Summer 8-15-2016

How Does A Targeted Services Intervention Program Focused On Base-Ten Place Value Development Impacts Growth Of Second Graders In Mathematics

Katherine J. Shelley
Hamline University, kshelley01@hamline.edu

HOW DOES A TARGETED SERVICES INTERVENTION PROGRAM FOCUSED ON BASE-TEN PLACE VALUE DEVELOPMENT IMPACTS GROWTH OF SECOND GRADERS IN MATHEMATICS

by

Katherine Shelley

A capstone submitted in partial fulfillment of the
requirements for the degree of Master of Arts in Education.

Hamline University

Saint Paul, Minnesota

August 2016

Primary Advisor: James Brickwedde, Ph.D.
Secondary Advisor: Margaret Williams
Peer Reviewer: Kandy Schroer

To my loving and supportive family, thank you for your patience and encouragement throughout the fulfilling journey of completing my degree. To my colleagues, friends, and capstone committee, thank you for your guidance, insightful feedback, and dedication to your crafts. To all of you, thank you for making our time together such a rewarding experience. I could not have done it without you.

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CHAPTER ONE

Introduction

In my role as Math Specialist, I work with small groups of students who are below grade level expectations in the area of mathematics. When working with second graders, my instructional focus is to help students gain number sense with multi-digit numbers in order to become flexible mathematical thinkers. Students who are flexible mathematical thinkers are able to look at and manipulate numbers in different ways, which makes problem solving easier. Becoming a flexible mathematical thinker requires active involvement by the student. My school district created a Conceptual Place Value (CPV) resource that provides a progression of learning tasks to promote understanding of number sense. Conceptually learning mathematics is the difference between rote learning and reaching an understanding of math concepts. Even though there has been an overall increase in student understanding of place value concepts with multi-digit numbers when using the CPV resource, after the first two years, about half of the second-grade students at my school continue to assess below grade level expectations in this area. Therefore, I ask the question: *How does a Targeted Services intervention program focused on base-ten place value development impact the growth of second graders in meeting district achievement expectations in mathematics?*

Growing Up

As was common instructional practice at the time, I grew up memorizing basic facts, following specific steps in an algorithm, and thinking that there was a right and wrong way to solve math problems. I did not have a true understanding of mathematics concepts, but I was good at memorizing facts and procedures so it appeared that I excelled in mathematics. During fifth grade, I spent the year in the hallway with my math textbook teaching myself and solving all of the problems in my workbook. I finished working my way through the textbook in the middle of the school year so I spent the remainder of the year helping classmates who were struggling. In sixth grade, I was placed in pre-algebra with other higher-level mathematics students. Although math was becoming more challenging than in elementary school, I continued to find success in memorizing procedures. However, in seventh grade algebra my seemingly excellent math skills fell apart. I did not understand how to solve for a variable; the procedures made no sense and simple memorization no longer worked for me.

Since my math instruction up to this point was focused around memorization and not understanding, I lacked foundational mathematics skills. I had memorized the steps to use algorithms, but I did not understand why they worked. I had memorized all of the basic facts, but could not apply this knowledge to higher-level math problems. “One of the key components to understanding is being able to explain why a procedure works or why a particular statement is true” (Carpenter, Franke, & Levi, 2003, p. 5). The purpose of the CPV resource and having an instructional focus on teaching number sense and place value concepts in the early elementary years is to allow children the opportunity to develop relational mathematical thinking, an opportunity I did not receive in my elementary mathematics. Relational thinking refers to the process of children developing their own efficient and flexible strategies, in which they use fundamental properties of number and operations in their intuitive strategies (Carpenter, Fennema, Franke, Levi, &

Empson, 2015, p. 173). My missed opportunity in developing relational thinking may be a contributing factor to why I started struggling during seventh grade algebra.

Teaching Mathematics

The first curriculum I used to teach mathematics, *Investigations,* (Pearson Scott Foresman, 2004) used a hands-on, discovery approach. In almost every math lesson the students were supposed to use manipulatives to explore the content and then draw conclusions based on their discoveries. Many of the veteran teachers in my school disliked the curriculum and encouraged me to teach the more traditional methods of algorithms and memorization. Being a first year teacher and not realizing the importance of these explorations in developing student understanding of mathematical concepts, I followed the advice of my colleagues. After all, it was the way I had been taught so it made sense to me to continue teaching with memorization and algorithms. It was not until years later I would realize the significance of allowing students to explore and develop math understanding.

After two years teaching *Investigations*, I switched schools. At my new school, we taught from the *Singapore Math* curriculum (Singapore Math Inc, 2004). The first unit taught to second graders in this curriculum is focused on traditional place value, which focuses on the position the digit is in rather than the relationship between the digits. That is, for example, given the number 35, a child would explain how the number is made up of 3 tens and 5 ones. This is a remarkable first step in understanding place value. Unfortunately, this is where the curriculum stopped. Development of decomposing and recomposing numbers was not nurtured. For example, 35 can also be made with 2 tens and 15 ones or with 1 ten and 25 ones. This understanding that numbers can be built in many ways without changing the value is important in developing higher-level mathematics (Carpenter, et al., 2003). In fact, the traditional algorithm is based on this idea.

After five years teaching *Singapore Math* I again switched schools and accepted a position as the K-5 Math Specialist at an elementary school. In this current role I work with classroom and supplemental teachers to develop a math intervention system to help struggling learners reach grade level expectations. This includes teaching small groups of students, one-on-one teaching, monitoring student growth in math concepts, and communicating needs between teachers. Additionally I support K-5 teachers in the area of mathematics, offering professional development opportunities and assisting in the use and delivery of instructional best practices for the core curriculum.

As part of my role, I received extensive training in going through the Math Recovery Intervention Specialist certification process. This program provides intensive intervention training in the areas of addition and subtraction, composing and decomposing numbers up to 20, number word sequences, number identification, multiplication and division, and place value. The training lasted for an entire school year. To receive certification I needed to complete 100 hours of one-on-one teaching and develop expertise in early number development and instruction. This intensive training not only prepared me for my job as the Math Specialist, but also introduced me to the complex ways of how young children develop mathematical concepts. I learned the importance of children exploring mathematics and developing their own understandings and realizations on how numbers relate to each other. I learned about the complexities of number in a way I had not previously thought about it. I became aware of how the traditional drill-and-practice approach of memorizing basic facts and procedures of algorithms hinders mathematical development.

Conceptual Place Value Resource

The district I am currently working in as a Math Specialist noticed a need for elementary students, especially those in first through third grade, to develop the ability to flexibly think about and manipulate numbers. Three years ago, which was my first year in the district, an instructional resource was created and distributed to all first, second, and third grade teachers to supplement our *Everyday Math* (Bell, Bell, & University of Chicago School Mathematics Project, 2007) curriculum. The resource, known as Conceptual Place Value (CPV), contains lessons and activities for teaching place value. Students are assessed using a district-created assessment to determine what level they are at in their place value understanding. CPV has a linear design breaking place value into 8 levels. By the end of first grade children are expected to be able to count backwards and forwards by tens and ones. Building on this, in second grade children progress to being able to mentally add and subtract two-digit numbers demonstrating understanding of how to use at least two strategies. Finally, in third grade, children develop strategies for mentally solving three-digit addition and subtraction problems.

The CPV resource is laid out with targeted learning outcomes, instructional strategies for teacher use, and activities for children to explore in order to develop flexible mathematical thinking and understanding. Some strategies explored in CPV for solving multi-digit addition and subtraction problems include adding or subtracting through the decade, breaking numbers apart into tens and ones, or transforming numbers to make the problem easier to solve. The specific strategies used are not the focus of the curriculum, but rather the focus is on children developing multiple strategies to choose from when solving addition and subtraction problems. One key idea of the resource is for children to explore, develop, and demonstrate a strong understanding of how place value directly correlates to addition and subtraction.

Rationale

Many students in my school continue to struggle with place value understanding, including retaining knowledge in the subject area and in application of their understanding. On a daily basis I work to determine the best way to help our students in acquiring these foundational math skills. Is there a need for more math discourse during instruction? Are we doing a good enough job tying the CPV resource to real-world problems? Is the CPV progression missing components? Although we have seen progress from students throughout the year, we continue to have about one-third of our students below district achievement expectations as determined by the CPV assessment at the end of second grade.

Process

There are several variables as to why we continue to see a need in this area. The purpose of this action research project is to determine the effectiveness of the CPV resource on helping below-grade level second graders become flexible mathematical thinkers and reach district achievement expectations. The action research will take place during a Targeted Services after-school intervention class, which allows for additional instructional support for struggling learners. Research will focus on determining which activities are the most beneficial in developing understanding and in which areas students are struggling the most. When students are struggling on a skill, I will utilize instructional methods from other research beyond the CPV resource to help students build their base-ten place value understanding.

Summary

In this chapter I discussed my own journey of understanding mathematics, through childhood successes with rote memorization to struggles in understanding algebra. As I started my career teaching mathematics I focused on the same rote memorization and procedural based methods I had been taught rather than using the beneficial exploration methods of the *Investigations* curriculum. Through extensive training during the Math Recovery Certification process and informal observations after the training occurred, I realize the importance of having students explore and develop their own realizations of number and mathematical concepts. Higher-level mathematics heavily relies on place value understanding; a skill which children can begin developing at an early age. My current school district created a resource, known as Conceptual Place Value (CPV), to supplement district curriculum and help students develop multi-digit numerical understanding. Even with this resource students at my school continue to struggle with place value, as almost one-third of our students are not meeting district achievement expectations, which are based on the Minnesota state standards, by the end of second grade. My action research is based on this need as I ask the question: *How does a Targeted Services intervention program focused on base-ten place value development impact the growth of second graders in meeting district achievement expectations in mathematics?*

CHAPTER TWO

Literature Review

Overview

The purpose of this study is to determine the effectiveness of an after-school Targeted Services intervention class in helping underperforming second grade students meet district achievement expectations, which are based on state standards, in the area of mathematics. The focus of the class will be on developing base-ten place value understanding and applying this understanding to solving addition and subtraction problems. The research question guiding this study is: *How does a targeted services intervention program focused on base-ten place value development impact growth of second graders in meeting district achievement expectations?* In this chapter researched based, peer reviewed literature pertaining to the content of the research question is reviewed.

The literature begins by reviewing interventions, including the reasoning for and importance of interventions. The review discusses the importance of having intervention instruction targeted to the specific and unique needs of each individual learner. In order to deliver this instruction, interventions require teachers to be highly trained in the content area they are teaching. The review also describes the importance of placing students into intervention groups as early as possible, to ensure students do not fall even further behind.

Next, the review goes on to discuss Targeted Services, a Minnesota state funded intervention program geared towards offering extra instructional support to students deemed at risk. Targeted Services is a specific type of intervention program offered in the state of Minnesota. The history and purpose of targeted services will be discussed. The review goes on to describe student eligibility guidelines and instructional expectations as laid out by state mandate. Finally, the effectiveness of Targeted Services, as shown in other studies, will be analyzed.

The last section of the review discusses place value and the application of understanding to solving addition and subtraction problems. This section describes the progression children go through in counting. It goes on to explain the importance of understanding number structure and groupings of ten. Finally, this section describes the importance of children applying place value understanding in the development of addition and subtraction techniques.

Interventions

If our goal is for all students to learn then interventions are a necessity, as not all students learn the same way at the same pace. According to the Response to Intervention (RtI) framework (Buffum, Mattos, & Weber, 2012) 80% of students should develop understanding of a concept during core instruction, the initial instruction students receive in the classroom. In order for the remaining 20% of students to develop the same understanding and to be successful, they require additional instruction, known as an intervention (Buffum et al., 2012; Gresham & Little, 2012). There are several characteristics of an effective interventions model.

There are many elements associated with creating an effective intervention process. According to Buffum et al., (2012), “There are two primary reasons why many schools struggle with identifying effective interventions: The ‘more of the same syndrome’ and the ‘what program do we buy?’ syndrome” (p. 130). In order to see improvement teachers cannot continue to instruct in the same way with the same methods as initially used in core instruction. Rather, teachers must align instruction to meet the learning styles and targeted academic goals of the students receiving intervention support.

Teachers and Interventions

Interventions are a critical part of helping students who are behind academically master the skills and concepts they need to reach grade level expectations. Those who teach intervention groups should be highly skilled and highly trained teachers. One metaphor, shared by Buffum et al. (2012):

> In the medical field, patients are assigned the help of medical professionals based on the severity of their illnesses and the expertise needed to address the problem. For example, someone suffering from the flu usually sees a nurse practitioner or family physician, while a cancer patient visits an oncologist. (p. 135)

Teachers who are specialized and have received extensive training are likely to be better prepared to offer high-quality instruction matching student needs as they have the most knowledge about academic progressions and learning styles. These are the teachers who should be working with the most vulnerable students, the ones in need of intervention (Buffum et al., 2012; Penuel & McGhee, 2010). A school or district cannot simply adopt an intervention curriculum to meet the needs of all students who are struggling, as the needs will vary. Specialized teachers have the skillset to create materials and adjust instruction to meet the unique needs of each individual learner. Research shows that one of a school's most effective learning strategies is to have highly trained teachers work with the students most at risk (Buffum et al., 2012, p. 135).

Intervention Content

Due to the diverse needs of students, there is not a curricular program a school can buy to ensure all needs are met. Mattos stated, "If you do find a program that is able to teach the essential standards and targeted goals to mastery for all students, use it for core instruction. There would no longer be a need for interventions" (personal communication, October 27, 2015). At this time, no such program has been created.

Interventions need to be specific and targeted to the standards and skills with which students are struggling. This is important to the success of an intervention. If the skill being taught is too broad, it takes more time for the child to develop understanding and the potential exists for the child to remain behind. According to Riccomini and Smith (2011), the instruction students receive in an intervention needs to be more systematic and explicit than what they received in core class instruction (p. 11).

Additionally, the remedial instruction of an intervention should be added to, not substituted for, core instruction. If students are pulled from core instruction to receive the remedial support they need, they will continue to be behind and the need for remediation will continue (Johnston, 2010, p. 15)

Student Placement in Interventions

Initially, students are placed into an intervention group based on formal data, frequently collected by the classroom teacher. Formal data indicating a child is in need of an intervention can be collected in many ways, but must result in determining specific areas of need. A standardized test, for example, can be used to determine that a child is behind grade level but does not indicate the specific skills with which the child is struggling. Therefore, if standardized tests and other similarly broad tests are used to place students in intervention groups, additional testing needs to occur to determine specific misunderstandings and skills to work on (Buffum, et al., 2012, p. 57).

