NUMBER SENSE INTERVENTION: A COMPARISON OF A PACKAGED PROGRAM AND A RESEARCH-BASED STRATEGY

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NUMBER SENSE INTERVENTION: A COMPARISON OF A PACKAGED PROGRAM AND A RESEARCH-BASED STRATEGY

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ABSTRACT

NUMBER SENSE INTERVENTION: A COMPARISON OF A PACKAGED PROGRAM AND A RESEARCH-BASED STRATEGY

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The purpose of this study was to determine the effects of two different Tier 2 number sense interventions on the mathematics performance of first-grade students identified as having mathematics difficulties on a universal screening tool. A quasi-experimental study was conducted utilizing single case design. Participants (N=6) were assigned to either a Number Worlds intervention or a cover-copy-compare intervention. It was hypothesized that the students receiving the Number Worlds intervention would demonstrate more growth from the winter to spring on the universal screening measure benchmark assessment than students receiving the cover-copy-compare intervention. This was measured by computing the $g$-index, the Mann-Whitney $U$ test of nonparametric measures, and visual analysis. The $g$-index indicated the Number Worlds intervention yielded a slightly larger effect size and the Mann-Whitney $U$ also supported the hypothesis but the results were not significant. The $g$-index, Mann-Whitney $U$, and
visual analysis each indicated positive effects on growth in number sense skills as measured by mathematics computation fluency measures.
# TABLE OF CONTENTS

ABSTRACT ................................................................................................................................. iv

LIST OF TABLES ......................................................................................................................... ix

LIST OF FIGURES ....................................................................................................................... x

CHAPTER I: INTRODUCTION ................................................................................................. 1

CHAPTER II: LITERATURE REVIEW ....................................................................................... 4

Development of Mathematics Skills .................................................................................. 4

Early Mathematics Skills .................................................................................................... 6

Remediation of Early Mathematics Deficits ...................................................................... 7

Efficacy Versus Effectiveness in Mathematics Research .................................................. 8

Causes of Mathematics Difficulty ....................................................................................... 9

Number Sense ....................................................................................................................... 11

Problem-solving ................................................................................................................... 12

Dyscalculia ............................................................................................................................... 12

Neuroscience Connection .................................................................................................... 13

Mathematics and Response to Intervention ...................................................................... 13

Mathematics Interventions ................................................................................................... 14

Packaged Programs Targeting Number Sense .................................................................. 16

Research-based Strategies Targeting Number Sense ......................................................... 18

The Present Research Study ............................................................................................... 19
## CHAPTER III: METHOD

- Research Question and Hypothesis ................................................................. 21
- Research Design ............................................................................................... 22
- Participants and Setting ..................................................................................... 23
- Materials ........................................................................................................... 23
  - Measures ........................................................................................................ 23
  - Treatment Integrity ......................................................................................... 24
  - Treatment Acceptability ................................................................................. 25
  - Intervention Materials .................................................................................... 25
    - SRA Number Worlds ................................................................................... 25
    - Cover- Copy- Compare ............................................................................... 26
- Procedures ......................................................................................................... 27
  - Preliminary Procedures .................................................................................. 27
  - Intervention Procedures ................................................................................. 28
- Data Collection ................................................................................................ 29

## CHAPTER IV: RESULTS

- Descriptive Results .......................................................................................... 30
  - SRA Number Worlds .................................................................................... 31
  - Cover- Copy- Compare .................................................................................. 34
- Treatment Integrity Checks ................................................................................ 38
  - SRA Number Worlds .................................................................................... 38
  - Cover- Copy- Compare .................................................................................. 38
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Acceptability</td>
<td>38</td>
</tr>
<tr>
<td>CHAPTER V: DISCUSSION</td>
<td>40</td>
</tr>
<tr>
<td>Review of Relevant Findings</td>
<td>40</td>
</tr>
<tr>
<td>Interpretation of Findings</td>
<td>42</td>
</tr>
<tr>
<td>Limitations</td>
<td>46</td>
</tr>
<tr>
<td>Implications for Practice</td>
<td>48</td>
</tr>
<tr>
<td>Future Research</td>
<td>48</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>50</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>60</td>
</tr>
<tr>
<td>Appendix A: Measures</td>
<td>60</td>
</tr>
<tr>
<td>Appendix B: Treatment Integrity and Acceptability</td>
<td>61</td>
</tr>
<tr>
<td>Appendix C: Intervention Material</td>
<td>65</td>
</tr>
<tr>
<td>Appendix D: IRB Material and Consent Letters</td>
<td>70</td>
</tr>
<tr>
<td>Appendix E: Intervention Training Materials</td>
<td>81</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 1     M-COMP winter to spring benchmark individual student growth chart 37
Table 2     Case study interpretation summary ........................................................................ 39
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Weekly progress monitoring outcome data</td>
<td>31</td>
</tr>
<tr>
<td>Figure 2</td>
<td>NW individual weekly progress monitoring graph Student 1</td>
<td>32</td>
</tr>
<tr>
<td>Figure 3</td>
<td>NW individual weekly progress monitoring graph Student 2</td>
<td>33</td>
</tr>
<tr>
<td>Figure 4</td>
<td>NW individual weekly progress monitoring graph Student 3</td>
<td>33</td>
</tr>
<tr>
<td>Figure 5</td>
<td>CCC individual weekly progress monitoring graph Student 4</td>
<td>34</td>
</tr>
<tr>
<td>Figure 6</td>
<td>CCC individual weekly progress monitoring graph Student 5</td>
<td>35</td>
</tr>
<tr>
<td>Figure 7</td>
<td>CCC individual weekly progress monitoring graph Student 6</td>
<td>35</td>
</tr>
</tbody>
</table>
Educators and researchers are increasingly interested in mathematics difficulties in children. It is currently estimated that 5-10% of school age children have mathematics disabilities (Fuchs & Seethaler, 2005; Bryant, Bryant, Gersten, Scammacca, & Chavez, 2008). Many of these children exhibit number sense difficulties from an early age. Number sense is the ability to think about numbers and understand how they are used (Gersten, Jordan, & Flojo, 2005); it is the foundation for all mathematics skills and thus a lack of number sense can impact mathematics achievement throughout a child’s education.

