 CD, moving him from below the 50th percentile to the 50th to 75th percentile range. E3 moved from below the 50th percentile to scoring above the 75th percentile. Prior to the intervention, E4 obtained one of the bottom scores (below 25th percentile); however, after the intervention phase, she scored at the 50th percentile.

The control group also experienced increases in their CD per two minutes rates. C1 experienced the greatest increase of 10 CD per two minutes (25th to almost 75th percentile). C2, C3, and C4 experienced similar increases—all three moved from below the 25th percentile to the 50th percentile or just below the 50th percentile.

These results indicate that intervention cannot be considered an effective method of increasing addition and subtraction skills for all students. Although all students in the experimental group increased their CD per two minutes rates on the post-intervention CBM probes, one student only increased by 1 CD. Furthermore, all the control students also increased their CD per two minutes rates.

Treatment Integrity

Treatment integrity checklists were completed on each day of the intervention with the exception of the first days of each intervention phase. The first day of each intervention phase was devoted to introducing the new phase to the students and going through the corresponding peer tutor guides. The researcher also demonstrated how to do each strategy. Students were encouraged to ask questions at this time. Due to time constraints, intervention steps were different on Fridays. On Fridays, the researcher had

to collect all eight students (experimental and control) in order to administer the progress monitoring CBM probes, then allowed the students in the experimental group to take turns in demonstrating how to complete addition or subtraction problems with regrouping.

Mondays & Wednesdays. The majority of the sessions were implemented at 100%; however, on three days, the intervention was implemented at 87%. During these days, the researcher offered help to the tutors although she was not asked first. She intervened on these days because the pairs of students were not cooperating with each other. In these cases, the peer tutee was disrespectful of the peer tutor and a pair of students was not attending to the tasks. On one day, the treatment integrity was 37%. This was due to the absence of one student. Due to the unequal pairing of students, the researcher wrote addition problems on the board and instructed the students to solve the problem using their base-ten blocks. Overall, the intervention was implemented at an average of 91.5%.

Fridays. All intervention sessions on Friday were implemented at 100%.

Intervention Rating Profile

At the end of the intervention phase, the teacher was given the Intervention Rating Profile to complete in order to obtain input on the math peer tutoring intervention. It was presented in a Likert scale format with six options ranging from Strongly Disagree (1) to Strongly Agree (6).

Based on the teacher's scores, the math peer tutoring intervention received a total acceptability rate of 76.5%. This indicates that the teacher accepted the intervention at a moderately high rate. The teacher *strongly agreed* that the implementation of the

intervention did not take place during direct instruction so the students in the experimental group did not miss any valuable instructional time and she also *strongly agreed* that the intervention would not result in negative side-effects for the children. The teacher *agreed* that it would be an acceptable intervention to increase addition and subtraction skills, it is a reasonable intervention for the academic problem addressed, she liked the procedures used in the intervention, the intervention was a good way to handle the students' academic problem, and that overall, the intervention would be beneficial for the students. She *slightly agreed* that the intervention was effective in increasing the students' addition and subtraction skills, she thought most teachers would find this intervention suitable for the academic problem described, she would suggest the use of the intervention to other teachers, she would be willing to use this intervention in the classroom setting, and that the intervention would be appropriate for a variety of children. The only item on the scale that she *slightly disagreed* with was that the intervention was consistent with those she had used in the classroom setting.

CHAPTER V

Discussion

The results of the visual inspection of the time series data and supporting PND summary statistic indicate that the math peer tutoring intervention was not effective in increasing math fluency in addition and subtraction skills. The experimental and control groups did not differ markedly in their math fluency gains. Two of the four students (E3 and E4) in the experimental group demonstrated weekly increases in their CD per two minutes rates with the exception of week 4 during the intervention phase. By the end of the intervention, E3 had increased her CD by 9 CD (an increase of approximately 1.2 CD per week). E4 increased her CD by 6 CD (an increase of approximately 0.8 CD). In addition, they both showed significant improvement on the post-intervention benchmarks. Therefore, the intervention may have been effective for E3 and E4. E2, on the other hand, initially increased his CD per two minutes rate; however, his performance began to decline after week 4. It was noted that toward the end of the intervention, E2 frequently complained about school and expressed less interest in the tasks. During the majority of the later sessions, he would engage in disruptive behaviors such as showing disrespect to his partner, banging his head with his fists or on the wall, and complaining that he was “bored and tired of school.” This attitude toward the intervention may have contributed to the decrease in performance. An analysis of his worksheets and his improvement on the post-intervention benchmark indicate that E2 understood the steps involved in solving addition and subtraction problems with regrouping—he may have just lost interest.