After a child is initially placed into an intervention, a mixture of informal and formal assessments should be utilized during instruction to track growth and make needed adjustments. When assessments are used to determine learning rates, level of performance, and for monitoring growth, we can make decisions about instruction and educational goals for maximizing achievement (Gresham & Little, 2012, p. 23).

Timing of an Intervention

Research shows effective interventions should happen as early as possible, ensuring students do not fall even further behind (Buffum et al., 2012; Johnston, 2010). Fitting the needed time for intervention into an already full school day can be difficult. Therefore, timing for interventions needs to be planned for and included in the master schedule. Interventions can occur before school, during the school day, or after school. One struggle to overcome when offering before and after school programming is attendance. Research shows regular attendance is necessary for students to benefit from intervention instruction (Penuel & McGhee, 2012, p. 29). There are numerous ways for schools to overcome this challenge, such as offering transportation home or offering alternative intervention classes during the school day for students unable to come before or after school. It is important for schools to work with students and families to ensure a system is put in place so students can receive the additional support they need.

Some interventions last for a relatively short time frame while others may be in place for an entire school year. The length of an intervention is dependent on the needs of the students. The National Center on Response to Intervention (2010) stated, “10 to 15 weeks of explicit instruction should be given to build targeted skills and competencies in mathematics” (p. 12).

Summary

Interventions are a necessity in helping students who are behind learn the needed remedial skills to meet grade level expectations. Successful interventions have highly-trained teachers who are able to deliver the appropriate instruction to meet the specific and targeted needs of the learner. Intervention support needs to be timely and begin as soon as possible to help ensure the child does not fall further behind. Furthermore, the remedial instruction of an intervention needs to occur in addition to, rather than in place of, core instruction.

Targeted Services

Targeted Services is the intervention programming that offers additional education support before-school, after-school, or in the summer to students enrolled in kindergarten through eighth grade (Office of Legislative Auditor, 2010). The additional instruction offered to students through Targeted Services is focused on helping students who are behind in one or more content areas, as determined by formal and informal assessing, receive the extra support they need to meet grade level expectations.

History

In 1987, a Minnesota Statute implementing special programming for eligible pupils aged five through twenty-two was adopted (Minnesota Department of Education, 2014). According to the Minnesota Department of Education (2014), eligible pupils include all learners deemed “at-risk” of not graduating high school. Initially, programming focused on individuals 16-years old through adult. In 1990, the Minnesota Department of Children, Families & Learning pushed for full implementation of the statue by bringing Targeted Services to elementary and middle school students (Minnesota Department of Education, 2014). According to Minnesota Statute 124D.128 (2013), “a learning year program provides instruction throughout the year on an extended year calendar, extended school day calendar, or both.”

Purpose

Targeted Services is an intervention program designed to help students who are below grade level expectations be successful and stay in a traditional school setting. As stated by the Minnesota Department of Education (2014), the alternative education mission statement is “To support viable educational options for students who are experiencing difficulty in the traditional system and are at risk of education failure” (p. 5). The program helps students build academic skills, through the use of remedial instruction, to support success in the regular curriculum. This is accomplished by increasing the amount of instructional time students receive through extending the school day or school year.

Student Eligibility

In order to participate in a Targeted Services class, a child must meet the defined at-risk criteria (Minnesota Department of Education, 2014). There are twelve eligibility points, as described in Minnesota Statute 124D.68, to determine if a child is at-risk (Graduation Incentives Program, 2012). The eligibility points for elementary students include performing below grade level on achievement tests, experiencing homelessness sometime within the past six months, and/or speaking English as a second language (Graduation Incentives Program, 2012).

In addition to meeting one or more of the defined eligibility points, students must show they are able to be independent, safe, and successful while attending the class (Office of Legislative Auditor, 2010). Children are typically not invited to participate if there is a concern that behavior will be a problem in class. There are alternative programs that exist for children with extreme behavior concerns who qualify for special education.

Instructional Expectations

Targeted services should be different from the core instruction happening during the school day. If it is just more of the same, most likely the results will be the same (Minnesota Department of Education, 2014). In order to see growth, it is imperative for Targeted Services programming to be focused on meeting the academic and learning style needs of the students. According to the Minnesota Department of Education (2014), "many students that are identified as at-risk have a learning style that is incompatible with the traditional environment" (p. 32). Therefore, classes need to be taught by highly qualified teachers. The teachers need to have strong background knowledge in the content being taught in order to make instructional adjustments to match academic needs as the needs change. In addition, the teachers need to understand the wide array of learning styles and how to appropriately deliver instruction to each so that academic growth occurs (Office of Legislative Auditor, 2010).

Effectiveness

According to the Office of Legislative Auditor for the State of Minnesota (2010), students who received targeted services showed higher-than-expected growth on the MCA-II and Northwest Evaluation Association (NWEA) Measure of Academic Progress (MAP) standardized tests when compared with other students (p. 42). In order to conduct the analysis, the Office of Legislative Auditor used three benchmarks to measure progress, two for the MAP test and one for the MCA-II test. Benchmarks used for the MAP test included “one based on national norms and the other based on a matched comparison group” (p. 42). The benchmark used for the MCA-II test was “based on other Minnesota students” (Office of Legislative Auditor, 2010, p. 42).

Results showed students who had received targeted services experienced increases on MAP and MCA-II test scores that exceeded expectation. The Office of Legislative Auditor (2010) findings showed students who received additional instruction through Targeted Services made statistically significant gains when compared to national norms as based on MAP results. Additionally, Targeted Services students outperformed the comparison group on MAP growth scores. Analysis of MCA-II data showed that of students who received targeted services a larger percentage showed high growth, 29%, than low growth, 25% (Office of Legislative Auditor, 2010, p. 42-44). The data shows that students who received targeted services intervention support demonstrated higher than expected growth on the MAP and MCA-II standardized assessments when compared with other students and national norms.

Summary

Targeted Services is a Minnesota state funded intervention program allowing students who are "at-risk" for academic failure to receive support through extended day or extended year calendars. Analysis has shown that participation in a Targeted Services class is effective in helping children make gains, as demonstrated on two standardized tests. Best practice for effective interventions and Targeted Services indicate that instruction needs to be different than what children receive during the school day; it needs to be focused on student learning styles and specific academic needs (Buffum et al., 2012; Minnesota Department of Education, 2014).

Place Value and Application

Base-ten place value understanding is a foundational skill in mathematics development. Children do not need to master one skill in its entirety before moving on to another. It is important to remember all students do not learn place value concepts in the same way and at the same time (Fosnot, 2010, p. 23). Some children need more time to understand a skill. Other children construct ideas and strategies in an order different than what the teacher predicted. According to Fosnot and Dolk (2001) "Because learning is not linear, teaching cannot be either" (p. 28). Some place value skills are progressive, with one needing to be learned before another. While other concepts should be taught and explored concurrently.

Counting

Children begin learning how to count at a young age. This task may appear simple at first, but is actually quite complex. According to Van de Walle, Karp, and Bay-Williams (2013) rational counting has at least two separate skills. First, children must recite the number sequence in order. This refers to rote counting word sequence, such as "One, two, three. . . ." Second, children must develop one-to-one correspondence. This is the ability to match one number word to one object (p. 131). Children demonstrate one-to-one correspondence by moving each item in a collection, or by pointing at each item, and coordinating each movement or point with a number word (Wright, Stanger, Stafford, & Martland, 2006, p. 48).

In addition to understanding one-to-one correspondence, children need to develop cardinality when counting a collection. Cardinality refers to the understanding that number means amount (Fosnot & Dolk, 2001; Van de Walle, et al., 2013). It is the idea that the last number said when counting is the amount you have. This amount stays the same, even if the items in the group are rearranged or covered up. Fosnot and Dolk (2001) stated, "All children struggle to understand cardinality. . . . No matter what country, what language, this is one of the first big ideas in a young child's mathematical development" (p. 33).

Another concept that children often struggle to understand in their early years is the idea of hierarchical inclusion. This is the idea that a number identifies a quantity that is one more than the previous number and that the new quantity is embedded in the previous quantity. Kamii and Joseph (2004) explained hierarchical inclusion as the child's ability to mentally include the quantity of 'one' within 'two,' the quantity of 'two' within 'three,' the quantity of 'three' within 'four,' and so on (p. 7). In order to develop mathematical thinking at a higher level, children need to understand that numbers represent amounts and smaller quantities are embedded in larger quantities.

Children need to understand the big ideas of rational counting, one-to-one correspondence, cardinality, and hierarchical inclusion to understand numbers (Fosnot & Dolk, 2001, p. 49). Without fully developing these understandings, number words are not connected to anything and, therefore, provide no meaning.

After children have developed the basic counting ideas of one-to-one correspondence, cardinality, and hierarchical inclusion they can begin learning how to count in groups. As children become more facile in their ability to count by ones, they will develop the ability to count in groups of objects. Typically, the ability to count by 10s develops before being able to count other groups (Wright, Ellemor-Collins, & Tabor, 2012, p. 28).

When initially learning to count objects in groups, there are two common misconceptions that occur. The first is that children think the overall amount changes. For example, a child counts a group of objects one at a time and arrives at the correct answer of twenty-four. Then, when asked to count the same group of objects by twos, the child does not realize they will still arrive at the answer of twenty-four. This is a natural stage in children's development (Richardson, 2012, p. 80). The second misconception occurs when the groups are broken into single objects. For example, a group of connecting cubes is made up of 4 tens and 5 ones, or 45 total cubes. One group of ten is then broken apart so there are now 3 tens and 15 ones. A child learning how to count by groups may not see that 3 tens and 15 ones is still 45 total cubes (Richardson, 2012, p. 81). With meaningful practice, students pick up the patterns of counting groups of items and develop the awareness that the amount in a group stays the same (Richardson, 2012; Wright, et al., 2012).

As children progress in their counting ability, they begin informally working on place value skills. Students are exposed to the base-ten place value system when counting groups of ten and some more (Wright, et al., 2012, p.79). Even though formalized instruction may not occur while practicing counting groups of ten, the exposure students receive during this practice helps develop place value understanding (Van de Walle, et al., 2013, p. 132).

Structure

Structure refers to children's ability to combine and partition numbers without counting. Students should begin by working on parts of numbers to five. This includes recognizing numbers up to five in a variety of configurations (Wright, et al., 2006, p. 66). For example, four can be broken into the parts one and three, two and two, or four and zero. To have full understanding of this concept, children need to recognize that the smaller parts are contained in the larger number (Richardson, 2012, p. 50). Once students demonstrate knowing parts to five, they should begin working on parts to ten (Wright et al., 2006, p. 67).

Facility in knowing the reference numbers five and ten helps students move past using count-from-one procedures to more developed ideas of relationships between numbers. Relating a given number to other numbers, specifically 5 and 10, is especially useful in thinking about various combinations (Van de Walle et al., 2013, p. 137). For example, 8 + 4 may be thought of as 8 + 2 + 2, which utilizes the reference number of 10. As children develop in mathematics, similar relationships can be applied to computation skills of larger numbers, such as 58 + 6. According to Wright et al. (2006) when children are facile in knowing the parts to five and parts to ten they are never more than two away from a reference point number (5, 10, 15, 20, 25, and so on). Knowing the structure of numbers up to ten is beneficial as children begin developing ideas on how to solve addition and subtraction questions using invented algorithms, as discussed later in this chapter.

Groupings of Ten

In order for place value concepts to be meaningful, children need to know that the underlying structure of number is based on organizing amounts into groups and counting these groups as single units (Richardson, 2012, p. 75). According to Carpenter, Fennema, Levi, and Empson (1999) to understand base-ten numbers the central principle children need to realize is that collections of ten can be counted (p. 59). This means, groups of ten can be talked about just as we talk about individual units. For example, forty-seven can be thought of as forty-seven individual counters or as four groups of ten counters and seven additional counters. Expanding further on this idea, forty-seven can also be seen as three groups of ten counters and seventeen additional counters or as two groups of ten counters and twenty-seven additional counters, and so on. The ability to flexibly think of numbers based on place value is essential in understanding mathematics. Researchers Carpenter et al. (1999) stated, "This understanding (flexibly thinking of numbers) represents an important milestone in the development of base-ten number concepts" (p. 62).

Multiplication and division. Using multiplication and division word problems can help children develop the idea of groups of ten (Carpenter, Fennema, Franke, Levi, Empson, 2015, p. 84). When these types of problems use ten as a group, children are able to develop and use ideas of the base-ten number system. For example, a multiplication question that develops the idea of base-ten would be: “Mr. Spencer has 5 boxes of pencils. There are 10 pencils in each box. How many pencils does he have?” Extending this, children should also be exposed to multi-step multiplication and addition problems with groups of ten and some more. An example problem of this idea is: “Mr. Oliver has 3 boxes of pencils. There are 10 pencils in each box. He also has 7 additional pencils. How many pencils does he have?” Measurement division problems can be used to develop base-ten ideas by breaking larger numbers into groups of ten. A measurement division problem example that develops base-ten understanding is: “Ms. Sophie has 36 library books. Each book-bin can hold 10 books. How many book-bins will be full? How many books will be in a bin that is not full?”

According to Carpenter et al. (2015) initially students will solve multiplication and division problems by using a counting-by-ones strategy. As awareness of counting in groups of ten develops, children will apply this understanding and begin solving problems through counting by tens. Once children develop the capability to count in groups of tens, they will be able to apply direct place value ideas (p.89). The graphic in Figure 1, adapted from Carpenter et al. (2015), illustrates the progression of solving multiplication problems through the stages of counting by ones, then counting by tens, and finally, direct place value.

To understand number children need to realize that collections of groups can be counted as single units. The ability to flexibly think about numbers is essential in mathematical development. One way to develop this understanding is through the use of multiplication and division word problems focused on groups of ten. As children develop strategies to solve these problems they concurrently begin to develop base-ten place value awareness. Children's flexibility in thinking about numbers as groups of items and individual units can be applied to the creation of addition and subtraction invented algorithms, as discussed later in this chapter.

	Strategy Progression		
Problem	Counting by Ones	Counting by Tens	Direct Place Value
Mr. Oliver has 3 boxes of pencils. There are 10 pencils in each box. He also has 7 additional pencils. How many pencils does he have?	Creates 3 groups of 10 counters to represent the full boxes. Then, sets out 7 additional counters. Finally, counts all of the counters by ones.	Counts 3 groups of 10 "10, 20, 30" followed by counting by ones "31, 32, 33, 34, 35, 36, 37". Keeps track of counts on fingers.	Answers 37. Knows 3 tens is 30 and 7 more is 37.

Figure 1. Grouping by Tens Progression. This figure illustrates the progression children go through in developing place value understanding through the use of multiplication word problems.