Studies on the impact of mathematics interventions on the performance of at-risk students are emerging and provide implications for the design and delivery of effective interventions (Bryant et al, 2008;; Bryant, Bryant, Roberts, Vaughn, Pfannenstiel, Porterfield, & Gersten, 2011; Fuchs & Seethaler, 2005). Few intervention programs have been empirically validated, and only a small number of research-based interventions have demonstrated effectiveness in the research. Little is known about the most effective components in a mathematics intervention, what types of interventions are most effective at strengthening number sense, and the amount of growth that can be expected in
response to these interventions. All of these questions are crucial for strengthening number sense abilities in students with mathematics difficulties.

Mong and Mong (2010) completed a quasi-experimental study comparing the cover-copy-compare intervention strategy (CCC) with the Mathematics to Mastery (MTM; Doggett, Henington, & Johnson-Gross, 2006) intervention program. CCC is a self-managed intervention strategy that provides a series of learning trials within a short period of time. CCC has been proven effective for deficits in spelling and writing skills as well as mathematics skills (Hansen, 1978; Skinner, Turco, Beatty, & Rasavage, 1989; Skinner, McLaughlin, & Logan, 1997). Repeated practice and self-evaluation of accuracy both contribute to CCC’s effectiveness. MTM is a structured, packaged intervention program that includes previewing problems, immediate feedback, repeated practice, and self-monitoring of progress. In their study, Mong and Mong (2010) found that the MTM intervention was more effective than the CCC intervention for the students in the intervention group.

The present research study compared the effectiveness of Science Research Associates (SRA) Number Worlds, a packaged intervention program for improving number sense to cover-copy-compare®, a research-based strategy that can be used in conjunction with the core curriculum. The SRA Number Worlds intervention program is an empirically-validated program that is effective for increasing number sense in elementary school-age children (Griffin, 2004). The CCC intervention has a large research backing and is an effective intervention for increasing mathematics computation (Skinner et al., 1997). A study of this nature is important because current economic conditions affect the resources allocated to schools and districts that must choose
intervention programs that will provide the greatest impact on student achievement while maintaining fiscal responsibility. Packaged intervention programs are often expensive and involve reoccurring annual expenses. Consequently, research-based strategies typically require little if any cost and only necessitate the time of the interventionist or classroom teacher to use materials already on hand in employing the strategy. A quasi-experimental design similar to Mong and Mong (2010) was utilized to compare the results of the two interventions on student growth in number sense as measured by weekly progress monitoring probes. Data from both interventions were analyzed and the results and implications from the study are discussed.
CHAPTER II
LITERATURE REVIEW

In 2004, the reauthorization of the Individuals with Disabilities Act (IDEA) introduced a new way of providing struggling students with extra academic help as an alternative to the previous practice of waiting for a student to fail before providing access to special education or intervention services. In response to No Child Left Behind (NCLB; 2001) states began to implement a response-to-intervention (RTI) process to identify students with learning difficulties and provide research-based intervention services before students fall far enough behind to need special education services (Bryant et al., 2011). Since 2004, a plethora of reading interventions have been developed and identified as research-based in the literature, but literature on research-based mathematics interventions remains scarce (Bryant et al., 2008; Fuchs, Compton, Fuchs, Paulsen, Bryant, Hamlett, & , 2005; Mong & Mong, 2010). The current literature review will examine the typical development of mathematical skills, identify common causes of mathematics difficulties, and describe mathematics interventions targeting early mathematics skills, specifically the acquisition of number sense.

Development of Mathematics Skills

In 2008 the U.S. Department of Education published the final report of the National Mathematics Advisory Panel. This panel investigated mathematics acquisition
and best practices in mathematics instruction in the areas of curricular content, learning processes, teacher education, instructional practices, instructional materials, assessment, and research. The report indicated that most children come to school with considerable knowledge of number concepts and those who don’t experience a widening of the achievement gap throughout elementary, middle, and high school. The consequences of poor mathematics achievement are pervasive in daily living and career advancement; students with mathematics skill deficits are more likely to be passed by for career opportunities (Jordan & Levine, 2009; Poncy, McCullum, & Schmitt, 2010). The report goes on to state that mathematics deficits, including deficits in students with learning disabilities, students living in poverty, and students in the lowest third of a typical class, can be remediated through explicit, concrete instructional practices.

The National Council of Teachers of Mathematics (NCTM; 2000) identified that there are five areas of mathematics that are essential to acquisition of higher order mathematics skills. These content areas include: number sense, concepts and operations, geometry and spatial sense, patterns and algebraic thinking, data analysis and probability, and measurement. The National Mathematics Advisory Panel (2008) and the NCTM Principles and Standards for School Mathematics (2000) note that mathematical difficulties can arise in any of the five areas of mathematics concepts and early intervention can help to close the achievement gap for these students.

Mathematical learning progresses through four phases: acquisition, fluency, generalization, and application (Burns et al., 2010). In the acquisition stage of learning students’ skills are slow and inaccurate; as accuracy improves tasks continue to be completed at a slow pace. As students develop speed in figuring out basic problems they
are able to use foundational skills on new and novel tasks. Finally as students are able to
generalize skills more accurately and quickly, they develop the ability to use these skills
to solve mathematical problems (Burns, Codding, Boice, & Lukito, 2010). Number sense
and mathematics fact fluency are vital in the development of mathematical knowledge
and understanding. When children don’t acquire number sense accuracy and
computational fluency it becomes more challenging for them to progress into the
generalization and application stages of development. Research indicates that students
who lack mathematics fluency are more likely to avoid mathematics tasks, thereby
avoiding practice and thus opportunities to, in turn, improve fluency (Poncy et al., 2010).
As students advance through the stages of mathematical development, interventions
should be linked to specific skill deficits that students exhibit. For example, if one 2nd
grade student struggles with mathematics fact fluency and one 2nd grade student struggles
with problem-solving, different interventions should be used that target each student’s
specific skill deficit.