Finally, E1 showed no increase in his CD per 2 minutes rate until the last week of the intervention. Using E1's last progress monitoring score, he experienced an increase of 8 CD per two minutes. This drastic increase in his CD per two minutes rate could be attributed to the fact that his teacher had administered his last progress monitoring CBM. The researcher had administered the other progress monitoring CBM probes to E1 and did not administer the last one due to E1's absence. It was noted that E1 was frequently off-task during testing. He engaged in off-task behaviors such as daydreaming, playing with his pencil, and looking around the room. The researcher prompted him frequently to continue testing. Therefore, E1 may have been more attentive when the teacher was administering the last progress monitoring CBM. In addition, the results of the post-intervention benchmarks showed that E1 only increased his CD per two minutes rate by 1 CD. He remained slightly below the 25th percentile. An analysis of his worksheets and the post-intervention CBM indicate that E1 had not mastered the skill of regrouping. His answers were inconsistent and he often forgot to regroup in the tens column.

During the intervention sessions, certain tutors were observed providing feedback to their peers and explaining how to obtain the correct answers. For instance, when E3 tutored E1, she noticed that he kept crossing off the entire top number before checking to see if regrouping was necessary. She told him to check if he needed to trade/borrow first, then to cross off and change the top number as needed. Positive feedback was also heard (e.g., "Correct! Good job!"). When E4 tutored E1 and E3, she told them what digit was incorrect in their answer. For instance, she said, "You almost got it right. Check the tens place—that number is wrong." If the tutee did not understand, she explained, "You forgot to borrow ten from here [hundreds place] and add ten to this number [tens digit]."

Then you subtract it.” E2 understood the steps involved in completing the regrouping problems; however, he was not a very patient tutor. He was observed raising his voice to the tutees and the researcher had to remind him to speak kindly and praise his partner for his/her hard work. E1 did not seem to understand the steps involved with regrouping. When he was the tutor, he would only say if the answer was correct or incorrect and would not offer any help.

Limitations of the Study

Throughout the intervention, it was apparent that there were many extraneous variables that may have affected the results of the math peer tutoring intervention. As noted earlier, the class had just completed instruction on addition with regrouping and was having instruction on subtraction with regrouping during the entire intervention phase. In addition, the teacher administered weekly math regrouping tests so students may have had added practice. On Fridays, there was another math group instructed by a math teacher that worked on various math skills, including addition and subtraction with regrouping. It was noted that a couple of the students in the control group participated in this math group (at the teacher’s request), thereby affecting the results of the intervention.

Furthermore, four weeks into the intervention, the teacher notified the researcher that E1 had a diagnosis of Attention Deficit/Hyperactivity Disorder (ADHD). E1 was easily distracted, constantly off-task (both physically and verbally), and needed constant prompting to engage in the peer tutoring tasks or complete tests. Throughout the intervention phase, he was the only student in the experimental group that decreased in performance every week except for the last week.

Considerations

As mentioned by Greenwood et al. (1989), one limitation of peer tutoring implementation in the classrooms was that mathematics was one of the more difficult subjects to teach using peer tutoring strategies. The more complex mathematical concepts were difficult to convey in a standard tutoring format. This proved true during the math peer tutoring intervention. It was difficult to construct a peer tutor script that was easy to follow. The peer tutors and tutees expressed confusion during the first weeks of each phase and a few had difficulty explaining how to obtain the correct answers.

Additionally, although students were shown the steps of the intervention through modeling and demonstrations (total of 20 minutes per intervention phase), it was still a difficult concept to grasp. Tutors may have benefited from longer training sessions before the actual implementation.

Furthermore, Barone and Taylor (1996) had advised having at least a two-year age difference between tutors and tutees. This age difference promoted greater effectiveness due to the younger tutee regarding the older tutor as a role model, the higher skill level of the older tutor that results in a better teaching role, and less behavior problems from the tutee. If an older tutor is not available, it is suggested that the peer tutor be a higher functioning student than the peer tutee. During the intervention, higher functioning peer tutees would be disrespectful to the peer tutor and complain about the tutor. This resulted in more behavioral problems and it affected the performance of both the tutors and tutees. Another consideration is to pair same-sex peers, depending on the students' grade levels. For instance, the second graders in the experimental group

constantly complained when they were paired with the opposite sex. Also, they tended to be more cooperative and attentive to tasks when they were with their same sex peers.