Addition and Subtraction

As students learn the structure of the base-ten number system and build awareness of place value, they begin applying their understanding to solving addition and subtraction problems. At first, children use counting to solve both addition and subtraction problems (Wright, et al., 2006, p. 25). As larger numbers are used students build understanding of ways to manipulate numbers to solve addition and subtraction problems through the use of invented algorithms.

By counting. Once students have developed awareness of counting by ones they are able to begin solving addition and subtraction problems. According to Wright, et al. (2006) the ability to solve basic addition and subtraction problems can begin before learning about place value. Initially, students will use a count-from-one strategy, sometimes referred to as direct modeling (Wright, et al. 2006, p. 126). An example of this can be seen in Figure 2. In the example, a child is solving 8 + 5. They begin by setting out a group of eight counters. Then, the child sets out a group of five counters. Finally, the child would go back and counts all of the counters to determine the answer 13.

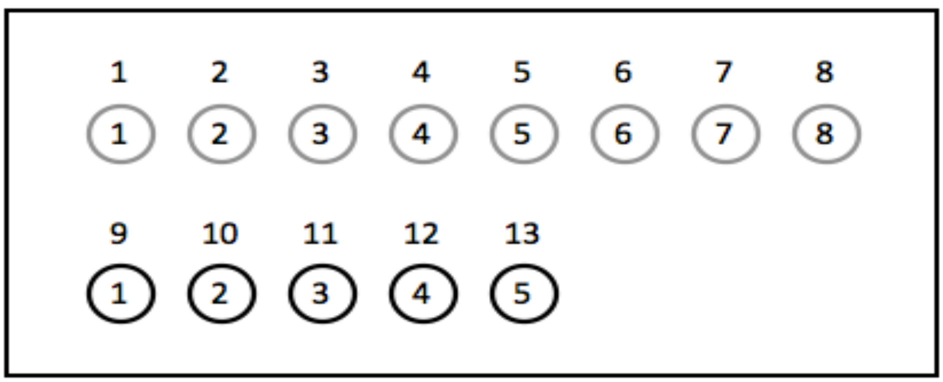

Figure 2. Count From One Strategy. This figure illustrates the thinking of a child using the count-from-one method for solving 8 + 5.

With appropriate experiences, most students will begin developing more advanced counting methods. The next stage for solving addition problems is referred to as counting-up-from (Wright, et al., 2006, p. 167). This stage builds on understandings developed while using the counting-from-one method. Rather than needing to start from one, children are able to count on from the first group. For example, in solving 8 + 5 the child is able to begin at eight and count on five more, such as “8, 9, 10, 11, 12, 13” (Van de Walle, et al., 2013, p. 133). Figure 3 illustrates using the count-up-from method for solving the question 8 + 5.

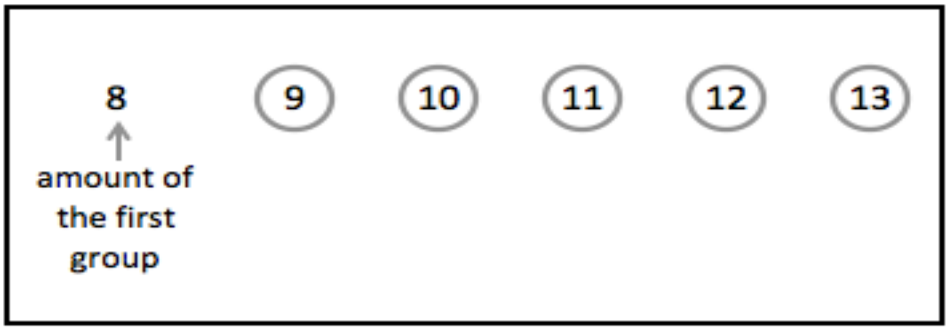

Figure 3. Count Up From Strategy. This figure illustrates the thinking of a child using the count-up-from method for solving 8 + 5.

Early counting strategies for addition and subtraction questions help develop understanding of number as children begin to see a quantity as a group. In order to solve addition and subtraction problems using counting strategies children need to apply initial understanding of numbers, such as counting and one-to-one correspondence.

Non-counting. As children continue to explore strategies for solving addition and subtraction problems they will develop more efficient, higher-level non-counting strategies (Wright, et al., 2006, p. 49) These strategies take the understanding of decomposing numbers and apply the concept to problem solving. In using non-counting strategies it is helpful for children to be facile in knowing the combinations of ten (Wright, et al., 2006 p. 58). Figure 4 shows one way a child may decompose numbers to solve an addition problem. To be successful the child needs to know three concepts: first, that five can be decomposed into two and three, second, that eight and two make ten, and finally, that ten plus three makes thirteen. Through time and practice, children realize that non-counting strategies are more efficient and reliable than counting strategies (Wright, Martland, Stafford, & Stanger, 2010, p. 204).

8 + 5 = 13

2 + 3

8 + 2 → 10 + 3 → 13

Figure 4. Decompose the Addend. This figure illustrates how the child would break apart 5 to make solving 8 + 5 easier.

Invented algorithms. Invented algorithms, also referred to as invented strategies, refer to any strategy children create to solve addition or subtraction questions. Many researchers agree on the importance of invented algorithms in the development of addition and subtraction understanding (Carpenter et al., 2015; Fosnot & Dolk, 2001; Van de Walle et al., 2013; Wright, et al., 2006). Some of the benefits of invented algorithms include fewer procedural errors, less re-teaching of steps, further development of number sense, and the creations of multiple flexible methods (Carpenter et al., 2015; Van de Walle, et al. 2013).

Types of invented algorithms. The concepts of counting in groups and decomposing and recomposing numbers in a variety of ways are applied in the creation of invented algorithms. According to research there are four common invented algorithms, including: Incrementing, Tens and Ones, Compensation, and Transformation (Carpenter, et al., 2015; Fosnot & Dolk, 2001; Van de Walle, et al., 2013; Wright, et al., 2012). These four categories were created based on how each strategy builds and develops different understandings pertaining to addition and subtraction. Figure 5 illustrates each invented algorithm method.

The Incrementing invented algorithm refers to making jumps forwards or backwards to solve for a problem (Van de Walle, et al., 2013, p. 221). Using the incrementing method, a child would solve 37 + 25 by decomposing 25 into parts then reconfiguring (addition) or decomposing (subtraction) the numbers in sequential increments. In order to be successful in this method a child must be facile in parts of 5 and parts of 10.

Another common invented algorithm children develop is the Tens and Ones strategy; also referred to as the combining the same units or split method (Carpenter, et al., 2015; Wright, et al., 2012). Using this strategy children apply understanding of number structure to decompose each number into tens and ones. Then, the child adds the tens together, the ones together, and combines to find the total amount. In solving 37 + 25 a child would add together 30 and 20 to make 50, then add together 7 and 5 to make 12, and finally combine 50 and 12 to make 62.

Compensating is a common invented algorithm children use when turning one addend into a different number makes computation easier (Carpenter, et al., 2015, p. 103). This strategy relies on children's understanding of numbers in relation to other numbers. In using this method, initially the child adds to or subtracts from one of the addends to make computation easier. Then, as the last step, the child undoes the compensation.

Transformation is used when changing both numbers allows for easier compensation (Van de Walle, et al., 2013, p. 223.) This method is very similar to compensating, in that the numbers in the original problem are transformed to make computation easier. In transformation, one number is decomposed and one of those addends is then re-associated with the second number.

Incrementing 37 + 25 37 + 20 → 57 + 3 → 60 + 2 → 62 (25 was split into 20 + 3 + 2 to make adding easier)	Compensation 53 + 39 Think: 39 + 1 = 40 53+ 40 = 93. That's 1 extra, so it's 92.
Tens and Ones 37 + 25 30 + 20 = 50 7 + 5 = 12 50 + 12 = 62	Transformation 53 + 39 Think: 39 + 1 → 40 Then, adjust the other number: 53 – 1 → 52 52 + 40 = 92

Figure 5. Common Invented Algorithms. Incrementing, Tens and Ones, Compensation, and Transformation are four common invented algorithms children discover when solving addition and subtraction problems.

Benefits. Invented algorithms are different from the traditional algorithm in that children create invented algorithms through the application of their own understandings of place value and numerosity (Carpenter, et al., 2015, p. 103). Invented algorithms are number oriented whereas the traditional algorithm focuses on the digit, rather than the value of the digit (Van de Walle, et al., 2013, p. 218). Using the traditional approach, the numbers 28 + 36 would be thought of as 2 + 3 rather than 20 + 30. According to Kamii and Dominick, the standard algorithm "unteaches" place value (as cited in Van de Walle, et al., 2013, p. 218). Invented algorithms also offer the benefit of the child creating a range of flexible options to use to solve problems rather than having "one right way", as the traditional algorithm teaches (Carpenter, et al., 2003). According to Van de Walle, et al. (2013) depending on the numbers being used, invented algorithms change as children apply number understanding to solutions. Using the traditional algorithm approach, specified steps are followed for all problems. The use of the traditional algorithm in solving 600 – 299, often leads to errors, whereas a mental strategy invented algorithm is relatively simple.

Research. Researchers Kamii and Dominick (1998) did a study on the effects of learning traditional algorithms versus invented algorithms. In the study, three groups of children were compared: those that had only been taught the traditional algorithms, those that had not been taught the traditional algorithm, and those that had been taught a mixture of the traditional and invented algorithms. The study involved children in second-grade. The question asked was 7 + 52 + 186. Of the students who had previous instruction using the traditional algorithm, 12% had the correct answer of 245. Of the students who had some instruction using the traditional algorithm and some instruction using invented algorithms, 26% had the correct answer. Of the students who had no instruction using the traditional algorithm, 45% had the correct answer. Analysis of her data further shows that the children who had received instruction using only the traditional algorithm had answers ranging from 9,308 to 29. However, the group of students who had received no previous instruction on the traditional algorithm had answers ranging only from 617 to 138 (Kamii & Dominick, 1998, pp. 133-134). According to Fosnot and Dolk (2001):

> This is strong evidence that the algorithm actually works against the development of children's understanding of place value and of number sense. As they focus on

> doing the procedures correctly, they sacrifice their own meaning making; they sacrifice an understanding of the quantity of the numbers they are dealing with. (p. 121)

A similar study by Carpenter, Franke, Jacobs, Fennema, and Empson (1997) found results consistent with the research by Kamii and Dominick (1998). Carpenter's et al. (1997) research was a three-year longitudinal study with 82 students in grades 1-3. They found that the students who initially used invented procedures demonstrated knowledge of base-ten number concepts before students who relied primarily on algorithms. In the fall of second grade 83% of the students who used invented strategies met the study's criteria for demonstrating knowledge of base-ten number concepts. In comparison, only 22% of students who used the traditional algorithm met this criteria. By the spring of second grade those students using invented strategies who demonstrated knowledge of base-ten number concepts had increased to 96%, whereas those students using the traditional algorithm were still only 67% successful. The study found that students who used invented strategies are able to think flexibly to transfer their use and understanding of number concepts to new situations (Carpenter, et al., 1997).

Invented algorithms are important in creating understanding of addition and subtraction techniques. Teaching the procedural steps of the traditional algorithm to children leads to misconceptions and computational errors. Invented algorithms allow for further development of number sense as children derive strategies to solve problems. There is more flexibility in the approaches used over that of the traditional algorithm. This flexibility allows for children to apply their understanding of number structures and place value concepts when finding solutions that make mathematical sense to the child.

Children need the opportunity to apply their own mathematical awareness in problem solving.

Beyond Addition and Subtraction

Place value understanding and the use of invented algorithms continues to promote mathematical understanding as students move to higher-level mathematics (Carpenter et al., 2015). The understanding children have from using invented algorithms to solve addition and subtraction problems helps set the foundation for multiplication and division. Baek (2006) studied 58 fourth- and fifth-grade student's invented algorithms. He found students often started solving multiplication questions using a doubling technique. As their mathematical understanding in multiplication became more solid students began using partitioning and compensating techniques much the same as they did for addition and subtraction. When partitioning students decomposed number to make the computation easier. When compensating students would round to the nearest ten, solve the problem, and then make the necessary adjustments to account for the rounding (Baek, 2006).

Conclusion

Effective interventions are needed in order to ensure children who are behind can reach grade level expectations. There are many characteristics of an effective intervention, including having highly skilled teachers delivering targeted instruction to meet the unique needs of each learner. Students should be placed into interventions as early as possible to ensure they do not follow even further behind. Targeted Services, a Minnesota state funded intervention program, was created to offer additional instructional support to the most at-risk students.

Base-ten place value understanding is a foundational skill in mathematics development. Place value understanding begins as young children learn how to count and develops throughout mathematics education. Traditional mathematics approaches, such as teaching the traditional algorithm, have been found to hinder students' mathematical development in the area of place value. Rather, it is essential for students to have time to explore, create, and develop place value ideas in order to apply understanding to solve addition and subtraction problems.

In chapter three, I will discuss the methodology of my research study. Information about research participants and the school instructional setting will be provided. In addition, I will provide the targeted services intervention plan including the weekly meeting schedule and length of intervention. The processes used to collect data are also described in the next chapter.

CHAPTER THREE

Methods

Introduction

The purpose of this study is to determine the impact a Targeted Services intervention program has on the development of base-ten place value understanding among second graders. Place value is a mathematical skill children need to have complete understanding of in order to be successful with higher-level mathematics. This project is of importance to me as second grade students in my school continue to struggle in the area of place value as determined by district assessment results. This chapter explains the methods used to answer the research question: *How does a targeted services intervention program focused on base-ten place value development impact the growth of second graders in meeting district achievement expectations in mathematics?* This chapter discusses the research paradigm, the setting and participants, data collection tools and rationale, and data analysis techniques.

Research Paradigm

This study is an action research project using a mixed-methods approach to explore the effectiveness of an after school class on increasing place value understanding. I chose the mixed-method approach as it allowed for a more thorough analysis by combining quantitative and qualitative approaches. According to Mills (2014), "The purpose of mixed-methods research is to build on the synergy and strength that exist between quantitative and qualitative research methods to understand a phenomenon more fully than is possible using either quantitative or qualitative methods alone" (p. 7). Quantitative research allows the researcher to test hypotheses and control for variables. By comparison, qualitative research relies on the researcher being able to explore a concept (Creswell, 2014, p. 110).