**Early Mathematics Skills**

Jordan and Levine (2009) categorize specific foundational skills involving
symbolic number knowledge that students should master in early mathematics education,
including: verbal subitizing, counting, numerical magnitude comparisons, estimation, and
arithmetic operations. Verbal subitizing involves recognizing the number of objects in a
set without counting. Counting involves the principles of one-to-one correspondence, the
idea that each item in a set can only be counted once; stable order, the idea that the
numbers said or used when counting must be used in a constant order; and cardinality, the
idea that the final number in a count designates the number of items in the group. As
counting skills develop children acquire more complex counting skills such as counting backward and skip counting. Numerical magnitude comparisons involve developing a mental number line. Children use the understanding that numbers represent magnitudes that are bigger and smaller than other numbers to learn place value and perform mental math. Estimation involves placing numbers on the mental line in the approximate place; this skill allows children to work within the base ten system more fluidly. Arithmetic operations involve using working and long-term memory to manipulate numerical representations (Jordan & Levine, 2009). Without the development of these early number sense skills, it becomes increasingly more difficult to perform higher order mathematics skills proficiently.

**Remediation of Early Mathematics Deficits**

Students exhibiting mathematics deficits later in elementary and middle school have difficulties with the symbolic systems of numbers, meaning they have weaknesses in number sense (Fuchs et al, 2005; Jordan & Levine, 2009, Kroeger, Brown, & O’Brien, 2012; Poncy et al, 2010). Intervention options for remediating mathematics deficits are available in the form of empirically-validated packaged programs as well as research-based strategies. These programs and strategies can be used to target the specific skill deficits that impede a child’s mathematical development.

With the current trend toward RTI, schools are increasingly using interventions with struggling students (Baker, Chard & Clark, 2008). Schools are implementing research-based strategies in the classroom and commercial programs are frequently marketed to address the many different types of difficulties struggling students face. Websites and teaching workshops are frequently dedicated to learning how to use
universal screening, curriculum-based measurement, and progress monitoring; forums are filled with discussions about best practices and successful interventions. Most of these interventions, workshops, and forums focus on interventions in reading. There are interventions addressing every area of the five big ideas in reading (National Reading Panel, 2000). Good mathematics interventions for specific difficulties, however, are scarce (Fuchs, Fuchs, Craddock, Hollenbeck, Hamlett, & Schatschneider, 2008; Poncy et al., 2010).

**Efficacy Versus Effectiveness in Mathematics Research**

The gap between research and practice in education is well documented in efficacy versus effectiveness studies (Glasgow, Lichtenstein, & Marcus, 2003). Efficacy trials are usually completed by researchers following a standardized research protocol; effectiveness trials are completed by educators with other competing demands on time. Without the other demands on teachers’ time, efficacy trials do not typically have the mitigating factors or limitations that are often experienced in school settings and fidelity of implementation is less likely to be affected. Effectiveness trials are performed in a setting similar to where the intervention will be utilized and are therefore believed to represent more generalizable outcomes to other school settings (Glasgow et al., 2003). Some packaged intervention programs are found to be efficacious in research trials, but do not produce the same results when applied in real-world settings, in particular, school environments. The gap between research and practice in education is caused by several factors such as limited time and resources of educators, lack of feedback and follow-up, and insufficient systems organization to support emerging practices (Glasgow et al., 2003).
According to the National Research Council’s report on educational research (2002), the Department of Education now encourages the use of randomized trials when testing interventions (Fuchs & Seethaler, 2005). Fuchs and Seethaler (2005) reviewed the studies published in the previous five years that assessed the effects of reading and mathematics group interventions using randomized trials; they found that of the 804 articles fitting this criterion, only 10 focused on mathematics interventions. More recently Burns et al. (2010) completed a meta-analysis of mathematics acquisition and fact fluency interventions to determine which type of mathematics intervention is appropriate for different developmental stages of mathematics instruction. The authors reviewed studies in which interventions for acquisition or fact fluency were implemented using single case design resulting in quantitative data that could be used to determine an effect size. Seventeen studies met the inclusion criteria. This indicates the need for more research in the area of effective mathematics interventions. Although little research on effective mathematics interventions exists, there is a growing bank of research examining the causes of mathematics difficulties.

**Causes of Mathematics Difficulty**

Pinpointing the cause of a student’s mathematics difficulties is challenging. Mathematical reasoning is a complex set of skills that requires logical functioning, motivation, problem-solving skills, memory skills, strategy acquisition and application, and vocabulary (Kroesbergen & Van Luit, 2003). A student can struggle with a particular mathematics concept or have pervasive mathematical weaknesses. Additionally, mathematics difficulties are not stable over time. For example, a student who has difficulty with mathematics in first grade may not necessarily have difficulty
with mathematics in sixth grade. The opposite can also be true; a student exhibiting strong mathematical skills in first grade may have mathematical difficulties in fourth grade (Baker et al., 2008).

Number sense and problem-solving are two areas that strongly affect children’s abilities to perform mathematical tasks (Räsänen, Salminen, Wilson, Anuio, & Dehaene, 2009; Fuchs et al., 2008; Kroesbergen & Van Luit, 2003). IDEA (2004) makes a distinction between these different aspects of mathematics cognition and notes mathematical problem-solving weaknesses and mathematical computation weaknesses to be distinct entities in the classification of learning disabilities. Researchers debate whether number sense and problem-solving abilities are linked or are mutually exclusive (Fuchs et al., 2008; Fuchs, Fuchs, Powell, Seethaler, Cirino, & Fletcher, 2008; Kroesbergen & Van Luit, 2003). Debate also exists as to whether reading difficulties affect a child’s ability to understand mathematical concepts (Powell, Fuchs, Fuchs, Cirino, & Fletcher, 2009). Reading difficulties and mathematic difficulties have been found to coexist in children; but evidence does not conclusively indicate that reading difficulties affect number sense. Studies show that children with coexisting reading and mathematics difficulties have a wider range of mathematics difficulties. Working memory and attention are predictors of both problem-solving and computational abilities; phonological processing is a predictor for computational abilities, and nonverbal reasoning is a predictor for problem-solving abilities (Fuchs & Seethaler, 2005). All of these factors make it difficult to determine the exact cause of mathematics difficulties for a child and therefore can make selecting the appropriate intervention challenging.
**Number sense.** Number sense is a cognitive process for thinking about numbers and how they are used (Gersten et al., 2005). Number sense includes quantity discrimination, understanding the magnitude of numbers, using mental computation, moving between different representations of the same number, and recognizing unreasonable answers (Bryant et al., 2008; Kalchman, Moss, & Case, 2001). Number sense skills are important for children to experience success with mathematical concepts in the early grades. Most children gain number sense naturally but others need formal instruction to help them learn basic concepts (Dev, Doyle, & Valente, 2002). Inattentive behavior and poor processing speed may inhibit the development of competent number sense (Fuchs et al., 2005).