Other things to consider include the time of day and year that the intervention was implemented. Although it may not be feasible to choose the time of day to implement the intervention (i.e., teacher requests), it may have been better to implement the intervention during the morning rather than the afternoon after recess. The students were usually tired and hot from playing outside. In addition to the time of day, the time of year is also something to consider. Due to difficulty in trying to find a teacher to participate in the study, the intervention did not take place until the last quarter of the school year. A few of the students would frequently complain about not wanting to do the work and say, "I'm sick of school already!" Therefore, implementing the intervention earlier than the last quarter may have affected the students' attitudes toward the intervention.

Lastly, it is important to enlist the help of the teacher when choosing students to participate in the intervention. They can give valuable information concerning the students' performance in the classroom as well as possible issues like absenteeism. It is also important to ensure that the teacher accepts the intervention at a moderately high rate. As the second grade teacher mentioned, it is best if the students are taught strategies that are consistent with those they use in the classroom otherwise it might result in confusion and failure.

CHAPTER VI

Conclusion

The purpose of this study was to investigate the effectiveness of a math peer tutoring intervention involving place value training to increase addition and subtraction computation skills. With the increasing diversity of students in the classroom, it is important that teachers have other instructional strategies to use in order to address this diversity. Many studies have shown the benefits of utilizing peer tutoring strategies within the classroom, including having the students actively engaged in academic behaviors and therefore less engaged in inappropriate behaviors, benefiting both the tutors and tutees academically, and enhancing cooperative learning and social skills in the classroom (Greenwood et al., 1988). However, it is difficult to utilize peer tutoring strategies in the subject of math. Complex math material is difficult to convey in peer tutoring format.

This study sought to improve addition and subtraction skills by using manipulatives and place value training. Although it proved to be an effective method for two of the students in the experimental group, math fluency gains were not markedly greater when compared to the control group. All students increased their Correct Digits per two minutes rate from pre- to post-intervention testing. Extraneous variables such as the academic functioning of the tutors, the pairing of tutors (i.e., same sex versus opposite sex), and the participation of a few students in the control group in another math group interfered with the intervention's effectiveness.

A peer tutoring strategy may be a useful tool to help the majority of students improve math skills while also identifying those in need of more individual attention.

Future studies should consider pairing students with same-sex peers, placing a higher functioning student with a lower functioning student, and conducting longer training sessions for peer tutors.

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Appendix A

Parent Consent for Son or Daughter to Participate

Dear Parent or Guardian:

I am a graduate student at the University of Dayton and am conducting a research project that will test the effectiveness of a math peer tutoring intervention on students' addition and subtraction skills. After administering math computation tests to a second grade class, several children were identified as students who would benefit from additional math instruction/activities.

Your child will be part of a sample that may be selected randomly to participate in an intervention. I would like to ask your permission for your son or daughter to participate in the 7-week intervention in order to assess the effectiveness of a math peer tutoring intervention that will first focus on teaching place value. With this additional training in place value, it is expected that your child will become more proficient with increasingly difficult addition and subtraction problems.

What is involved? Students who participate will be involved in a 7-week intervention that consists of the following three phases: (a) Phase One: Place Value Training with base-ten blocks, place-value arrows, and math worksheets; (b) Phase Two: Addition skills; and (c) Phase Three: Subtraction skills. There will be three sessions per week for 20 minutes per day. During each session, your child will be paired with a peer and they will be tutoring each other on these specific skills. I will be present at each session to help the students and to ensure that the intervention is accurately implemented. With the exception of the place value training phase, weekly addition and subtraction tests will be administered to monitor your child's progress.

Potential Benefits and Concerns. Although I will schedule each session so that your son or daughter does not miss important lessons, he or she may have to make up the missed weekly assessments conducted at the end of each week. Possible benefits of being in the project would be increased performance in the particular area of difficult addition and subtraction skills, increased practice and confidence, and of course, your contribution to the educational field in helping to find more tools to address the diversity of students in the classroom.

Participation is voluntary. Your son's or daughter's participation in this study is completely voluntary. There will be no penalty if you do not wish your son or daughter to be in this study, and he or she may withdraw at any time during the study. This project has been approved by the Board of Education and your son's or daughter's school.

Information is confidential. All information will be held as confidential as is legally possible. Only the researcher will see the student's assessment scores and all information will only be accessible to me. The results of all assessment scores will be reported only by group—no individual results will be reported. In addition, I will not use any students' names or other identifying information. All results will be stored in a locked file cabinet only accessible to me and all data retrieved before, during, and after the intervention will be saved in a password-protected computer file that only I will be able to access.