Creswell stated (2014), "The problem may be one in which a need exists to both understand the relationship among variables in a situation and explore the topic in further depth" (p. 111). The primary goal in this research is to determine how effective an after school intervention class is on improving students' base-ten place value understanding. Through the collection and analysis of quantitative data I will be able to determine student growth by using teacher-created assessments given bi-weekly and district-created pre- and post-assessments. My hypothesis is that by student participation in a focused, targeted services intervention program, place value understanding will increase over time as monitored by the bi-weekly place value assessments. I also believe retention will be higher due to the frequent exposure to place value concepts and skills, as monitored by the pre- and post-assessments. The collection of qualitative data, including student journals and teacher observations, allows for further exploration into how the instructional procedures impact the growth in student understanding of specific strategies.

Class Overview

Setting

The research took place in a suburban community in the upper Midwest. The school had approximately 675 students enrolled. The school population is comprised of 67% white, 13% black, 11% Asian, 7% Hispanic, and 3% American Indian students. In addition, 13% of the students qualify as English Language Learners and 14% of the student population receives special education services. Forty-six percent of the school population qualifies for free and reduced lunch, a poverty level indicator.

The school receives school-wide Title I federal funding. Title 1 funding provides financial assistance to schools with a high-percentage of children from low-income families to help ensure all children meet challenging state academic standards (U.S. Department of Education, 2015). Schools with at least 40% of children from low-income families are eligible to use Title 1 funds for school-wide programs, meaning funds can be used for any child enrolled in the school. The school has been recognized by the state as a Reward School for the previous four years. A Reward School is among the top 15% of Title I schools in the state. To qualify as a Reward School, schools must increase student academic performance while reducing the achievement gap, as measured on state standardized tests (Minnesota Department of Education, 2015).

Participants

There were twenty-three second grade students and one classroom teacher participating in the class. Two students dropped out of the class part way through. One dropped out due to an after school conflict and the other moved out of district. One student in the class had been identified as and English Language Learner. When the class started, all student participants were below district achievement expectations in the area of place value as measured on the district-created assessment, found in Appendix A. In order to participate in the after-school class children needed to have parent or guardian permission to attend. In addition, students needed to find transportation home from school, as bus service is not offered. The researcher in this instance served as the classroom teacher.

Class Requirements

The Targeted Services intervention class must adhere to state and district requirements. The one-hour and ten-minute classes met twice a week and lasted for twenty-one sessions. Students had a ten-minute break between the end of the school day and beginning of the Targeted Services class. During this break children were supplied with a healthy snack. Enrollment in the course is completely optional and dependent on parent or guardian permission and access to transportation.

Both the School District and University Human Subjects review processes approved conditions for this research.

Teaching Method

Getting Started

The first class session focused on administering the teacher-created assessment, found in Appendix B, to determine student need. This assessment was created by the teacher and follows the same format as the district-created assessment used to monitor student growth throughout the school year. This assessment was then given every other week throughout the remainder of the course to monitor student growth and needs.

Additionally, the first two class sessions focused on setting up expectations and routines to create a successful learning environment. Emphasis was placed on learning together through discussion, small-group work, and whole-group sharing. Incorrect answers and mistakes were looked at as opportunities to learn. Initially, some of these routines and expectations were a shift in the way children had previously received instruction.

Instructional Model

Each class began with a whole-group warm-up problem focused on developing base-ten place value ideas. According to Carpenter, Fennema, Franke, Levi, and Empson (2015), “The central principle that children must grasp to understand the base-ten number system is that collections of ten can be counted” (p. 85). An example of a warm-up problem is: Tim has 5 boxes of crayons. There are 10 crayons in each box. How many crayons does Tim have? Students were given time to independently solve the question. Strategies used to solve the question were shared with the class and connections between strategies were made.

Specific, targeted interventions are key to student success (Buffum, Mattos, & Weber, 2012). In order to create specific and targeted lessons students worked in small groups that were based on individual need as determined by assessments and teacher observation. Small group instruction occurred after the whole-group warm-up. Instructional methods used during this time were based on results from the district-created and teacher-created assessments. Lessons focused on applying place value understanding in the creation of strategies to solve addition and subtraction problems.

During small group instruction, if students were not meeting with the teacher they were either working independently or on a partner task. Independent work included time to solve student journal problems. Partner work included games and activities to develop place value skills and concepts.

The closing of each lesson was a whole group wrap-up and review of the opening question. The student journal problem was shared and strategies discussed. Students also had the opportunity to share learning from the day. Table 1 explains the structure of each lesson.

Table 1
Daily Lesson Structure

Part	Length	Rationale
Whole-group warm-up	10-15 minutes	Students had time to problem-solve and hear other student's solutions. The warm-up gave time to make connections.
Small group	35-45 minutes	Students were instructed and working on skills at their level. This allows for specific and targeted instruction.
Closing	5-10 minutes	Students shared strategies and learning from the day. This time allowed for more connections.

Data Collection

District-Created Assessment

Students were given the district-created assessment, see Appendix A, four times during the school year. Students took this assessment at the beginning of the school year in September and once after each trimester in November, March, and June. Data collected using this assessment showed student growth throughout the school year. It allowed for comparison of assessment scores from before class began, while class was happening, and after the class had ended. This data will be analyzed to determine if the Targeted Services class had an impact on student learning.

All of these data collection tools allowed me to see trends in the development of place value understanding and the impact it has on mathematical ability. Triangulation occurs by using several sources to collect data, adding to the validity of the study

(Creswell, 2014, p. 201). Refer to Table 2 for data collection techniques used in this study.

Teacher-Created Assessments

Place value assessments created by the researcher, see Appendix B, will be used on a bi-weekly basis to monitor student progress over the course of the after-school class. This assessment is modeled after the district-created assessment used for tracking growth throughout the school year. Student answers were analyzed for two purposes. First, the assessment allowed me to determine what strategies students used in solving problems and what misconceptions existed. This information helped me in planning future lessons. Second, scores were analyzed to track growth. According to Mills (2014), "Gathering data from teacher-made tests provides classroom teachers with accessible information about how well their students are responding to a particular teaching or curriculum innovation" (p. 101).

Student Journals

During each class students were asked to solve one math question in their notebook. Students were asked to solve the questions independently using the most efficient strategy for them at the time. This activity occurred after small group instruction, so students were able to show understandings or misconceptions from that day's learning. In addition, students were asked to write why they chose the strategy they did.

Although all journals were reviewed, four students' journals were chosen to monitor at the end of each class session. In order to get an accurate portrayal of student work at different levels one journal was chosen of a student who scored higher on the teacher-created assessment, two students were chosen who scored in the middle, and the last student chosen had scored lower. I focused on analyzing the strategies used by these students and looked for growth in application of place value understanding to problem solving. This analysis allowed for data to be collected on students' progress specifically related to the type of strategy used.

Teacher Observation Field Notes

Writing in this journal occurred briefly during instruction and more in-depth directly following the end of each class session. These reflection times were important to adhere to in order to ensure the most accurate notes were taken. The field notes allowed for reflection on instructional practices and student learning. These notes were used to guide instruction for future class sessions.

Mills (2014) suggested three strategies for taking field notes including: observe and record everything you possibly can, observe and look for nothing in particular, and look for 'bumps' or paradoxes (pp. 86-87). I feel the best method for my research was in looking for bumps or paradoxes while teaching. I focused on looking for students who made connections between strategies and developed awareness of new strategies. When this happened I documented what instruction or conversation was taking place at the time and other pertinent information, such as the specific problem being worked on. I also looked for misconceptions and noted how they impacted students' misunderstandings.

Summary

To improve mathematics understanding among struggling learners an after school intervention class on base-ten place value was offered. Research supports the need for place value understanding in developing math ideas (Carpenter, Fennema, Franke, Levi, & Empson, 2015). The goal of this research is to answer the question: *How does a* *targeted services intervention program focused on base-ten place value development impact the growth of second graders in meeting district achievement expectations in mathematics?* Through analysis of data collected using a mixed methods approach, trends were determined to guide instruction.

Table 2
Data Collection

Data Type	Data Collection	Frequency	Description and Purpose
Quantitative	District-Created Assessments	Four times during the school year	This assessment showed growth throughout the school year.
Quantitative	Teacher-Created Assessments	Bi-weekly	Students were given this assessment every-other week to monitor student growth and retention.
Qualitative	Student Journals	Each class session	Students answered questions using the most efficient strategy for them. Students described why the strategy was used. Analysis was done to determine growth and misconceptions.
Qualitative	Teacher Observation Field Notes	Each class session	Detailed notes taken by the teacher during and directly following instruction. Notes focused on connections made between strategies, new strategy development, and misconceptions.

CHAPTER FOUR

Results

Introduction

Throughout the research process the focus remained: *How does a targeted services intervention program designed to focus on base-ten place value development impact the growth of second graders in meeting district achievement expectations in mathematics?* Chapter three provided reasoning for the use of a mixed-methods research approach when analyzing this question. In order to triangulate the data, quantitative data was kept using district-created and teacher-created assessments and qualitative data was analyzed through the use of student journals and teacher observations.

The class took place after school in a second grade classroom. In the beginning there were 23 students enrolled in the class. One student in class qualified as an English Language Learner and received services during the school day. None of the students in class were in IEPs for mathematics. During the course of 10 weeks, two students withdrew from class – one due to a move and the other due to an after school conflict. Of the remaining 21 students, 18 families returned consent forms to participate in the study. The consent form can be found in Appendix C.

Instruction focused on increasing student's place value understanding and application of this understanding in solving addition and subtraction problems. The class structure was divided so students received whole-group instruction on grade level skills. Then, students were placed into flexible small groups where they received instruction focused on individual needs around place value concepts. These needs were determined by teacher observation and assessments.

This chapter explains and analyzes the data collected throughout the study and the implications to student learning. The chapter begins by looking at the quantitative data gathered through district-created and teacher-created assessments. The district-created assessments were given three times throughout the school year while the teacher-created assessments were given every two weeks throughout the course of the after-school class. Next, the findings from the student journals will be reported. Students wrote in their journals during every after-school session. Finally, the teacher field notes, which include observations made by me on the impact each lesson had on student learning, will be shared.

Quantitative Assessments

Two types of assessments, district-created summative and teacher-created formative, were used to collect quantitative data. The district-created assessments were given to student four times throughout the year. Second grade classroom teachers, title-one teachers, and myself, the math specialist, all help give this one-on-one assessment during the course of the regular school day. The teacher-created assessments, administered only by me, were given every two weeks during the after-school class.

District-Created Assessment

Every second grade student was given the district-created assessment four times during the year – once at the beginning of the year and then at the end of each trimester. District expectations, based on state standards, have been set indicating what benchmark level students should meet during each assessment cycle. Figure 6 shows these expectations. The results from trimester one were used to help determine which students in second grade would be invited to participate, with parent or guardian consent, in the

Testing Period	Assessment Level	Skills passed (Student is able to…)	Example
Baseline *Assessed beginning of year	Level 2	- Count by tens and ones	10, 20, 21, 22, 23
		- Switch between counting by tens and ones	10, 20, 21, 22, 32, 42, 43, 44
Trimester 1 *Assessed end of November	Level 4	Skills listed above as well as:	
		- Use non-counting strategy to add a single digit number to a decade number	40 + 3
		- Use non-counting strategy to subtract a single digit number back to a decade number	46 - 6
		- Use non-counting strategy to add to a two-digit number to get to the next decade	53 + ____ = 60
		- Use non-counting strategy to subtract from a decade	30 - 6
Trimester 2 *Assessed middle of March	Level 6	Skills listed above as well as:	
		- Use non-counting strategy to add a two-digit and one-digit number	27 + 6 27+3→ 30+3→ 33
		- Use non-counting strategy to subtract a one-digit number from a two digit number	74 – 8 74-4→ 70-4→ 66
		- Use non-counting strategy to add a decade number and a two-digit number	50 + 27
		- Use non-counting strategy to subtract a two-digit number back to a decade	63 - ____ = 40
Trimester 3 *Assessed beginning of June	Level 7	Skills listed above as well as:	
		- Use non-counting strategies, two or more, to add two two-digit numbers	48 + 35 *Solve using two invented algorithms
		- Use non-counting strategies, two or more, to subtract two two-digit numbers	73 – 29 *Solve using two invented algorithms

Figure 6. District Place Value Level Expectations. This figure shows the levels students should be at to meet district grade-level expectations during the four testing periods in second grade.

after-school Targeted Services class. Students were expected to use mental strategies to solve each question and explain their thinking to the teacher administering the assessment. The goal in having students explain their thinking is to accurately document what method the student is using to solve each question. This helps in planning for future instruction. This is a linear assessment in that a student must pass one level before moving on to the next. The assessment directions and questions can be found in Appendix B.

In order to follow district protocol, the district-created assessment was not given at the start and end of the Targeted Services class. Rather, the data from this assessment shows student growth from the beginning of second grade through the end of the school year. Scores for each student can be found in Table 3.

At the beginning of the year, baseline assessment results show that 2 of the 18 students in the study were meeting district expectations. When looking at Trimester 1 results 0 of the 18 students were meeting district expectations. Between baseline assessing, given on September 10, 2015 and Trimester 1 assessing, given on November 30, 2015, the average growth for the eighteen students in the Targeted Services class was only 1.06 levels. District expectations indicate students should grow from a Level 2 to a Level 4, or two complete levels, during this time frame. These results indicate that the students who registered for the Targeted Services class were experiencing growth at slower rate than what is expected. Additionally, because many of these students were already behind grade level expectations they need to experience growth at a faster rate in order to catch-up. This data was used to help choose which kids would benefit from receiving Targeted Services intervention support. At the time this data was collected, no after-school Targeted Services classes had yet to have taken place.

Table 3
Student Levels: District-Created Assessment

	Baseline	End of Trimester 1	End of Trimester 2	End of Trimester 3
Student	Date: 9/10/15	Date: 11/30/15	Date: 3/10/16	Date: 6/3/16
1	1	1	3	4
2	1	2	3	3
3	0	2	3	4
4	1	3	5	7
5	0	2	3	7
6	1	3	6	8
7	0	3	4	6
8	1	3	6	8
9	3	3	6	6
10	1	1	4	7
11	2	3	6	7
12	1	2	3	7
13	1	3	4	7
14	1	1	3	4
15	1	1	4	7
16	1	1	2	7
17	0	1	3	4
18	1	2	4	7

The district created assessment was next given on March 10, 2015 at the end of Trimester 2. The Targeted Services class had at this point in time met for 8 of the 21 class periods. The data indicated that 2 of the 18 students met the district expectations of being at a Level 6 on the assessment. When looking at growth between Trimester 1 and Trimester 2, the average gain for students in the study was 1.8 levels. District expectations indicate students should grow from a Level 4 to a Level 6, or two complete levels, during this time frame. The students had made more growth during this assessment time frame than they had previously when no Targeted Services classes had taken place. However, they are still not meeting the district expectation of growing a full two levels.