The NCTM *Principles and Standards for School Mathematics* (2000) identified number and operations concepts as the most important standard. Without a solid understanding of basic numerical representations, students have difficulty applying number concepts to higher-level mathematics applications such as problem-solving and algebra. With NCTM’s development of the Curriculum Focal Points (2006) students are now expected to go beyond concrete understanding of number concepts and algorithms and apply acquired number sense skills to a variety of different mathematical concepts. Students with number sense difficulties develop more problems with counting than the typical student. These counting difficulties cause a failure to shift from concrete operations to memory-based operations (Fuchs, Powell, Seethaler, Cirino, Fletcher, Fuchs, & Hamlett, 2010). Deficits in memory-based operations and automatic retrieval of facts is a commonality in students displaying mathematics difficulties (Butterworth &
Laurillard, 2010; Carr, Taasoobshirazi, Stroud, & Royer, 2011; Fuchs et al., 2010; Fuchs et al., 2009; Fuchs et al., 2008; VanderHeyden & Burns, 2009).

**Problem-solving.** Problem-solving is a higher order thinking skill that involves combining basic mathematical skills with phonological skills to understand how to apply a strategy to solve a problem (Kroesbergen & Van Luit, 2003). In computation, a child must solve a problem that has already been set up, but in problem-solving a child must use linguistic information to set up the problem before solving it. This skill involves finding missing information, putting information together in new ways, understanding which pieces of information are not important, and using knowledge of different strategies to set up a problem to compute. Language plays an important role in the development of problem-solving skills (Fuchs et al., 2005).

**Dyscalculia.** Research is often conducted on students experiencing mathematics difficulties as well as students identified with a mathematics disability. Butterworth and Laurillard (2010) completed a study showing that individuals with dyscalculia, a specific learning disability in math characterized by delays in counting, delays in using counting strategies for addition, and difficulties in memorizing basic math facts, have abnormalities in the parietal lobe of the brain. The parietal lobe is the part of the brain that processes number comparisons and interprets the relationship between a represented set and the number that goes with the set. The way that most children learn number sense is by counting and using manipulatives to see relationships between representations and numbers. Children with dyscalculia struggle with both of these tasks (Butterworth & Laurillard, 2010). Individualized interventions should be matched to the distinct need of each child regardless of whether the need is due to an abnormality in the brain, an overall
low sense of numeracy or weak problem-solving skills. Emerging research in mathematics intervention indicates that choosing mathematics interventions based on cognitive abilities and norm-referenced assessment is not as effective as directly observing mathematics behavior to determine specific skill deficits (Burns et al., 2010).

**Neuroscience connection.** Recently scholars in the fields of neuroscience, cognitive psychology, and education have attempted to merge relevant finding into transdisciplinary discussions and research. One of the reasons for the importance of these connections is to determine what works for helping children experiencing mathematics difficulties (Kroger et al., 2012). Mathematics cognition develops through an interaction of multiple factors including neural activity, behavior, and environment (Brown & Chiu, 2006). Effective interventions are being developed by triangulating research in these fields and marketing programs that have included neuroscience research as part of the program evaluation process (Kroeger et al., 2012). Neuroscience research on mathematics cognition is still an emerging field and there are limited intervention programs supported by peer-reviewed neuroscience components (Kroeger et al., 2012).

**Mathematics and Response to Intervention**

Once a universal screening is administered or when a teacher has identified a student with more intensive needs than the core curriculum can accommodate, interventions need to be implemented. Early identification and intervention for at-risk students prevents over-identification of learning disabilities (Hanley, 2005). If students can begin to receive intervention early, remediation of weaknesses can occur before the gap widens and special education services are needed. Interventions must be explicit,
systematic, and designed around components that are research-based (Bryant, Compton, Davis, Fuchs & Fuchs, 2007; Hanley, 2005; IDEA, 2004; NCLB, 2001).

Particular areas of difficulty need to be identified to provide an intervention that matches the needs of the child. Interventions are divided into categories according to the different weaknesses that are targeted. Mathematical interventions are typically divided into two categories: number sense interventions and problem-solving interventions (IDEA, 2004). Number sense interventions cover a broad range of skills and need to be examined before implementation to ensure that the intervention is matched with the appropriate skill deficit. Number sense interventions generally cover magnitude comparison, counting, number identification, and simple arithmetic (Aunio et al., 2009). Problem-solving interventions differ in that these interventions explicitly teach students to identify a strategy for solving the problem, such as 1) read, 2) plan, 3) solve, and 4) check (Fuchs et al., 2005; Polya, 2004).

**Mathematics Interventions**

Although professional organizations acknowledge the significance of number sense instruction there is no agreement as to which method is the most appropriate for improving acquisition and fluency (NCTM, 2000). Minimally guided instruction that utilizes discovery learning is preferred by educators and researchers who follow a more constructivist approach to education. This method involves allowing students to discover the principles and processes underlying mathematical concepts in a setting where they are encouraged to explore and problem-solve allowing learning to be constructed by the individual student. There are also methods of guided-inquiry within the constructivist approach in which materials and resources are provided and suggested to students for use
in exploring individual tactics for learning and exploring new concepts. This approach utilizes a guided instruction framework within an inquiry model of instruction. A more guided approach stems from theories of behaviorism and favors systematic instruction that involves providing students with targeted instruction to teach foundational procedures. The guided approach emphasizes the importance of repeated practice and reinforcement for correct responding. There is debate among mathematical researchers around which approach, constructivistic or behavioralistic, are more effective at increasing student outcomes on growth measures; both approaches are supported in the research literature (NCTM, 2000; NCTM, 2005; Poncy et al, 2010; Van de Walle & Lovin, 2006).