Questions? I would appreciate it if you would return the signature form on the last page whether or not you would like your child to participate, so that we know that this information has reached you. You may keep the attached copy of this letter for your records. If you have any questions, please feel free to contact Ms. Shauna Gega (937-256-0227), or the supervising assistant professor Dr. Julie Morrison (937-229-3621).

Furthermore, if you have questions about you or your child's legal rights, or the protections available to him or her, please contact Mr. Jon Nieberding, Chair, Institutional Review Board for the Protection of Human Subjects in Research, at (937) 229-4053 or jon.nieberding@udri.udayton.edu. If you contact Mr. Nieberding, please cite the name of the study, or the researcher's name.

Thank you for your consideration.

Sincerely,

Shauna L. S. Gega, MSE
Graduate Student
University of Dayton
School Psychology Program
sgega717@yahoo.com

Julie Q. Morrison, Ph.D.
University of Dayton Supervisor
Assistant Professor
School Psychology Program
Julie.Morrison@notes.udayton.edu

Parental Consent Form

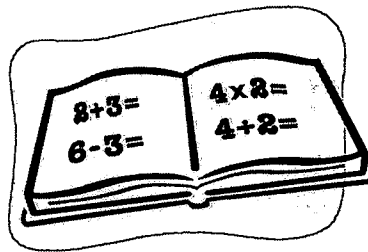
Please check the appropriate boxes and send this form back to school with your son or daughter.

- ☐ I have read and I understand the permission letter. I give consent for my child to participate in this study.
- ☐ I have received a copy of Ms. Gega and Dr. Morrison's letter for my records.
- ☐ I would like more information before giving consent for my child to participate in this study. Call me at _____.
- ☐ I do not wish for my child to participate in this study.

Parent's Signature _____ Date _____

Child's Name _____

Please send this form back to school with your son or daughter. Thank you!



Appendix B

Peer Tutor Guide

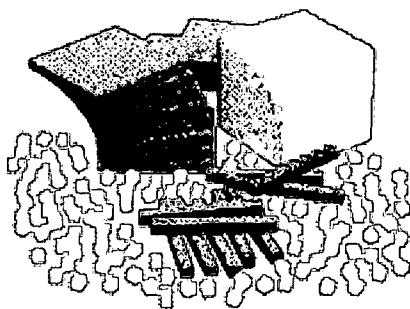
Phase One: Place Value Training

Student Name: _____

Date: _____

Instructions: With your partner, you will be going over the skills listed in this guide. Use the pictures to help guide you. You will first demonstrate each skill and then ask your partner to show you what you have just taught them. If you have any questions or need further assistance, please don't hesitate to ask Mrs. Gega! **DON'T FORGET TO PRAISE YOUR PARTNER FOR HIS/HER EFFORT AND A JOB WELL DONE!**

- 1) Show your partner what place value each base-ten block represents.



Yellow (little cubes) – *units* represent ones
 Green – *rods* represent tens
 Blue – *flats* represent hundreds
 Red – *cubes* represent thousands

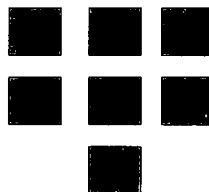
*Ask your partner to show you what place value each base-ten block represents.

- 2) Pick up a digit card and show your partner what the number looks like using the base-ten blocks.

Example:

1742

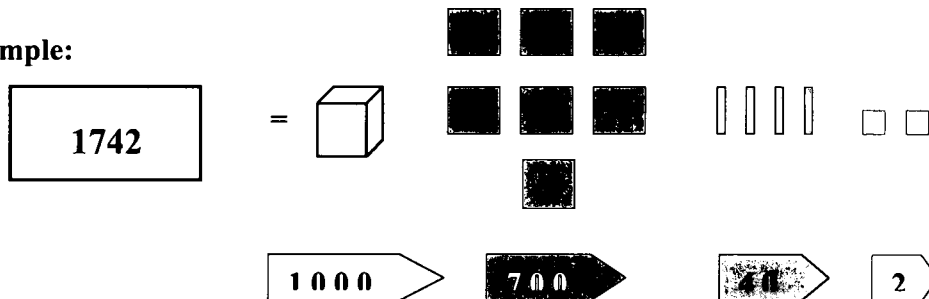
=



*Pick up another digit card and ask your partner to show you what the number looks like using the base-ten blocks.

- 3) Using the same number, show your partner how to make the number using the place value arrows. Reminder: The place value arrows match (colors) to its corresponding base-ten blocks!