The final assessment was given on June 2, 2015 at the end of Trimester 3. The Targeted Services class had met for all 21 class sessions, totaling an extra 24 hours of instruction on place value outside of the regular school day. The district expectation is for students to grow from a Level 6 to a Level 7, or a total of one level, during this time frame. On average students in the study grew 2.4 levels. Additionally, 11 of the 18 students were at a Level 7 or higher, indicating students had made enough growth to reach grade level expectations. Of the remaining 7 kids who were not at grade level, all made growth throughout the duration of the school year. Two of the seven students had reached a Level 6, but were not fluid in using multiple non-counting strategies to solve two-digit addition and subtraction questions mentally. Rather, each student was only able to explain understanding of one strategy. Five of the students who did not meet the grade level expectation scored a Level 3 or 4 on the assessment. Each of these students had grown between 2 and 4 levels throughout the school year, but continued to struggle with breaking apart single-digit numbers in order to add and subtract using non-counting strategies.

It is impossible to know where the students would have ended up had they not received extra place value instruction during the Targeted Services class. We do know that at the end of Trimester 1 all 18 students were below grade level expectations and growth was less than expected. At the end of the year, after participating in the 21

Targeted Services classes, 11 of the 18 students were at or above grade level expectations.

Teacher-Created Assessments

The teacher-created assessment was used as a formative assessment to monitor student growth every two weeks. The assessment, found in Appendix A, resembles the district-created assessment and is given to students using a similar format. The numbers for each question have been changed and students are expected to accurately answer at least two addition and two subtraction questions before passing to the next level. Just as the district-created assessment requires, this assessment also mandates students solve the questions mentally and be able to explain their thinking. Student's scores for each testing period can be found in Table 4.

Table 4
Student Levels: Teacher Created Assessment

Student	Day 1	Week 2	Week 4	Week 6	Week 8	Week 10	Growth
	2/9/16	2/18/16	3/3/16	3/24/16	4/7/16	4/21/16	
1	Level 1	Level 1	Level 2	Level 3	Level 3	Level 4	3 levels
2	Level 2	Level 2	Level 2	Level 3	Level 3	Level 3	1 level
3	Level 2	Level 2	Level 2	Level 3	Level 3	Level 4	2 levels
4	Level 3	Level 3	Level 4	Level 5	Level 6*	Level 6*	3 levels
5	Level 2	Level 2	Level 2	Level 3	Level 4	Level 6*	4 levels
6	Level 3	Level 3	Level 4	Level 4	Level 6*	Level 7*	4 levels
7	Level 3	Level 3	Level 3	Level 4	Level 5	Level 6*	3 levels
8	Level 2	Level 3	Level 4	Level 6*	Level 6*	Level 7*	5 levels
9	Level 3	Level 3	Level 3	Level 3	Level 4	Level 6*	3 levels
10	Level 2	Level 2	Level 2	Level 4	Level 4	Level 6*	4 levels
11	Level 3	Level 3	Level 4	Level 6*	Level 6*	Level 7*	4 levels
12	Level 2	Level 2	Level 3	Level 3	Level 4	Level 6*	4 levels
13	Level 3	Level 3	Level 4	Level 4	Level 6*	Level 6*	3 levels
14	Level 2	Level 2	Level 3	Level 3	Level 3	Level 4	2 levels
15	Level 2	Level 3	Level 4	Level 4	Level 6*	Level 7*	5 levels
16	Level 1	Level 1	Level 2	Level 2	Level 5	Level 6*	5 levels
17	Level 1	Level 1	Level 3	Level 3	Level 4	Level 4	3 levels
18	Level 2	Level 2	Level 3	Level 4	Level 5	Level 7*	5 levels

* At the time the test was given the student scored at or above grade level expectations.

In order to determine current needs and get initial data for the Targeted Services class, this assessment was given to each student on the first day of class. Based on district benchmarks, students should have been at a Level 2 or higher on the first day of class. By Week 6, which was the end of Trimester 2, students should have been at a Level 6. In order to stay on track to meet the district benchmarks by the end of Trimester 3 between Weeks 6 and 10 of class students should have been mastering multiple strategies to mentally solve two-digit addition and subtraction questions.

The teacher-created assessment scores helped in guiding instruction, both whole group and small group. Initially, whole group instruction concentrated on building numbers in multiple ways with a focus on using the tens and ones structure of numbers. In order to develop higher-level mathematical skills students need to understand the structure of numbers and how to manipulate numbers to make them easier to use. Initial assessment scores were also used to place students into small groups. This allowed for small group instructed to be pinpointed and focused on individual student needs. The small groups were flexible in that once a child had mastered a concept they were moved to a different group where the work focused on new skill needs.

The goal of giving these assessments on a bi-weekly basis was to formally monitor student growth and check for understanding. It also allowed for better accuracy in placing students into groups. Some students took longer to develop an understanding of a concept at one level than other students did. For example, Student 10, stayed at a Level 2 for the first five weeks of class. However, once the student was able to pass Level 2 the student easily moved on to higher levels and was meeting district benchmarks by the end of the class. Other students, such as Student 18, grasped concepts more quickly but needed to receive concise small group instruction at each level in order to do so.

The teacher-created assessment allowed for close monitoring of student's understanding and growth throughout the course. The data was valuable in forming small groups and guiding instruction. The consistent testing schedule allowed for errors and misunderstandings to be monitored and documented in order to guide instruction.

Qualitative Assessments

Student journals and teacher observation field notes were used to collect qualitative data. The students answered a journal prompt question each class session. The student answers were used to look for understandings and misconceptions, which helped guide future instruction as well as determine student placement during small group instruction. Teacher observation field notes were kept during whole-group and small-group instruction. Again, notes were kept on understandings and misconceptions. Additionally, the teacher observation notes documented connections made between concepts and strategies.

Student Journals

Students were given a prompt to answer in their journals during each class session. This question related to the skill discussed during whole group instruction and was the same question for each student in the class. Students worked independently to answer the prompts at the end of each class session. Instructions were given for students to show or explain the strategy they used.

For the purpose of this study, I chose to follow four students' journals during the course of the class. In order to analyze and reflect on a variety of student work, I used the data from the first teacher-created assessment and chose to follow students at three different levels: one high, two middle, and one lower.

Using parts of ten. Initial instruction began with extending student understanding of ways to make ten in order to add up to a decade number and subtract back down from a decade number. See Figure 7 for student responses.

Student 12 Response	Student 13 Response
Begin at 48, what's the next decade? Answer: 58 How far of a jump it it to get there? Answer: 10 Explain your thinking. Answer: (left blank)	Begin at 48, what's the next decade? Answer: 50 How far of a jump it it to get there? Answer: 2 Explain your thinking. Answer: 8 + 2 = 10
Student 16 Response	Student 17 Response
Begin at 48, what's the next decade? Answer: 50 How far of a jump it it to get there? Answer: 2 Explain your thinking. Answer: 8+2 makes 10 so 48+2 makes 50	Begin at 48, what's the next decade? Answer: 4 How far of a jump it it to get there? Answer: 52 Explain your thinking. Answer: (left blank)

Figure 7. Journal Prompt: Using Parts of Ten. Student responses to the journal prompt of beginning at 48 and adding up to the next decade.

Based on these initial journal responses, two students seem to have a solid understanding of getting up to a decade number using a non-counting strategy. Both students used parts of ten to reach the decade. Student 16's explanation of how the answer was found went further than Student 13. Before moving on to the next concept, checking to make sure Student 13 understands how 8+2=10 helps to solve 48+2=50 would be valuable. If Student 13 is able to demonstrate understanding of this connection they are ready to move on to the next step. If the idea is not fully developed spending more time on the concept would be beneficial. Neither Student 12 nor Student 17 seemed to understand what a decade number was. Student 12 has a misconception about getting to the next decade number. This could be a mathematical misunderstanding on what a decade number is or a vocabulary misunderstanding of the difference between decade numbers versus adding ten. Although this may seem like a minor misconception, it is important to address so the student can utilize previous knowledge of making ten and tie it to other non-counting strategies. Student 17 seems confused about the question in general. There are many reasons the student could have written 4 as the next decade. I assume the student either wrote 4 because that is the number in the tens place or the student simply guessed. Then it appears Student 17 added 48 and 4 together. This shows me the student needs further instruction around decade numbers and possibly on ways to make 10. When looking at journal entries the student in not present to ask clarifying questions and, therefore, the teacher is left to interpret the student's answers. It may be plausible that the student understands the mathematical idea but lacks the ability to communicate it in a written form.

Over the next few weeks, instruction began focusing on higher-level place value skills. For Student 12 and Student 17 small group instruction focused on helping clarify misunderstandings. Student 12 was able to accurately answer a similar question to the one above after two small group sessions focused on understanding decade numbers. Once Student 17 understood what a decade number was, the student continued to struggle with knowing ways to make 10. Many activities the student worked on during class focused on these ideas. After an additional 5 lessons focused on the skill above the student was able to accurately answer a similar question.

Double-digit and single-digit addition and subtraction. Instruction continued to review ideas of decade numbers and using the parts of ten to add up to and subtract from a decade number. Since most students in class were successful with the first journal prompt on this skill, the next prompt focused on adding a two-digit number with a one-digit number. The initial journal prompt on this skill, given at the third class session, and student responses can be seen in Figure 8.

Student 12 Response 37 + 5 = 42 Explain your thinking. 37 + 3 + 2 = 42	Student 13 Response 37 + 5 = 42 Explain your thinking. 37 + 4 = 41 + 1 = 42
Student 16 Response 37 + 5 = 42 ^ 3 + 2 Explain your thinking. 37 + 3 = 40 40 + 2 = 42	Student 17 Response 37 + 5 = 42 Explain your thinking. I added 5 and got 42

Figure 8. Journal Prompt: Double-Digit and Single-Digit Addition. The question was to solve 37 + 5 using a non-counting strategy.

This journal prompt offered a lot of insight into the different understandings and misunderstandings each student had. Student 16 appears to have a clear understanding of adding through the decade number and is able to offer a clear explanation. I found this interesting as Student 16 had only assessed at a Level 1 on the teacher-created assessment when this prompt was given. This prompt is a Level 4 question. Student 12 leaves me questioning whether the student understands adding through the decade. The explanation does imply splitting the 5 into 3 and 2, but the student does not make it explicit as to why this was done. A follow-up discussion would help to fully analyze this student's understanding as it may simply be the student did not communicate splitting the 5 into parts rather than a lack mathematical understanding. Student 13, who has the highest score on the teacher-created assessment, utilizes the idea of decomposing the single digit number. However, the idea of adding through the decade was not utilized. Student 13 has already shown understanding of how to add up to the decade on the teacher-created assessment, but application of this understanding of the slightly more difficult question does not occur.

I continued to monitor student journal entries for the next few weeks checking to see what understandings and misunderstandings were still happening. Student 12 began writing the decade number into the explanation after an additional two class sessions. Student 17 was still working on knowing ways to make 10. Once Student 17 had a firm understanding of these combinations the student was able to apply the understanding to solve questions similar to the one in the journal prompt. Student 13 continued to break the single-digit number into two parts, but did not utilize the idea of adding through the decade. An interesting sequence of questions answered by Student 13 is shown in Figure 9. Based on this sequence, Student 13 knows there are multiple ways to decompose single-digit numbers and is efficient in doing so. However, the student does not utilize previous knowledge of adding up to the decade number. I am questioning whether the student understands why the single-digit number is decomposed or if the student simply thinks this is a step to follow in answering the question and then counts-on to find the answer. Instruction will focus on understanding the student's thinking and then utilizing the decade number.

A.	B.	C.
38 + 6 = 44	29 + 6 = 35	86 + 6 = 92
3 + 3	4 + 2	5 + 1
38 + 3 = 41	29 + 2 = 31	86 + 1 = 87
41 + 3 = 44	31 + 4 = 35	87 + 5 = 92

Figure 9. Response to Decomposing and Adding 6. Student 13 shows understanding of how to split 6 multiple different ways: 3+3, 4+2, 5+1. However, Student 13 does not utilize the non-counting idea of adding through the decade.

We spent eight class sessions focused on the concepts of adding a two-digit number with a one-digit number and subtracting a one-digit number from a two-digit number using non-counting strategies. Instruction was focused on using the decade number as a reference point. Decade numbers refer to the rounded, tens numbers such as 10, 20, 30, 40, etc. For example, in solving the addition question of 46 + 8 the 8 would be split into 4 and 4. Then, solving 46 + 4 → 50 + 4 → 54 utilizes the decade number of 50. After the eight sessions, Students 12, 16, and 17 were able to successfully demonstrate the use of a non-counting addition and subtraction strategy. All three students gave the explanation of using the decade number to help with adding and subtracting. Student 13 was successful in adding using the decade number, but was still working on subtracting back through the decade number.

Double-digit addition and subtraction. As most students were demonstrating fluency in solving two-digit with one-digit addition and subtraction questions, I decided to start working on two-digit mental addition and subtraction strategies. The first journal prompt on this concept was given during the twelfth class session. Students were asked to solve the problem at least one way and give an explanation or show the steps they followed. Answers to this journal prompt can be found in Figure 10.

Student 12 Response	Student 13 Response
37 + 69 = 99 Explain your thinking. 30 + 60 = 90 + 9 = 99	37 + 69 = 106 Explain your thinking. 30 + 60 = 90 9 + 7 = 16 90 + 16 = 106
Student 16 Response	**Student 17 Response**
37 + 69 = 106 ^ 3 + 66 Explain your thinking. 37 + 3 = 40 40 + 60 = 100 100 + 6 = 106	37 + 69 = 105 Explain your thinking. 60 + 30 = 90 7 + 9 = 15 90 + 15 = 105

Figure 10. Journal Prompt: Double-Digit Addition. The question was to solve 37 + 69 second strategy. In order to be flexible mathematical thinkers it is important to have more than one strategy to use when solving a problem.

Student 13 and 17 used a tens and ones strategy, showing they understand how to decompose numbers by place value. Student 16 used an incremental, or jumping, approach. This student brought the knowledge of getting to the next decade number into solving this problem. Only one of the students, Student 12, had an incorrect answer. This student initially started off using an approach that would work to solve the question, but did not add the 7 back into the problem. This error could have been either a correct understanding of a strategy with a calculation error or an incomplete understanding of an emerging strategy. The student may have been taking a risk in trying a new strategy, but is not yet able to fully navigate all the steps of the strategy.