Intervention programs aimed at remediating basic mathematical skills deficits should be systematic—utilizing guided approaches to provide appropriate instruction and opportunities for repeated practice. Skills should be taught in a specific hierarchy so that acquired skills can be combined to solve increasingly complex problems; once prerequisite skills are mastered students can then be taught to apply basic skills to more advanced problems (Poncy et al., 2010). Empirically-validated programs and teaching strategies are scarce in the field of mathematical intervention, although a growing bank of research-based strategies is beginning to emerge (Fuchs, Fuchs, Stuebing, Fletcher, Hamlett, & Lambert, 2008).

While the constructivist approach to mathematics instruction is supported in the literature, the current study is based on the tenants of a behavioralistic approach to intervention. For the purposes of this present study, mathematics intervention is defined as any program or instruction that occurs in addition to the general education curriculum
and is used to provide supplementary instruction to students either in small groups or individually. Research-based interventions such as Cover, Copy, Compare (Lee & Tingstrom, 1994; Skinner et al, 1989), computer assisted interventions (Butterworth & Laurillard, 2010; Räsänen et al., 2009) and ‘think alouds’ (Bryant et al., 2011) can provide additional practice and review of mathematics concepts in small or large group settings in conjunction with instruction provided in the general education core curriculum. These approaches can be relatively easy to implement and inexpensive to add into the instructional day because they can implemented with materials already possessed by a district with minimal to no additional staffing required. However, using these strategies in conjunction with instruction may not provide intervention that is intensive enough to remediate significant mathematical skill deficits. Packaged intervention programs, on the other hand, provide an explicit and systematic approach to remediating mathematics deficits. These programs may be expensive to purchase and implement, but they rely on strategies that have been empirically validated to target a wider range of mathematics difficulties.

**Packaged programs targeting number sense.** Kroeger et al. (2012) identified twenty mathematics intervention programs that targeted number sense skills as well as working memory, problem solving, and executive function skills for pre-kindergarten through third grade students in a review of the literature. Of the twenty identified programs, only five were supported by empirical peer-reviewed research: *Accelerated Math* (Renaissance Learning, nd), *Corrective Mathematics* (The McGraw-Hill Company, nd), *Fluency and Automaticity through Systematic Teaching with Technology (FASTT Math)* (Scholastic, nd), *Number Worlds* (SRA/ McGraw-Hill, 2007), and *The Number*
Race (Wilson, Revkin, Cohen, Cohen, & Dehaene, 2006). Of these programs, only the Number Worlds program (Griffin, 2004) was found to have a neuroscience basis and target the cognitive skills of representation, working memory, problem solving, and executive functioning.

Number Worlds (Griffin, 2007) is a commercially available mathematics intervention program aimed at remediating number sense deficits in students grades Pre-K to 6. Intervention packages, levels A-J, cost approximately $800 per level, the Grade 1 standard intervention package costs approximately $1000, and the Grade 1 deluxe intervention package costs approximately $2300. The program used neuroscience research in its initial development and it targets working memory deficits, representational weaknesses, problem-solving deficits, and executive functioning deficits (Kroeger et al, 2012; Griffin, 2004). Number Worlds begins with a pretest to determine the student’s current mathematical skill level, and then places the student in the program at his or her instructional level. The program is hands-on and utilizes paper and pencil tasks and computerized activities to teach the core skills of computing, applying, remembering, and problem-solving starting with number sense through algebra (Kroeger et al, 2012; Griffin, 2004).

A three year longitudinal study of the Number Worlds program was conducted using two different forms of evaluation. The first part of the study compared scores of students participating in the Number Worlds intervention with matched controls who had participated in different mathematics readiness programs on tests of mathematical knowledge, general developmental measures, and experimental measures of learning potential. The children participating in the Number Worlds group consistently
outperformed the students in the control groups. The second evaluation followed students from three different groups across a three year period. The *Number Worlds* intervention group participated in the *Number Worlds* intervention in Kindergarten. The study then followed the students in the intervention group through 2nd grade and compared growth scores with the scores of two different groups of students. The first comparison group was students from a low-socioeconomic status who were identified as having superior achievement in the area of math; the second comparison group was students from a middle class socioeconomic status attending a magnet school with a special mathematics coordinator and an enriched mathematics program. The study extended from the beginning of Kindergarten to the end of 2nd grade. At the end of the study, the children who had participated in the *Number Worlds* program outperformed students in both comparison groups on tests of number knowledge and procedural knowledge; the skills of problem-solving and conceptual knowledge were not measured in this study (Griffin, 2005).

**Research-based strategies targeting number sense.** Research indicates that procedures such as repeated practice, modeling, and corrective feedback increase the accuracy as well as the automaticity in responding to all mathematical work (Mong & Mong, 2010; Skinner et al., 1989). The model/ guided practice/ independent practice model of instruction is also a research-based instructional strategy (Jordan & Levine, 2009). As previously discussed, these strategies can be embedded in classroom instruction as well as delivered in small group instructional settings with relative ease. One specific research-based intervention designed to address mathematics skills deficits is CCC, a self-managed intervention that provides students with a series of learning trials
across a short timespan utilizing the principles of drill and practice. CCC was originally
developed as a spelling intervention to increase accuracy in spelling (Hansen, 1978);
Skinner, Turco, Beatty, and Rasavage published research in 1989 providing evidence on
the effectiveness of CCC as a number sense intervention. The immediate self-evaluation
aspect of CCC allows students to practice many trials in a short time, thereby increasing
speed and fluency while also ensuring high levels of accuracy (Mong & Mong, 2010).

CCC, when used as a mathematics intervention, can be implemented to increase
speed and accuracy in mathematics facts, a critical component of number sense skills, by
providing a visual model and then immediate self-evaluation when answering the same
problem several times in a row. This intervention can also be used in spelling practice as
well as vocabulary instruction.

The Present Research Study

Current research in the area of mathematical difficulties, mathematics instruction,
and mathematics intervention is driving the changing climate of education as well as
extending the use of the three tiered RTI model from reading and behavior into the
development of Tier 2 and Tier 3 mathematics interventions in schools. As more research
is conducted more options for research-based strategies and empirically validated
programs will become available to educators.

Few studies have compared the use of an empirically-validated mathematics
intervention program with the implementation of research-based strategies used in
conjunction with the core mathematics curriculum. Strategies such as modeling,
corrective feedback, guided practice, and self-evaluation can be easily adjusted to
complement core instruction with potentially more ease than adopting a supplemental
packaged program. However, there is little research comparing these two options for improving mathematics skills such as number sense.