Example:



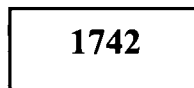
Place the arrows on top of each other to get this:



* Pick up another digit card and ask your partner to show you what the number looks like using base-ten blocks and place value arrows.

- 4) *Ones* place. Pick up another digit card and use the place value arrows to show your partner which digit is in the ones place.

Example:



The digit in the ones place is 2.

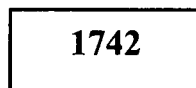
Show your partner the correct place value arrow.



*Pick up another digit card and ask your partner to use the place value arrows to show which digit is in the ones place.

- 5) *Tens* place. Using the same digit card, use the place value arrows to show your partner which digit is in the tens place.

Example:



The digit in the tens place is 4.

Show your partner the correct place value arrow.



*Pick up another digit card and ask your partner to use the place value arrows to show which digit is in the tens place.

- 6) *Hundreds* place. Using the same digit card, use the place value arrows to show your partner which digit is in the hundreds place.

Example:

1742

The digit in the hundreds place is 7.
Show your partner the correct place value arrow.



*Pick up another digit card and ask your partner to use the place value arrows to show which digit is in the hundreds place.

- 7) *Thousands* place. Using the same digit card, use the place value arrows to show your partner which digit is in the thousands place.

Example:

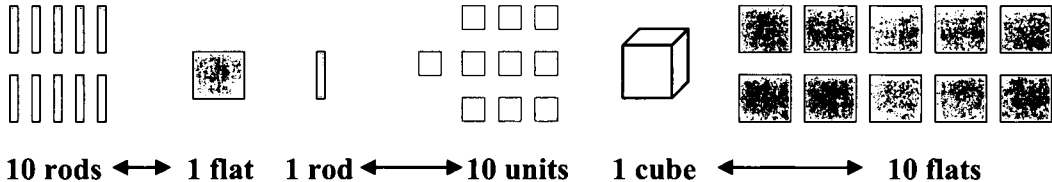
1742

The digit in the thousands place is 1.
Show your partner the correct place value arrow.

1000

* Pick up another digit card and ask your partner to use the place value arrows to show which digit is in the thousands place.

- 8) Show your partner adjacent place trades (10 for 1 or 1 for 10 trades).



- 9) Pick up another digit card and show your partner the number in its expanded form using the place value arrows.

Example:

1742

$$= 1000 + 700 + \quad + 2$$

* Pick up another digit card and ask your partner to show you its expanded form using the place value arrows.

AFTER YOU ARE DONE WITH ALL SKILLS, YOU MAY WORK ON ANY OF THE SKILLS THAT YOU PARTNER NEEDS HELP WITH UNTIL TIME IS UP. GREAT WORK!

Peer Tutor Guide

Phase Two: Addition

Student Name: _____

Date: _____






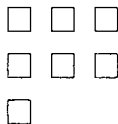
Instructions: With your partner, you will be going over the skills listed in this guide. Use the pictures to help guide you. You will first demonstrate each skill and then ask your partner to show you what you have just taught them. If you have any questions or need further assistance, please don't hesitate to ask Mrs. Gega! **DON'T FORGET TO PRAISE YOUR PARTNER FOR HIS/HER EFFORT AND A JOB WELL DONE!**

1) Make sure you have the following items:

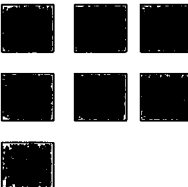

- Base-ten blocks
- Place value mat
- Place value arrows
- Math worksheets (Give blank worksheet to partner; keep the one with the correct answers!)

2) Show your partner the 2 strategies to solve the addition problems using the base-ten blocks. Reminder: If the sum of a column is 10 or greater, you must make a 10 for 1 trade with the next higher place value!

Sample Addition Problem: 725
 + 447

	Thousands	Hundreds (100)	Tens (10)	Ones (1)	
<u>1st addend</u>					725
<u>2nd addend</u>					+
<u>Answer</u> (Under place mat)					?