Over the next few class sessions, instruction was focused on using more than one strategy to solve two-digit addition questions. During this time frame, Student 13 and 16 were accurately able to use a Tens and Ones strategy and an Incremental jumping strategy. Additionally, Student 16 showed solid understanding of using a Compensation strategy. Both Students 12 and 17 struggled more. They attempted to use the Tens and Ones strategy, but were inconsistent in using it correctly. Errors included forgetting to add one of the numbers, basic-computation errors and incorrectly combining the parts back together. Occasionally each student accurately used the Tens and Ones method, indicating they were on their way to understanding.

Students 13 and 16 were also given double-digit subtraction questions to solve. Both students successfully used an Incremental jumping strategy. Student 16 attempted to use a Tens and Ones strategy, but struggled with the idea of having a negative number. This student's answer can be seen in Figure 11.

Student 16 Response
62 – 29 = 47
Explain your thinking. 60 – 20 = 40 2 – 9 = -7 40 + -7 = 47

Figure 11. Journal Prompt: Double-Digit subtraction. Student 16 correctly subtracts 2-9, indicating some understanding of negative numbers. This student is still developing understanding of how to add a negative number.

The student journals offered an interesting insight into the way each child thought about solving problems and how they applied place value concepts to help them out. Looking through the journals to find misconceptions helped drive instruction further. Even though some of the students were working a few levels above where they scored using the district-created and teacher-created assessments all students were able to show some understanding of the concept being taught. The ability for students to solve questions above where they assessed could be, in part, based on the testing structure. Some students have anxiety around testing and yet other students do their best work in groups with social interaction. Therefore, assessment scores are not always an accurate reflection of the student's true ability. Due to this, the additional data from the student journals combined with assessment results helped to pinpoint each child's true ability.

Teacher Observation Field Notes

I took notes and wrote in my reflection journal during every class. Due to limited time for taking notes while teaching, I wrote quick notes during whole-group and small-group instruction and then spent time after each class session writing additional notes or expanding on the quick notes written during instruction. I kept separate notes for whole-group and small-group instruction. Since small groups were flexible with kids changing groups to meet their needs it was difficult to keep accurate notes on how each small group was performing. Therefore, I started keeping small group notes by student names.

The class was organized to open with 15 minutes of whole-group instruction. This instruction was focused on grade-level expectations, as determined by state standards, in the area of place value and district benchmarks. Whole-group instruction was followed by 45-minutes of small-group instruction, independent work, and activity time. Typically students spent about 15 minutes with me in small-group instruction. The time spent on independent work and activities varied based on student needs. Class ended with a ten-minute wrap-up review of the day. This time frame truly helped me reflect on student connections, understandings, and misconceptions from each class session.

Keeping track. During whole-group instruction, I got in the habit of keeping track of how students were performing based on quick tallies. Using tallies, I kept track of how many students were accurately answering questions and how many students were willing to participate in sharing answers. An example can be seen in Figure 12. In doing this I was able to know how many students were confident in their ability to successfully answer questions on the concepts we were discussing. At one point, I had asked a question and noticed, by a quick glimpse of looking on student's individual white boards, that only 2 students had a correct answer. This allowed me to adjust my instruction in the moment as well as look at where the next lesson should focus. Other times, I would have nearly every student in class with a correct answer.

This quick method of keeping track helped me in making future instructional decisions for whole-group instruction. If a limited amount of students were successful in answering a question, I knew more time was needed on the concept. Occasionally I even took steps back to review previous skills or to fill possible holes in place value development. When most of the class was successful I knew I could move on to the next step.

Date	Question	Correct Answer White Board (Independent)	Willing to Share Answer	Strategies Shared
3/1/16	36 + 6	IIIII IIIII IIII (14)	IIIII IIII (9)	36+3→39+3→42* 36+4→40+2→42 36+6 as 6+6=12 30+12=42

Figure 12. Teacher Field Notes: Whole-Group Instruction Tallies. There were 14 students able to accurately answer the question on their white boards, but only 9 students willing to share their answers with the class. Three methods for solving the question were shared. The first method shared was discussed in further detail and connected to the second method shared.

Student names. I kept track of which students were sharing during whole-group instruction and what strategy they used. Additionally, I included if the student used a successful strategy, was initially unsuccessful but independently fixed their mistake, or if they needed help in solving the question. Keeping track of this data did not guide my whole-group instruction as much as it helped me in forming and planning for small-group instruction.

During small-group instruction, I started taking all notes with a student's name attached. Initially I had not been doing this and was only keeping track of the ideas discussed in each group. However, as students moved from one group to another I realized it was important to be able to look back and see which specific student in a group had shared out an answer.

Strategies, connections, and misconceptions. These were my favorite notes to reflect on. Often times, these were the notes I wrote after class, as I didn't have enough time while instructing to write all of the details down. Discussion in mathematics is important in developing understanding. After students would share answers, the class would discuss what they had noticed about the strategy just shared. This lead to valuable discussions on how some strategies were similar to others and allowed students to see how previous skills were being used to solve harder questions. As time went on, I was able to look back at my notes to determine when students arrived at successfully using new strategies and being able to explain why those strategies worked.

Equally as important as keeping track of what strategies were used, and the connections between them, was keeping track of student's misconceptions. Often times these misconceptions existed due to limited understanding of a place value concept. By examining misconceptions, I was able to better focus my instruction to help students. An example can be seen in Figure 13.

Summary

This chapter outlined my research results in detail. I chose to use a mixed-method research approach in order to gather both quantitative and qualitative data. I used three different methods of gathering data including formal assessments, student journals, and teacher reflection. The assessments allowed me to see student growth over time based on specific leveled benchmarks. I was able to analyze student journals to determine understandings and misconceptions each student was having, which helped guide my instructional planning decisions. My teacher field notes allowed me to reflect on how the students were making connections between strategies and place value ideas. All of these data points helped to guide my instruction to meet the needs of the individual learners as well as the class as a whole. The next chapter will look at the limitations and next steps of the study. Additionally, the results from the study will be compared to the literature examined in Chapter 2.

<table>
<tr><th>Date</th><th>Question</th><th>Strategies Shared</th><th>Student who Shared</th><th>Notes</th></tr>
<tr><td>4/21/16</td><td>37 + 69</td><td>60 + 30 = 90
7 + 9 = 16
90 + 16 = 106
(tens and ones)</td><td>Student 9</td><td>- paused to figure out 90 + 16.
- knew name of the strategy</td></tr>
<tr><td></td><td></td><td>60 + 30 = 90
90 + 9 = 99
99 + 1 = 100
100 + 6 = 106
(incremental, tens and ones)</td><td>Student 6</td><td>- easily decomposed numbers to add
- didn’t know the name of strategy
- class shared similarity of 60+30 in previous strategy</td></tr>
<tr><td></td><td></td><td>37 + 3 = 40
40 + 60 = 100
100 + 9 = 109
109 – 3 = 106
(compensation)</td><td>Student 15</td><td>- only three kids raised hands to show they understood why you added 3 then subtracted
- showed the transfer on the number line</td></tr>
<tr><td colspan="5">Summary: In general, students have a strong understanding of how to use Tens and Ones and Incremental. Next session see if anyone is able to share using Incremental without breaking apart the tens and ones. More instruction around the Compensation strategy is needed. Focus on showing this on a number line.</td></tr>
</table>

Figure 13. Teacher Field Notes: Whole-Group Instruction Answers. Three students shared the strategy they used to solve the question 37+69. Notes were taken on what occurred as each individual student shared. At the end of class a quick summary of the lesson, including some next steps, was written.

CHAPTER FIVE

Conclusion

This study explored place value development and the important role it plays in developing mathematical understanding in order to answer the research question: *How does a targeted services intervention program focused on base-ten place value development impact the growth of second graders in meeting district achievement expectations in mathematics?* The previous chapter discussed the results of the research study and examined how student understanding of place value grew throughout the after-school course. This chapter compares the results of this study to the literature review found in Chapter 2. The study's limitations are also examined. Finally, my closing reflection and future plans in relation to the study will be discussed.

Compare Results to Literature

How do the results of the study compare to what the literature says? Chapter 2 examined literature about three main topics: Interventions, Targeted Services, and Place Value Development and Application. This section compares the results from this study to the literature.

Interventions

Effective interventions need to be focused on student-learning styles, student needs, and utilize different methods than initially used during core instruction (Buffum et al., 2012). Due to the diverse needs of students, there is not a curriculum a school district can buy that will ensure all students' needs are met. Rather, materials should be created and instruction should be adjusted, based on targeted and measureable academic goals, to meet the unique needs of each learner (Riccomini & Smith, 2011). If core instruction is replaced with the remedial instruction of an intervention we cannot expect students to meet grade level expectations. Therefore, the instruction received in a remedial intervention needs to be in addition to and in alignment with core instruction (Johnston, 2010). Formal data, collected through assessing, should be used to initially determine which students are in need of intervention instruction. Then, a mixture of formal and informal assessments should be used to adjust instruction as needs change and to track growth (Buffum et al., 2012). The most effective interventions require regular attendance by students.

The study closely followed most of what the research around interventions shows to be best practice. Whole-group instruction focused solely on developing place value skills associated with state standards and district benchmarks. Then, small group instruction focused on the specific skills with which student's struggled. Independent and partner activities also focused on specific skills. The lessons and activities, all of which were based on state standards and district objectives, were created to meet the individual needs that arose through ongoing formal and informal assessments and observations. Initially, students had been invited to class based on the formal assessment given to each student in the district. Only students who were below grade-level were invited to participate in the intervention.

The study did not align to research in a few ways. First, once students were meeting grade level expectations they continued to receive the intervention. The nature of this class, being focused on where students were performing mathematically, allowed students to be nurtured at the level of their understanding. Continuing the additional intervention instruction longer than the student needed offered a chance for the student to build a more solid understanding of the concepts. This helps ensure students do not regress and end up needing an intervention again (Buffum et al., 2012). Attendance was a concern for a few of the students in the study. Due to targeted services guidelines, transportation is not offered for after-school classes. Therefore, some of the students in the study missed many classes, as they had no transportation home after the regular school day buses had left or they had other after-school conflicts arise. Based on the data, the students who missed 3 or more class sessions saw, on average, the lowest growth. Additionally, the students who missed fewer classes were more likely to meet grade-level benchmarks by the end of the year. Table 5 shows these averages.

Table 5
Score Averages Based on Attendance

	Average Growth	Meeting End-of-Year Grade Level Benchmarks
Absent 2 or fewer times	3.8 levels	9 / 12 75%
Absent 3 or more times	2.8 levels	2 / 6 students 33%

Targeted Services

Targeted Services is a state-funded program offering additional instructional support to students who are determined to be below grade level expectations. The program helps students build academic skills through the use of additional instruction occurring before or after-school (Minnesota Department of Education, 2014). The increased amount of instruction time helps support success within the regular curriculum. Instruction in a targeted services class should differ from the instruction happening during the school day (Minnesota Department of Education, 2014).

Due to state mandates around holding a Targeted Services class, the guidelines were all closely followed. The only students invited to attend class were underperforming based on the district-created assessment. The class offered 21 hours of additional instruction in the area of place value to help build skills to support mathematical development.

Place Value and Application

Place value concepts build the foundation of mathematics. It is important to remember not all students learn place value concepts in the same way or at the same pace. Some place value skills are progressive, meaning one skill needs to be mastered before moving on to the other. At the same time, some concepts should be explored concurrently (Fosnot, 2010). There is not a specific order in which to teach place value, but if a concept within place value is missed, it can be detrimental to future mathematical understanding. In the beginning stages of place value development students learn to count by ones. As children begin to master this idea they start learning how to count objects in groups, such as counting by ten (Van de Walle et al., 2013). Children are exposed to the underlying structure of the base-ten place value system when they count by groups of tens and ones (Wright et al., 2012). As student's understanding continues to progress they begin realizing that the smaller parts of a number are contained within a larger number (Richardson, 2012). Expanding on this idea allows children to compose and decompose numbers to make them easier to work with. Facility in using the reference numbers of five and ten helps students move past using counting strategies as they begin implementing higher-level non-counting strategies (Van de Walle et al., 2013). These higher-level strategies, when discovered and explained by the student, are known as invented algorithms. Invented algorithms refer to any strategy children create to solve addition or subtraction questions. Many researchers agree on the importance of invented algorithms in the development of addition and subtraction understanding (Carpenter et al., 2015; Fosnot & Dolk, 2001; Van de Walle et al., 2013; Wright, et al., 2006).

The study closely followed this research in many ways. Whole-group instruction focused solely on developing place value skills using the idea of exploring these concepts concurrently (Carpenter et al., 1997). Whereas, small-group instruction took a more linear path in which students worked on mastering one skill before moving on to the next (Wright et al., 2006). I believe using both methods in teaching place value helped students to be as successful as they were. The small group instruction helped ensure students address the holes in their understanding whereas the large group instruction helped students expand and develop understandings on their own. The first few classes focused on counting forward and backward by groups of tens and ones. When students struggled with this skill during whole group it became a focus of small-group instruction. Additionally, this skill was brought into games and activities for kids to explore counting and arrive at their own conclusions. Once most of the class was facile in knowing how to count by tens and ones the skill of decomposing numbers to solve addition and subtraction with non-counting strategies became the instructional focus for the remainder of the class. This skill drew on previous knowledge about decomposing numbers up to 10. Initially, this was reviewed for all students in the class and then worked on during small group for students needing the extra support. For example, 75 + 7 was solved as 75 + 5 → 80 + 2 → 82. Students also determined they could break apart the two-digit number by place value and add the ones together. For example, 75 + 7 was solved as 5 + 7 → 12 + 70 → 82. In order to decompose the numbers in this way, and put them back together again, students had to understand that the smaller number is contained within the larger number and that breaking the number apart does not change the overall value of the number. This is an important development in understanding. From here, students began working on double-digit addition and subtraction strategies in much the same format. Although no direct instruction was given on how to do this, instruction was intentional based on number choices used in problems, critical-thinking questions asked, and the materials given for exploration. In doing so, students were inventing algorithms that worked for them and which they understood.

Limitations

During this study, certain limitations became apparent. Many of the limitations were caused by the design of targeted services requirements, which sets specific parameters that must be followed. Collecting data through the use of student journals created another problem in this study in that the questions asked were geared towards whole group instruction and not at individual student levels. The wide array of teaching styles by the classroom teachers during the regular school day created the final limitation of this study.

The class schedule was one of the larger issues. Class met after-school on Tuesdays and Thursdays. Often times, students would begin to understand a concept by Thursday, but then if they were not working on the skill again until the next class on

Tuesday, many students would regress. It is difficult for students to retain and master a concept if it is not worked on more frequently than twice every seven days. Attendance in class also added to the class schedule dilemma. Since class was held after-school and relied on outside transportation to get students home, a number of students missed class more than one time. Since I did not work with the students during the school day, making up content from missing a class was nearly impossible.