The purpose of this quasi-experimental study was to examine the effects of the *SRA Number Worlds* (Griffin, 2007) intervention, an empirically-validated packaged intervention program, and cover-copy-compare a research-based strategy for improving number sense in first grade students with identified mathematics deficits. There were two different independent variables in this study: the *SRA Number Worlds* intervention program was the independent variable for Group A and CCC was the independent variable for Group B. The dependent variable in this study was student growth on weekly mathematics computation (M-COMP) progress monitoring probes from the Academic Improvement Measurement System based on the web (AIMSweb).
CHAPTER III

METHODS

Research Question and Hypothesis

The current research study investigated the following question: Is there a difference between the outcomes for 1st grade students participating in the Number Worlds intervention and 1st grade students participating in the cover-copy-compare intervention? It was hypothesized that the intervention group receiving the SRA Number Worlds program would demonstrate more growth from winter to spring on the AIMSweb mathematics computation benchmark assessment than the group receiving the CCC intervention. The SRA Number Worlds program and the CCC intervention have both been empirically validated in peer-reviewed studies, but the SRA Number Worlds program is built on a neuroscience basis and purportedly addresses the cognitive skills of representation, working memory, executive functioning, and problem solving. These cognitive deficits in combination frequently cause number sense deficits. CCC was designed on the concepts of self-monitoring, repeated practice, modeling, and corrective feedback. While these strategies are suggested to improve number sense, they are generalizable to a wide range of difficulties and not specifically targeted to only number sense deficits. Therefore, an intervention program such as SRA Number Worlds that
directly addresses these causes of number sense deficits was hypothesized to cause more growth in mathematics computation skills (Griffin, 2004; Mong & Mong, 2010)

**Research Design**

The current study employed a quasi-experimental research design. This design was chosen because the goal of the study was to evaluate the effects of the two different intervention programs on students in mathematics, but a large sample and true random assignment were not feasible in the school setting. The benefit of this quasi-experimental design is that the groups can be constructed without denying intervention to those students who demonstrate a need for it. The assumption behind the study was that an effective intervention would significantly improve the scores of those students who scored low enough to merit a Tier 2 intervention group. In this study, Tier 2 was defined as small group instruction two days per week for at least 30 minutes, in addition to core mathematics instruction.

The sample was based on an opportunistic sample due to the access the researcher has to the population. The dependent variables in this study were the growth in students’ mathematics computation as measured by scores from the winter benchmark assessment, the spring benchmark assessment, and weekly progress monitoring scores. The independent variable is the *SRA Number Worlds* intervention program for Group A and the CCC intervention strategy for Group B. All students continued to receive the core mathematics instruction, *Envision Math* (Pearson, 2011), in the 1st grade classroom for 45 minutes daily.
Participants and Setting

Participants in the study included (n = 6) first grade general education students from a rural town in the Midwestern region of the United States. All of the students in the study were Caucasian, which is reflective of the demographic makeup of the participating school district. All first grade students in the district were administered the winter benchmark assessment in accordance with district policy. Children scoring in the well-below average range, below the 10th percentile, on the AIMSweb M-COMP winter benchmark were selected to participate in the present research study. The average age of the students was seven years old.

The intervention took place two days a week for 30 minutes each session in the elementary school library. The first grade paraprofessional implemented both interventions for each group of students.

Materials

Measures. The AIMSweb M-COMP assessment (see Appendix A) was used to screen the participants for the study and to evaluate outcomes. This assessment is given to all students in the school (grades 1-8) in the fall, winter, and spring. The assessment is a curriculum-based measure (CBM) that measures mathematics computation. On the first grade M-COMP, all students are given eight minutes to complete as many problems as they can. The assessment begins with single-digit addition and moves to single-digit subtraction, then to double-digit addition. There are also several problems involving addition of three one-digit numbers such as 3 + 2 + 4. Students were given a score of 1, 2, or 3 for a correct answer based on the scoring guide in the answer key that gives weighted scoring based on problem difficulty, and a 0 for incorrect answers. Scores were
then graphed and ranked in the online AIMSweb program according to score. Graphs are also available, in the online program, which compare student scores to local and national norms. Students’ scores were gathered using the winter AIMSweb assessment, the spring AIMSweb assessment, and weekly progress monitoring probes to determine growth in the area of mathematics computation. The weekly progress monitoring probes were reflective of the skills on the benchmark assessments. Mathematics computation measures were used to reflect number sense skills; while these measures are not fully inclusive of all number sense skills, mathematics computation is an important component of number sense as mathematics fact retrieval is an indicator of future mathematics performance (Fuchs et al., 2006).

**Treatment integrity.** Treatment Integrity checklists (see Appendix B) were completed by the intervention agent during each intervention session. The integrity checklists included the date, time, and location of the intervention session as well as all required steps for the intervention; the checklist questions were marked “yes” or “no” for completion of each component of the intervention for each session. The *Number Worlds* integrity checklist, created by the research agent for the purpose of this study, included each section of the lesson that needed to be completed during the session, a record of whether the optional software was used, monitoring of student behavior, and a section to record any noteworthy observations about the intervention session (see Appendix B). The CCC integrity checklist included materials needed for each session, procedures that need to be followed throughout the intervention session, and evaluation of how the student self-managed errors and corrections during the session (see Appendix B).
**Treatment acceptability.** A treatment acceptability questionnaire (see Appendix B) for each intervention was completed by the intervention agent following the intervention to provide a quantitative and qualitative measure of impressions of the interventions. The intervention agent completed a separate but identical treatment acceptability rating scale for the *Number Worlds* and CCC interventions that included questions about willingness to use the intervention in different settings, side-effects of the intervention, fairness of the intervention, increases in achievement due to the intervention, maintenance and generalization of skills from the intervention, and generalizability to different settings. The same treatment acceptability questionnaire was completed for each intervention.

**Intervention materials.** Intervention materials included in this study were SRA Number Worlds (Griffin, 2004) and Cover-Copy-Compare (Skinner et al., 1989).