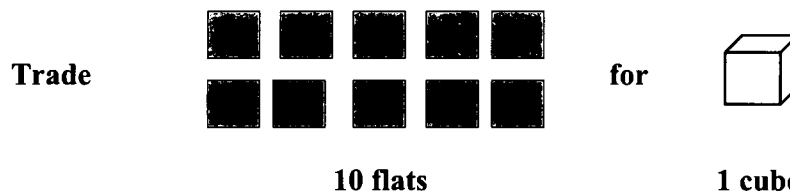
- Strategy #1 (front-end addition or left to right)

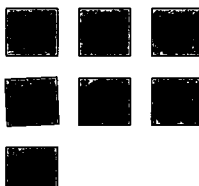

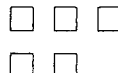


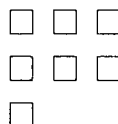



	Thousands	Hundreds (100)	Tens (10)	Ones (1)
<u>1st addend</u>				
<u>2nd addend</u>				
<u>Answer</u> (Under place mat)		$7 + 4 = 11 \text{ flats}^*$ $11 - 10 \text{ flats} = 1 \text{ flat}$ Trade 10 flats for 1 cube and leave remaining flat		

Steps:

1. Add up each column, starting from the left.
2. Add up the cubes in the thousands column.
3. Add up the flats in the hundreds column.

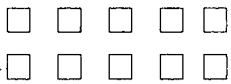

*Sum is 10 or more, so make a 10 for 1 trade with the next higher place value!

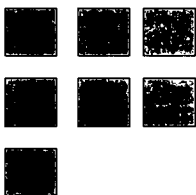

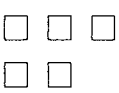


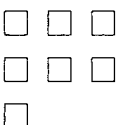




**Steps:**

	Thousands	Hundreds (100)	Tens (10)	Ones (1)
<u>1st addend</u>				
<u>2nd addend</u>				
<u>Answer</u> (Under place mat)		 Remaining 1 flat after trading for 1 cube		$5 + 7 = 12 \text{ units}^*$ $12 - 10 = 2 \text{ units}$ Trade 10 units for 1 rod and leave remaining units

4. Add up the rods in the tens column. Place the sum in the answer section.
5. Add up the units in the ones column. Place the sum in the answer section.
6. Show the answer using place value arrows and write answer on worksheet.

***Sum is 10 or more, so make a 10 for 1 trade with the next higher place value!**

Trade  for 
10 units 1 rod

	Thousands	Hundreds (100)	Tens (10)	Ones (1)	
<u>1st addend</u>					7 2 5
				+	
<u>2nd addend</u>					4 4 7
<u>Answer</u> (Under place mat)				 Remaining 2 units after trading for 1 rod	1 1 7 2

- Strategy #2 (back-end addition or right to left)
 - Start from right to left (ones to thousands column) first!
 - Reminder: If the sum of a column is 10 or greater, you must make a 10 for 1 trade with the next higher place value!
- 3) Have your partner work on each addition problem on the math worksheet, alternating between using front-end and back-end addition strategies.
- Use your answer sheet to check if your partner's answers are correct.
 - If the answer is not correct, give them the correct answer and move onto the next problem. You may explain why he/she did not answer it correctly.
 - Always praise your partner for his/her hard work and a job well done!
- 4) Keep working on each addition problem on the math worksheet until time is up.

Peer Tutor Guide

Phase Three: Subtraction

Student Name: _____

Date: _____

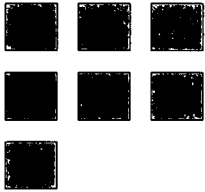

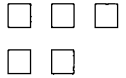


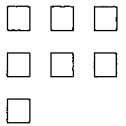
Instructions: With your partner, you will be going over the skills listed in this guide. Use the pictures to help guide you. You will first demonstrate each skill and then ask your partner to show you what you have just taught them. If you have any questions or need further assistance, please don't hesitate to ask Mrs. Gega! **DON'T FORGET TO PRAISE YOUR PARTNER FOR HIS/HER EFFORT AND A JOB WELL DONE!**

1) Make sure you have the following items:

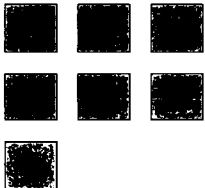

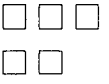


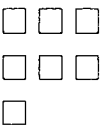

- Base-ten blocks
- Place value mat
- Place value arrows
- Math worksheets (Give blank worksheet to partner; keep the one with the correct answers!)

2) Show your partner the 3 strategies to solve the subtraction problems using the base-ten blocks. **Reminder:** If the top number in a column is smaller than the bottom number, you must make a 10 for 1 trade with the next higher place value! Basically, you must *borrow* 10 from the next higher place value.