Gathering whole-group data using student journals put a limitation on the study in that it did not show if students were making growth at their learning levels. The whole-group questions were sometimes up to four levels higher than where the student had assessed. When looking through student journals often times the students who had assessed at a lower level had many misconceptions at the higher levels. If data had been kept for both whole-group and small-group instruction in the student journals, the analysis of growth would have been more accurate.

The issue that may have had the most impact on the study was the classroom teachers. Some classroom teachers focused heavily on developing place value concepts within the regular school day core instruction. Other teachers rarely discussed place value concepts in class, relying instead on teaching the step-by-step procedures of the traditional algorithm. These two differences in daily instruction had a strong impact on student growth and success in the area of place value (Kamii & Dominick,1998).

Closing Reflection

The data shows there was growth made by many of the students in the targeted services class. However, I continue to struggle with why there were seven students who did not make much growth. There were definite challenges in the class and things I would do differently next time.

Overall, the additional instruction students received by attending the Targeted Services class seemed beneficial. Of the 18 students who participated in the study, 11 were able to meet district benchmark expectations by the end of the year. This means, during Trimester 1 no students were meeting the district benchmark and by the end of the year 61% of the students were able to meet the benchmarks. Of the 7 students who did not meet the end of year benchmarks, 4 missed three or more days of Targeted Services. Attendance is a key factor in having a successful intervention (Buffum, Mattos, & Weber, 2012).

Unfortunately, many students received limited, if any, instruction on place value concepts between the class sessions. This means, between the Thursday and Tuesday class some students received no place value instruction for five days. This made it difficult for students to retain new ideas and concepts. In the future having the goals and objectives of the Targeted Services tied to the classroom objectives during core instruction would be beneficial. In aligning these goals the students would receive more cohesive instruction and have a better chance of retaining new ideas. Additionally, having better communication between the classroom teachers and the targeted services teacher about the academic goals being taught in each class would be beneficial.

The targeted services class started with 23 students and ended with 21. Although this amount of kids would be ideal for a classroom it is too many students to have an effective intervention. Students receiving intervention support are performing below grade-level. Therefore, it is important to have focused instruction around the individual student's needs and learning styles (Buffum, Mattos, & Weber, 2012). Having an intervention group with over 20 students made this task very difficult to manage.

The teaching schedule of the class, having time to teach whole-group, small group, and for students to explore through activities, worked very well. The whole-group instruction allowed kids to expand on higher-level ideas, share thoughts with classmates, and build on one another's understandings. Small-group instruction allowed for students to work on the specific skills they were struggling with. Additionally, I was able to adapt my small-group instruction to better meet the learning style of the students in the group. Utilizing two instructional methods was beneficial in helping meet the learning needs of each student in the class.

Future Plans

I will continue to teach interventions on place value and work with students on understanding the important skills place value understanding brings to mathematics. Previously, I had thought of mathematics learning in a more linear way, thinking one skill needed to be mastered, or close to mastery, before moving on to the next skill. Through this research I have seen the importance of exposing students to higher-level questions and allowing students a chance to explore and develop ideas on their own. Having received both whole-group instruction on higher-level questions and small-group instruction based on individual student needs truly seemed to help in student's development of place value understanding.

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APPENDIX A

District-Created Assessment

Student: Homeroom:

Task 1: Quantify with 10's and 1's
Do: Place the cards in front of the student **Say:** *"How many squares?"*
Counting to establish the length of the first stick, does NOT make the child "emergent".

36	**Correct**	□ Counted by 10s and 1s	Continue
		□ Counted by 1s	STOP (Emergent)
	Incorrect	□ Counted by 10s and 1s	
		□ Counted by 1s	
61	**Correct**	□ Counted by 10s and 1s	Continue
		□ Counted by 1s	STOP (Emergent)
	Incorrect	□ Counted by 10s and 1s	
		□ Counted by 1s	

Task 2: Increment and Decrement with 10's and 1's
B = Bundle S = Sticks
Do: Establish that 1B is the same as 10 sticks. Then display 2B and 4S.
Say: *"How many? How do you know?"*
If the student is able to respond using language of 10s and 1s, cover the collection and continue by briefly showing and then covering.

24+1B ➔34	+4S ➔ 38	+3B ➔ 68	68 – 2B ➔ 48	-3S ➔45	- 1B ➔ 35

Notes:

Correct	□ Counted by 10s and 1s	Continue
	□ Counted by 1s only	STOP (L1)
Incorrect	□ Counted by 10s and 1s	
	□ Counted by 1s only	

Task 3A: Adding From a Decade Number
Do: Show the 3A card. **Say:** *"If I start at 40 and jump forward 8, where would I land?"*

40 + 8	**Correct**	□ Automatic	Continue
		□ Counted by 1s	STOP (L2)
	Incorrect	□ Automatic	
		□ Counted by 1s	

Task 3B: Subtracting To a Decade Number
Do: Show the 3B card. **Say:** *"If I start at 37 and jump back 7, where would I land?"*

37 - 7	**Correct**	□ Automatic	Continue
		□ Counted by 1s	STOP (L2)
	Incorrect	□ Automatic	
		□ Counted by 1s	

Task 4A: Adding to a Decade Number
Do: Clarify the term "decade number"
Say: *"Do you know what a decade number is? It's a number like 10 or 20 or 30. We say it when we count by 10s."*
Do: Show the Task 4A card.
Say: *"If I start at 66 and jump forward, what is the next decade number? How big of a jump is that?"*

66

Correct	□ Automatic	Continue
	□ Counted by 1s	STOP (L3)
Incorrect	□ Automatic	
	□ Counted by 1s	

Task 4B: Subtracting From a Decade Number
Do: Show the 4B card. **Say:** *"If I start at 80 and jump back 9, where would I land?"*

80

Correct	□ Automatic	Continue
	□ Counted by 1s	STOP (L3)
Incorrect	□ Automatic	
	□ Counted by 1s	

Task 5A: Adding through a Decade Number
Do: Show the Task 5A card.
Say: *"If I start at 57 and jump forward 5, what number would I land on? How do you know?"*

57 + 5

Correct	□ Added thru decade	Continue
	□ Added 10s/1s separately	
	□ Counted by 1s	STOP (L4)
Incorrect	□ Added thru decade	
	□ Added 10s/1s separately	
	□ Counted by 1s	

Task 5B: Subtracting through a Decade Number
Do: Show the Task 5B card.
Say: *"If I start at 93 and jump back 6, what number would I land on? How do you know?"*

93 - 6

Correct	□ Subtracted thru decade	Continue
	□ Regroup	
	□ Counted by 1s	STOP (L4)
Incorrect	□ Subtracted thru decade	
	□ Regroup	
	□ Counted by 1s	

Task 6A: Adding with 10s and 1s from a Decade Number
Do: Show the Task 6A card.
Say: *"Solve this problem. How do you know?"*
*****The important idea here is that the child uses a non-count-by-ones strategy
.

40 + □ = 66

Correct	□ 10s and 1s	Continue
	□ Counted by 1s	STOP (L5)
Incorrect	□ 10s and 1s	
	□ Counted by 1s	

Task 6B: Subtracting with 10s and 1s to a Decade Number
Do: Show the Task 6B card.

Say: *"Solve this problem. How do you know?"*
*****The important idea here is that the child uses a non-count-by-ones strategy.

78 - □ = 60

Correct	□ 10s and 1s	Continue
	□ Counted by 1s	STOP (L5)
Incorrect	□ 10s and 1s	
	□ Counted by 1s	

Task 7A: Flexible Mental Strategies: Addition – NO MATERIALS
Do: Show the Task 7A card. **Say:** *"Solve this problem."*
Do: After the student has solved and explains his/her strategy, ask for another way.
Say: *"Great! Now solve it using a different strategy."* (**Note: Count by 1s strategy not accepted)**

48 + 34

Strategy One:

Strategy Two:

2 Correct Strategies	Continue
1 or 0 correct strategies	STOP (L6)

<u>Task 7B</u>: Flexible Mental Strategies: Subtraction – NO MATERIALS
Do: Show the Task 7B card. **Say:** *"Solve this problem."*
Do: After the student has solved and explains his/her strategy, ask for another way.
Say: *"Great! Now solve it using a different strategy."* (**Note: Count by 1s strategy not accepted**)

93 - 28

<u>Strategy One:</u>

<u>Strategy Two:</u>

2 Correct Strategies	Continue
1 or 0 correct strategies	STOP (L6)

<u>Task 8A</u>: 3 – Digit Flexible Mental Strategies: Addition – NO MATERIALS
Do: Show the Task 8A card. **Say:** *"Solve this problem."*
Do: If the student has solved 597 + 363 using the standard algorithm, ask him/her to solve the problem using a different strategy.

597 + 363

<u>Record **mental math** strategy:</u>

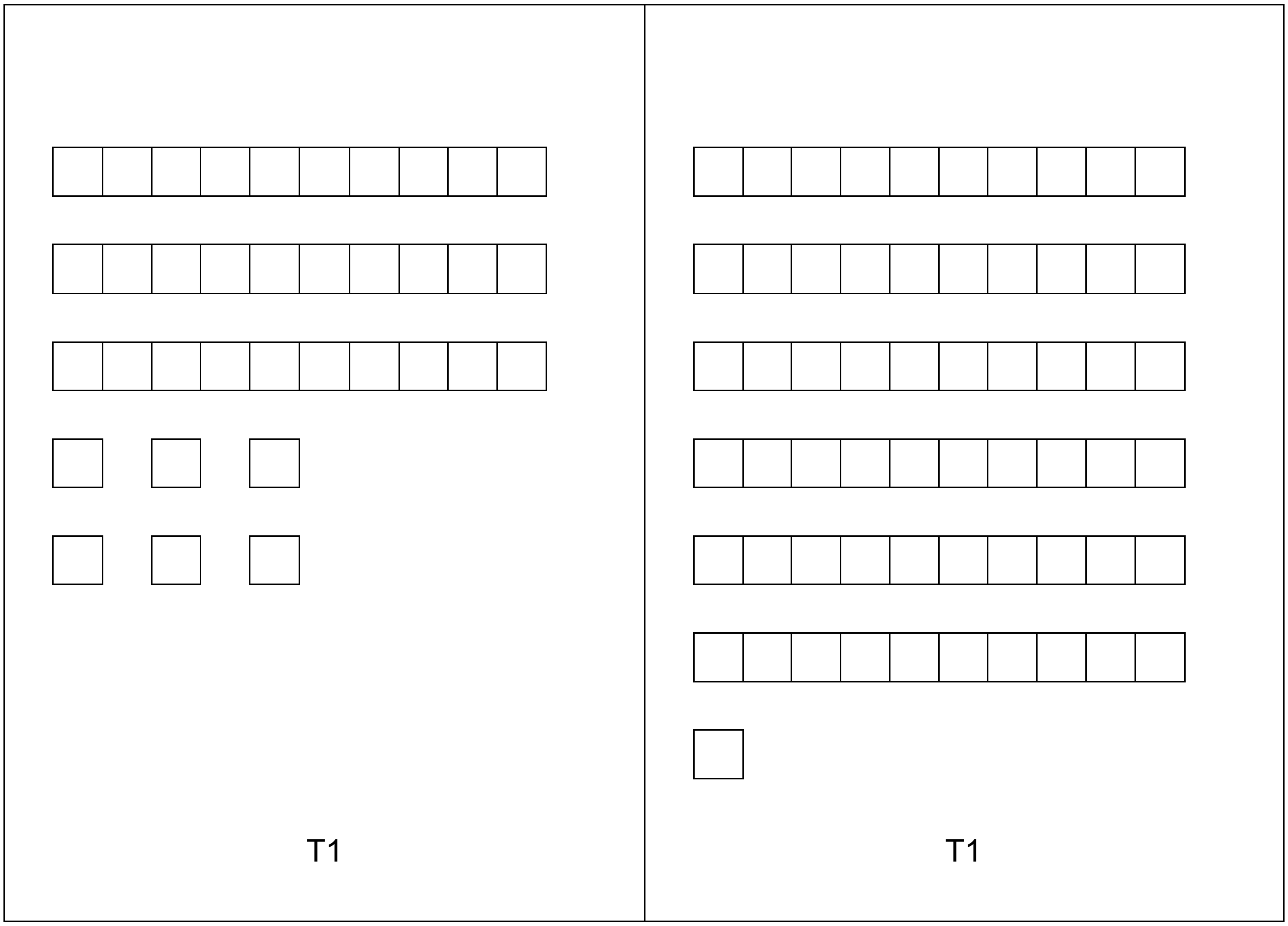
Correct Strategy (not the standard algorithm)	Continue
Only standard algorithm or incorrect	**STOP (L7)**

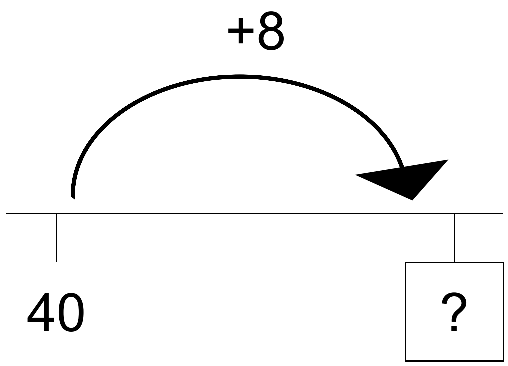
<u>Task 8B</u>: 3-Digit Flexible Mental Strategies: Subtraction – NO MATERIALS
Do: Show the Task 8B card. **Say:** *"Solve this problem."*
Note: If the student has solved 823 - 299 using the standard algorithm, ask him/her to solve the problem using a different strategy

823 - 299

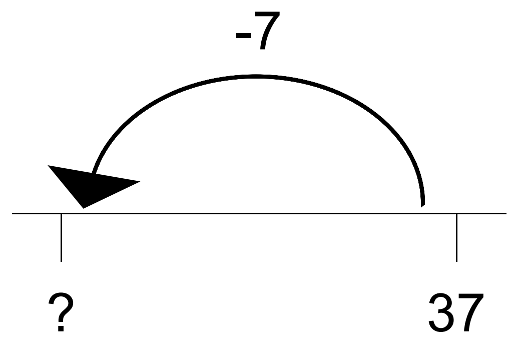
<u>Record **mental math** strategy:</u>

Correct Strategy (not the standard algorithm)	Level 8
Only standard algorithm or incorrect	**STOP (L7)**