**SRA Number Worlds.** The *SRA Number Worlds* (Griffin, 2004) program, which is a packaged program published by McMillan/McGraw/Hill, was implemented with Group A. The intervention agent followed the structured format of the *Number Worlds* program to deliver lessons using student workbooks, games, and manipulatives included in the intervention program. Each lesson began with a review of concepts; a hands-on lesson for the day was delivered while using manipulatives and providing ongoing immediate feedback to engage the students (see Appendix C for a sample lesson). The students practiced the skill using the student workbook and in some lessons a game was played to review foundational skills taught earlier in the program and strengthen fluency with these skills. The SRA placement test was administered to determine a correct placement point in the program based on student skills (see Appendix C).
Cover- Copy- Compare. (CCC) (Skinner et al., 1989) worksheets were implemented with Group B. The research agent created the CCC worksheets each week based on the skills taught in the first grade curriculum, as well as the spiral review worksheets (e.g., one digit subtraction, two digit subtraction, and fractions in a mixed review format on the same worksheet) used every fourth session. Problems on these worksheets included skills such as single digit addition and subtraction, double digit addition, geometry, and fractions. No skill was included on the review worksheets until it was taught and reviewed for at least one week in the classroom. The worksheets were set up in the method of CCC (See Appendix C for an example). A model was written on the worksheet, the student copied the model. The model and the copy were covered and the student wrote the problem again, from memory, and then compared the problem with the model. The student then wrote the problem from memory two more times, comparing the answer with the model each time. The rest of the worksheet was completed in this way using a variety of problems following the target mathematics concept. For example, the problem 2+4=6 was provided as a model on the worksheet, the student then copied 2+4=6 in the next space to the right of the model. The student then covered both the model and the copy and wrote 2+4=6 from memory and then checked the answer with the model. The student wrote 2+4=6 a second time from memory and checked the answer with the model. The student wrote 2+4=6 a third time from memory and checked the answer with the model. Then the student moved to the next one-digit addition problem. The CCC worksheets covered a variety of topics taught in class each week including one-digit subtraction, multi-digit subtraction with and without regrouping, and fractions.
Procedures

Approval was obtained from University of Dayton’s Internal Review Board (IRB) to conduct this research. Permission was obtained from the district to conduct the study. Parental consent was obtained from the parents or guardians of the participating students (see Appendix D for IRB materials). Students were recruited based on AIMSweb MCOMP winter benchmark scores. The six students with the lowest scores on the winter M-COMP benchmark were selected for participation. For the purposes of this study, the participants were ranked according to their scores on the AIMSweb benchmark beginning with the lowest score, placing the student with the lowest score into Group A, the student with the 2nd lowest score into Group B, the student with the 3rd lowest score into Group A, the student with the 4th lowest score into Group B, the student with the 5th lowest score into Group A, and the student with the 6th lowest score into Group B. This procedure for assigning students to an intervention group was utilized because all of the students had comparable benchmark scores and this allowed for randomization of group assignment.

Preliminary procedures. The researcher provided one-on-one training to the intervention agent via Skype and one training face-to-face prior to the start of the intervention. The intervention agent received the Number Worlds package, a description of the CCC procedure, sample CCC worksheets, and treatment integrity checklists prior to the first training to become familiar with the materials and to have an opportunity to write down specific questions about the procedures for the researcher.

During the Skype training (session 1) the researcher and intervention agent went through a PowerPoint presentation about the Number Worlds program (see Appendix E). The researcher then modeled the delivery of a lesson and answered any additional
questions from the intervention agent. Then the researcher modeled the CCC format using the worksheet the students would use during the first intervention session and answered any questions.

During the face-to-face training (session 2), the researcher went through the e-tools software for the *Number Worlds* training and went through the procedures for administering the placement test; the researcher also answered additional questions from the intervention agent about the *Number Worlds* intervention. Then the intervention agent modeled and the researcher role-played different problems that might occur with students during intervention and how to handle these problems such as the student writing the wrong answer or the student quickly copying the same answer each time without going through the correct CCC procedure. The procedure for completing treatment integrity checklists as well as the importance of treatment integrity was also discussed during the Skype training.

The researcher provided ongoing consultative support to the intervention agent via email and phone calls. Two observations of the intervention agent, occurring in the second and the sixth week of the intervention period, were also completed by the researcher to ensure at least 80% inter-rater agreement of the treatment integrity checklists.

**Intervention procedures.** The intervention agent at the school implemented the intervention two days a week to each intervention group. Group A participated in the *Number Worlds* intervention. Group B participated in the CCC mathematics intervention. Group A met from 8:40 to 9:10 am on Mondays and Wednesdays and Group B met from 8:40 to 9:10 am on Tuesdays and Thursdays.
The *Number Worlds* group was administered the placement test that accompanies the *SRA Number Worlds* program, and was used to determine a starting point for the group. In this study, all students’ placement tests indicated the need to begin at Week One, Lesson One.

Instead of following a scripted program, the students in Group B--the CCC intervention group--used the CCC method to practice the mathematics concept taught the preceding day in the classroom. Each student was given a worksheet, created by the intervention agent, with problems from the day’s lesson and followed the CCC method to complete the worksheet. Every fourth session after completing the first worksheet, the students used the same method to complete another worksheet with review problems that included any mathematics skills that was already taught in the classroom and in the intervention. The intervention agent followed the integrity checklist for each group and completed it following each intervention session.

**Data collection.** A baseline period occurred in the four weeks preceding the implementation of the intervention. Existing data was used to establish a baseline given that the classroom teacher currently uses the M-COMP progress monitoring measure to track the progress of students identified at-risk in the general education program. Progress during the intervention period was monitored weekly using the AIMSweb M-COMP progress monitoring probes. Existing data were used from the winter benchmark scores on the AIMSweb mathematics computation winter benchmark and spring benchmark data were collected in May at the conclusion of the study. The winter and spring benchmark measures were administered to the entire class by the classroom teacher.
CHAPTER IV

RESULTS

Baseline data were collected four weeks prior to implementation of the intervention and intervention data was collected for eight weeks. The mean score of each group’s correct points on weekly M-COMP progress monitoring probes was graphed and displayed in Figure 1. Visual analysis of the data indicated that both Number Worlds and CCC resulted in an increasing trend in scores. Single case design statistics were used to evaluate the hypothesis that the students in the Number Worlds intervention would demonstrate more growth on weekly progress monitoring probes than the students in the CCC intervention. The g-index was calculated for each group using the mean score each week on progress monitoring probes as a measure of determine the effect size of each intervention. The effect size for the Number Worlds group was 0.25, indicating a positive effect for this intervention. The effect size for the CCC group was -0.63, indicating a negative effect for this intervention. It should be noted, however that Student 6 in the CCC group obtained an outlying score in the baseline phase that was higher than most scores in the intervention phase; this skewed the effect size calculation of the CCC group. Without the outlying score, the effect size of the CCC group would have been 0.50. This will be addressed in the Discussion section.
A Mann-Whitney U Test was conducted to evaluate the hypothesis that the students in the *Number Worlds* intervention would demonstrate more growth on weekly progress monitoring probes than the students in the CCC intervention. The results of the test were in the expected direction but were not significant, $z = -1.09, p = .28$. The *Number Worlds* group had an average rank of 4.33, while the CCC group had an average rank of 2.67.