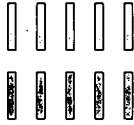
Sample Subtraction Problem: 725
 - 447

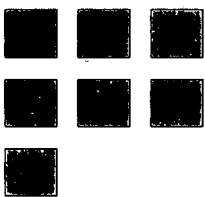

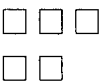


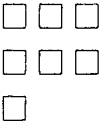


	Thousands	Hundreds (100)	Tens (10)	Ones (1)	
<u>1st addend</u>					725
<u>2nd addend</u>					447
<u>Answer</u> (Under place mat)					?

- Strategy #1 (front-end subtraction or left to right)


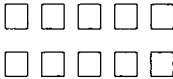
	Thousands	Hundreds (100)	Tens (10)	Ones (1)	
<u>1st addend</u>					Steps: 1. Subtract each column, starting from the left, putting answer in answer section. 2. Subtract the cubes in the thousands column. 3. Subtract the flats in the hundreds column. 4. Subtract the rods in the tens column.
<u>2nd addend</u>					
<u>Answer</u> (Under place mat)			Cannot minus 4 from 2* Borrow 10 from the hundreds place, then subtract again		

* Top number is smaller than the bottom number! Regroup and borrow 10 from the next higher place value!

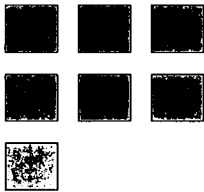



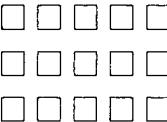


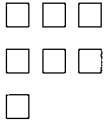





Borrow  for 
 1 flat 10 rods

	Thousands	Hundreds (100)	Tens (10)	Ones (1)	
<u>1st addend</u>					Steps: 5. Subtract the rods in the tens column. 6. Subtract the units in the ones column. 7. Show answer using the place value arrows and write correct answer on worksheet.
<u>2nd addend</u>					
<u>Answer</u> (Under place mat)		 1 flat traded for 10 rods to obtain larger top number in tens place		Cannot minus 7 from 5* Borrow 10 from the tens place, then subtract again	

*** Top number is smaller than the bottom number! Regroup and borrow 10 from the next higher place value!**

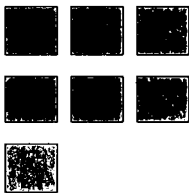




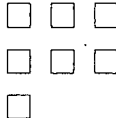
Borrow  for 

1 rod 10 units



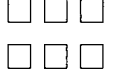


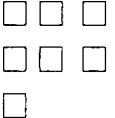
	Thousands	Hundreds (100)	Tens (10)	Ones (1)	
<u>1st addend</u>			  		7 2 5
<u>2nd addend</u>					4 4 7
<u>Answer</u> (Under place mat)			  		2 7 8

- **Strategy #2 (back-end subtraction or right to left)**
 - Start from right to left (ones to thousands column) first!
 - **Reminder:** If the top number in a column is smaller than the bottom number, you must make a 10 for 1 trade with the next higher place value! Basically, you must *borrow* 10 from the next higher place value.
- **Strategy #3 (checking top numbers and doing all regrouping first)**
 - This is easier than doing problems column by column and helps to avoid common mistakes.


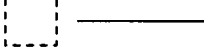













Strategy #3: Checking top numbers and doing all regrouping first:

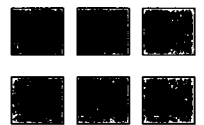







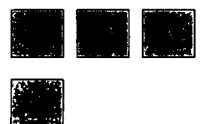



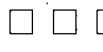
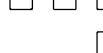





	Thousands	Hundreds (100)	Tens (10)	Ones (1)	<u>Steps:</u>
<u>1st addend</u>					1. Check the top numbers of each column first to make sure they are larger than the bottom numbers. 2. Check the top number in the ones column. 3. Make the necessary 10 for 1 trade.
<u>2nd addend</u>					
<u>Answer</u> (Under place mat)				Top number is smaller than bottom number* Borrow 10 from the tens place.	

*** Top number is smaller than the bottom number! Regroup and borrow 10 from the next higher place value!**

	Thousands	Hundreds (1000)	Tens (10)	Ones (1)	<u>Steps:</u>
<u>1st addend</u>					4. Place the borrowed 10 into the top row with the other units. 5. Check the top number in the tens column. 6. Make the necessary 10 for 1 trade.
<u>2nd addend</u>					
<u>Answer</u> (Under place mat)			Top number is smaller than bottom number* Borrow 10 from the hundreds place		