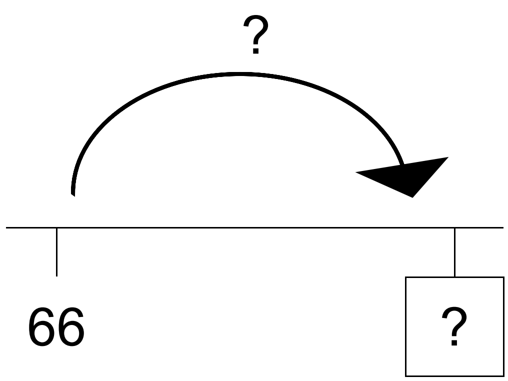

T1
T1



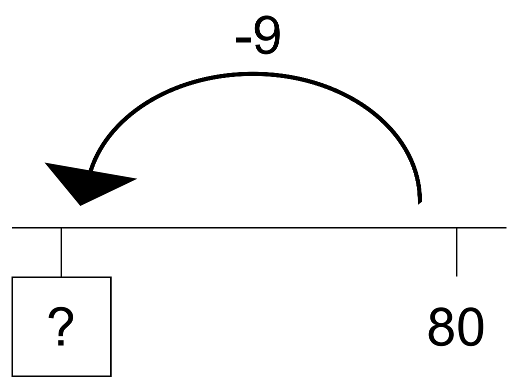
T3A



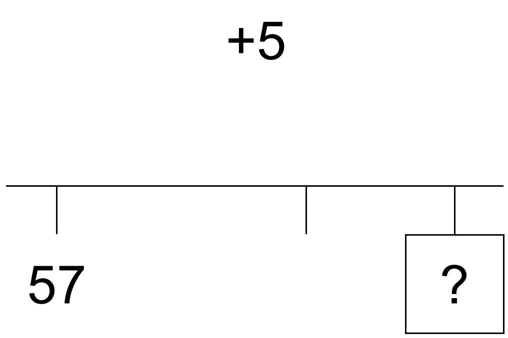
T3B



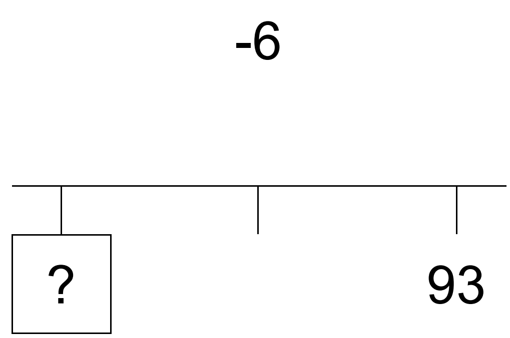
T4A



T4B



T5A



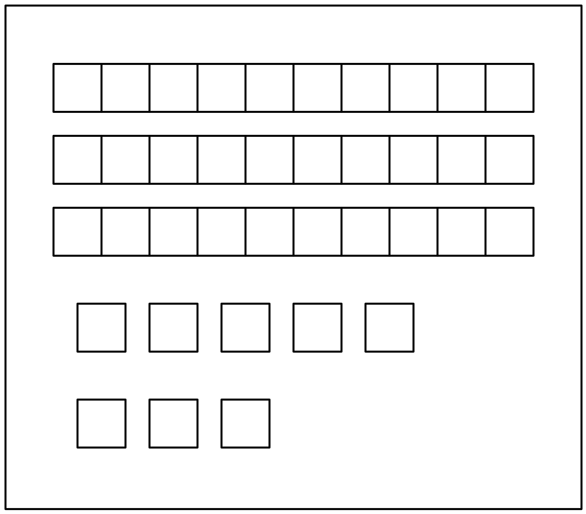
T5B

40 + □ = 66 T6A	78 - □ = 60 T6B
48 + 34 T7A	93 - 28 T7B
597 + 363 T8A	823 - 299 T8B

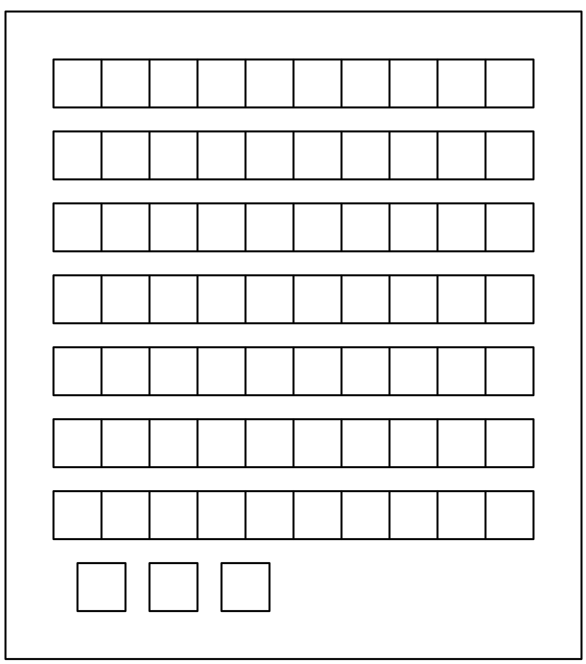
APPENDIX B

Teacher-Created Assessment

Task 1A:
How many squares are there? (must count by 10s and 1s to pass)



Task 1B:
How many squares are there? (must count by 10s and 1s to pass)



Task 2A:
Increment and Decrement by 10s and 1s

B= Bundle S= Sticks

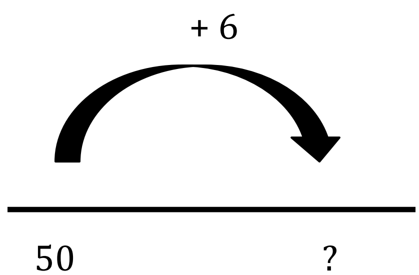
Display 3B and 2S. How many are there?
If the student is able to respond with the answer 32, cover the collection and continue with the progression below.

32 + 1B → 42	+ 4S → 46	+ 3B → 76	- 2B → 56	- 3S → 53	- 1B → 43

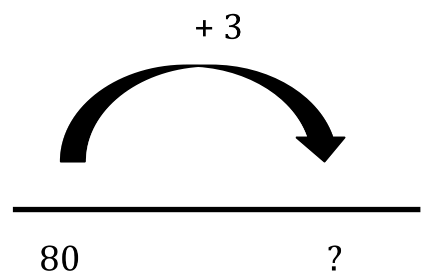
*If student is stuck on Task 2A they are a Level 1.

Task 3A:

If I start at 50 and jump forward 6, where will I land?

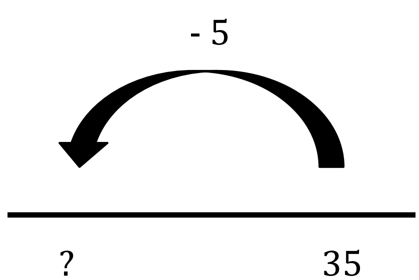


If I start at 80 and jump forward 3, where will I land?

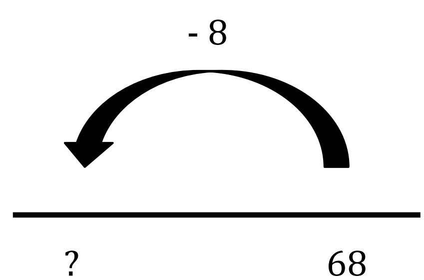


Task 3B:

If I start at 35 and jump back 5, where will I land?



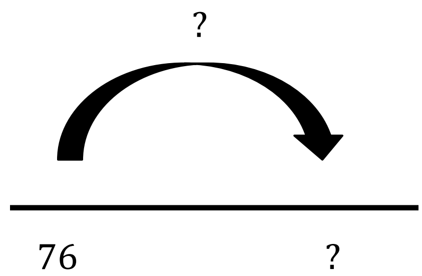
If I start at 68 and jump back 8, where will I land?



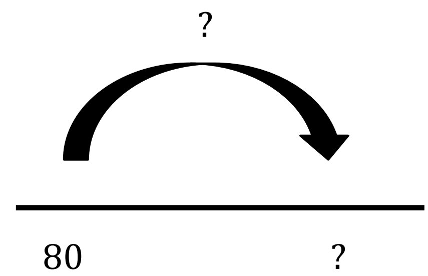
*If student is stuck on Task 3A or 3B they are a Level 2

Task 4A:

If I start at 76 what is the next decade number? How big of a jump is that?

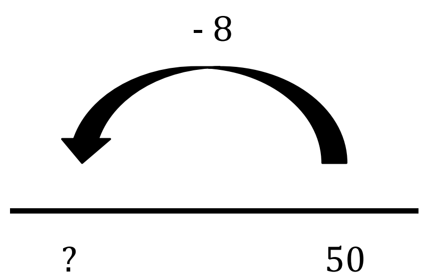


If I start at 43 what is the next decade number? How big of a jump is that?

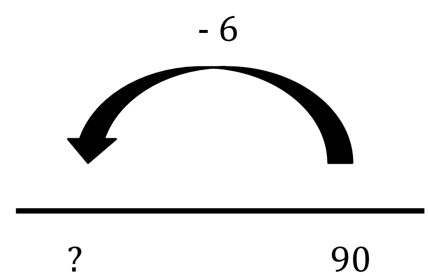


Task 4B:

If I start at 50 and jump back 8, where would I land?



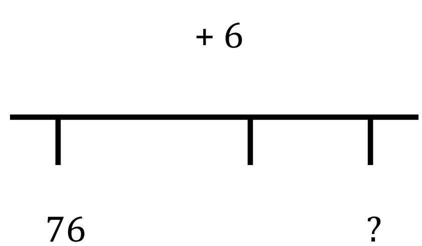
If I start at 90 and jump back 6, where would I land?



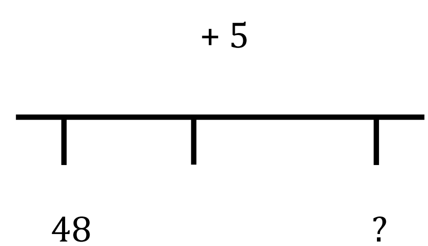
*If student is stuck on Task 4A or 4B they are a Level 3

Task 5A:

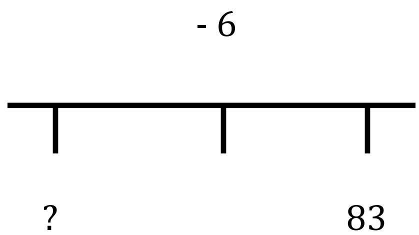
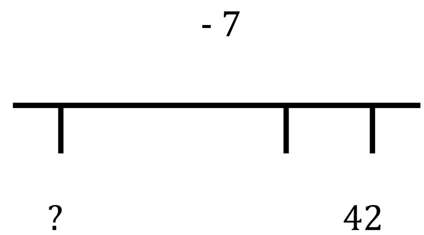
If I start at 56 and jump forward 6, what number will I land on? How do you know?



If I start at 48 and jump forward 5, what number will I land on? How do you know?



Task 5B:

If I start at 83 and jump back 6, what number will I land on? How do you know?  	If I start at 42 and jump back 7, what number will I land on? How do you know? 

*If student is stuck on Task 5A or 5B they are a Level 4.

Task 6A:

Solve this problem. Explain how you found the answer. 60 + _____ = 84	Solve this problem. Explain how you found the answer. 40 + _____ = 62

Task 6B:

Solve this problem. Explain how you found the answer. 97 - _____ = 70	Solve this problem. Explain how you found the answer. 113 - _____ = 90

*If student is stuck on Task 6A of 6B they are a Level 5.

Task 7A:

Solve this problem. Explain how you found the answer. 56 + 28	Solve this problem. Explain how you found the answer. 47 + 25

*If a successful strategy was used have the student use another strategy to solve the same question. The student needs to know at least 2 ways to solve each question in order to pass to the next level.

Task 7B:

Solve this problem. Explain how you found the answer. 82 - 26	Solve this problem. Explain how you found the answer. 93 - 37

*If a successful strategy was used have the student use another strategy to solve the same question. The student needs to know at least 2 ways to solve each question in order to pass to the next level.

*If student is stuck on Task 7A or 7B they are a Level 6.

APPENDIX C

Consent Form

February 9, 2016

Dear Parents/Guardians,

My name is Kate Shelley and I am the Math Specialist at xxxxx Elementary. I will be teaching your child's Targeted Services mathematics class. I am currently completing my master's degree at Hamline University. As part of my graduate work, I am required to complete a research project, which will take place during the Targeted Services classes from February 2016 – May 2016. The purpose of this letter is to ask your permission for your child to participate in the research. This research is public scholarship, the abstract and final product will be cataloged in Hamline's Bush Library Digital Commons, a searchable electronic repository and it may be published or used in other ways. The study design has undergone the review and approval process through the district and university.

The study will be based on data from the Conceptual Place Value (CPV) district assessment and informal observations. Specifically, I want to investigate how a second grade targeted services intervention program focused on place value impacts a student's growth in this area as well as a student's overall achievement in mathematics. All students will receive the same instruction and services during class time, whether they participate in the study or not. If you choose to decline participation in the study you are only declining use of your child's data for the study, instruction for your child will remain the same. All students will be given informal and formal assessments on a weekly basis. Informal assessments will be taken through observations and notes. Formal assessments will be given using the CPV alternative assessment cards. Information from these assessments will guide instruction for the upcoming week. Informal and formal assessment results of students who choose to participate in the study will be analyzed for growth during targeted services.

The risks will be minimal in the study. The benefit of participating in the study is offering the opportunity to analyze how our district CPV resource influences mathematical achievement.

If your child participates in my research, his or her identity will be protected. No real names, photos, of any personal identifying information will be included in my final research product. All personal student information will be kept confidential. Participation in this study is completely voluntary and you or your child may decide not to participate, at any time, without any negative consequences.

I have received approval for my study from the School of Education at Hamline University and from Anoka-Hennepin's Research, Evaluation, and Testing (RET) committee.

If you agree that your child may participate, keep this page. Please complete and return the permission form on the following page. Call or email if you have any questions or concerns.

Sincerely,

Kate Shelley
Math Specialist

Informed Consent to Participate

February 9, 2016

Dear Mrs. Shelley,

I have received and read your letter about conducting research on conceptual place value and targeted services intervention. I understand that your goal is to better understand how targeted services intervention affect student scores on the district conceptual place value assessment for second graders.

I give my child, ____________________________________, permission to participate in your research and for use of his/her math scores to be used for you Master's Degree project. I understand that all results will be confidential and anonymous and that my child may stop taking part at any time without negative consequences.

Signed,

____

Parent/Guardian Signature

________________________ ____

Date Parent/Guardian Phone Number