*** Top number is smaller than the bottom number! Regroup and borrow 10 from the next higher place value**

	Thousands	Hundreds (100)	Tens (10)	Ones (1)	
<u>1st addend</u>		 	  	  	Steps: 4. Place the borrowed 10 into the top row with the other rods. 5. Check the top number in the hundreds column. 6. Make the necessary 10 for 1 trade. 7. After all top numbers have been checked, subtract each column.
<u>2nd addend</u>		 	 	  	
<u>Answer</u> (Under place mat)					

	Thousands	Hundreds (100)	Tens (10)	Ones (1)	
<u>1st addend</u>		 	  	  	<div>7 2 5</div> <div>-</div> <div>4 4 7</div> <hr/> <div>2 7 8</div>
<u>2nd addend</u>		 	 	  	
<u>Answer</u> (Under place mat)				 	

- 5) Have your partner work on each subtraction problem on the math worksheet, alternating between using the 3 subtraction strategies.
- Use your answer sheet to check if your partner's answers are correct.

- If the answer is not correct, give them the correct answer and move onto the next problem. You may explain why he/she did not answer it correctly.
 - Always praise your partner for his/her hard work and a job well done!
- 6) Keep working on each subtraction problem on the math worksheet until time is up.

Appendix C

Treatment Integrity Checklist

MONDAYS & WEDNESDAYS

Name: _____ Date: _____ Day: M T W Th F

Instructions: For each step in the intervention, check "Y" if the step is completed or "N" if the step is not completed.

Intervention Steps	Y	N
I made sure that each group had all materials (i.e., base-ten blocks, place value arrows, place mats, digit cards, worksheets) before the session began.		
Before the start of the session, I randomly picked the names of the tutors.		
I gave the tutors their worksheets with the correct answers on it.*		
I gave the tutors their peer tutor guides.		
I circulated around the room, monitoring each group to ensure the accurate implementation of the peer intervention.		
When I heard the intervention implemented inaccurately, I quickly reminded the tutor(s) to adhere to the intervention steps.		
I did not help the tutor(s) until I was asked for help.		
I ensured that positive feedback and praise was given by the tutors.		

*Fill out only during addition and subtraction phases.

Treatment Integrity Checklist**FRIDAYS**

Name: _____ Date: _____ Day: M T W Th F

Instructions: For each step in the intervention, check "Y" if the step is completed or "N" if the step is not completed.

Intervention Steps	Y	N
I made sure that the group had access to all materials (i.e., base-ten blocks & placemats) before the session began.		
Before the start of the session, I randomly picked the names of the tutors.		
I wrote a math computation problem (addition or subtraction with regrouping, depending on phase) on the board.		
I instructed the chosen group member to demonstrate how to complete the math problem.*		
I did not help the tutor(s) until I was asked for help.		
After completing the problem, I asked the tutor to explain each step and how he/she obtained the answer.		
I ensured that positive feedback and praise was given by the other group members by modeling the behaviors.		
The entire procedure was continued with different group members until time was up.		
I administered a 2-minute math probe for progress monitoring.		

* Student had the choice of using the base-ten blocks or written procedure when solving problems.

Appendix D

Intervention Rating Profile

Intervention: Math Peer Tutoring w/ Place Value Training
and Base-Ten Blocks

The purpose of this questionnaire is to obtain your input about the math peer tutoring intervention that the graduate student implemented with the experimental group. This intervention sought to increase addition and subtraction skills (with and without regrouping) of students who are performing at the low average range for these math skills. Please circle the number which best describes your agreement or disagreement with each statement.

		Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
1.	This would be an acceptable intervention to increase addition and subtraction skills.	1	2	3	4	5	6
2.	This intervention was effective in increasing the students' addition and subtraction skills.	1	2	3	4	5	6
3.	I would suggest the use of this intervention to other teachers.	1	2	3	4	5	6
4.	The implementation of the intervention did not take place during direct instruction.	1	2	3	4	5	6
5.	Most teachers would find this intervention suitable for the academic problem described.	1	2	3	4	5	6
6.	I would be willing to use this intervention in the classroom setting.	1	2	3	4	5	6

7.	This intervention would <u>not</u> result in negative side-effects for the child.	1	2	3	4	5	6
8.	This intervention would be appropriate for a variety of children.	1	2	3	4	5	6
9.	This intervention is consistent with those I have used in classroom settings.	1	2	3	4	5	6
10.	This intervention is reasonable for the academic problem addressed.	1	2	3	4	5	6
11.	I liked the procedures used in this intervention.	1	2	3	4	5	6
12.	This intervention was a good way to handle the students' academic problem.	1	2	3	4	5	6
13.	Overall, this intervention would be beneficial for the students.	1	2	3	4	5	6

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