**Descriptive Results**

**SRA Number Worlds.** Weekly progress monitoring scores for each student who participated in the *Number Worlds* intervention are presented in Figure 2. A $g$-index was calculated to determine the effect size of the *Number Worlds* intervention for each student. During the baseline phase, Student One obtained a mean score of 13.25 points.
The student displayed a gradual increase with a mean score of 16.5 during the intervention phase. The effect size was 0.38, which indicated a positive effect.

During the baseline phase, Student Two obtained a mean score of 7.75. The student displayed a gradual increase with a mean score of 19.75 during the intervention phase. The effect size was 0.50, which indicated a positive effect.

During the baseline phase, Student Three obtained a mean score of 10.5. The student displayed a gradual increase with a mean score of 22 during the intervention phase. The effect size was 0.38, which indicated a positive effect.

Figure 2

NW individual weekly progress monitoring graph Student 1
Figure 3

_NW individual weekly progress monitoring graph Student 2_

Figure 4

_NW individual weekly progress monitoring graph Student 3_
**Cover- Copy- Compare.** Weekly progress monitoring scores for each student who participated in the CCC intervention are presented in Figure 3. An g-index was calculated to determine the effect size of the intervention for each student. During the baseline phase, Student Four obtained a mean score of 11.5 points. The student displayed a gradual increase with a mean score of 20.5 during the intervention phase. The effect size was 0.5, which indicated a positive effect.

During the baseline phase, Student Five obtained a mean score of 5.5 points. The student displayed a gradual increase with a mean score of 11 during the intervention phase. The effect size was 0.38, which indicated a positive effect.

During the baseline phase, Student Six obtained a mean score of 14.25 points. The student displayed a gradual increase with a mean score of 21 during the intervention phase. The effect size was -0.5, which indicated a negative effect.

Figure 5

*CCC individual weekly progress monitoring graph Student 4*
Figure 6

*CCC individual weekly progress monitoring graph Student 5*

Figure 7

*CCC individual weekly progress monitoring graph Student 6*
Student scores on the AIMSweb M-COMP winter and spring benchmark assessments were also analyzed to answer the research question examining a possible difference in outcomes for the students participating in the different intervention groups. The benchmark assessments and progress monitoring assessments are the same format and assess the same skills but progress monitoring data represents individual student growth while the benchmark data provides a peer comparison. Students participating in the Number Worlds intervention group obtained an average score of 4.67 points on the AIMSweb M-COMP winter benchmark, which falls below the 10th percentile and in the well-below average range based on a national normative sample. Students participating in the CCC intervention group obtained an average score of 6.30 points on the AIMSweb M-COMP winter benchmark, which falls below the 10th percentile and in the well-below average range.

Students participating in the Number Worlds intervention group obtained an average score of 18.30 points on the AIMSweb M-COMP spring benchmark, which falls at the 10th percentile and in the well-below average range. Students participating in the CCC intervention group obtained an average score of 20.67 points on the AIMSweb M-COMP spring benchmark, which falls between the 25th and 10th percentile and in the below average range. This indicates that although the effect size for the Number Worlds intervention was larger based on progress monitoring scores, the CCC intervention group obtained similar growth outcomes based on benchmark assessment data. See table 1 for individual student growth scores on the benchmark assessments.
Table 1

*M-COMP winter to spring benchmark individual student growth chart*

<table>
<thead>
<tr>
<th>Student</th>
<th>Intervention</th>
<th>Winter Benchmark</th>
<th>Winter Skill Level</th>
<th>Spring Benchmark</th>
<th>Spring Skill Level</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NW</td>
<td>0</td>
<td>Well below average</td>
<td>12</td>
<td>Well below average</td>
<td>+ 12</td>
</tr>
<tr>
<td>2</td>
<td>NW</td>
<td>7</td>
<td>Well below average</td>
<td>29</td>
<td>Average</td>
<td>+ 22</td>
</tr>
<tr>
<td>3</td>
<td>NW</td>
<td>7</td>
<td>Well below average</td>
<td>14</td>
<td>Well below average</td>
<td>+ 7</td>
</tr>
<tr>
<td>4</td>
<td>CCC</td>
<td>8</td>
<td>Well below average</td>
<td>22</td>
<td>Below Average</td>
<td>+ 14</td>
</tr>
<tr>
<td>5</td>
<td>CCC</td>
<td>4</td>
<td>Well below average</td>
<td>10</td>
<td>Well below average</td>
<td>+ 6</td>
</tr>
<tr>
<td>6</td>
<td>CCC</td>
<td>7</td>
<td>Well below average</td>
<td>30</td>
<td>Average</td>
<td>+ 23</td>
</tr>
</tbody>
</table>

*a NW = Number Worlds; CCC = Cover- Copy- Compare
b Winter target score = 26; Spring target score = 37*
Treatment Integrity Checks

**SRA Number Worlds.** The intervention integrity checklist for the *Number Worlds* intervention included five steps for each lesson. The intervention agent completed integrity checks during each of the sixteen lessons, two lessons per week for eight weeks. Overall, 80 steps were included, with the intervention agent completing 78 steps of the intervention correctly, which yields a treatment integrity of 98%.

**Cover-Copy-Compare.** The intervention integrity checklist for the CCC intervention included 12 steps for each lesson. The intervention agent completed integrity checks during each of the sixteen lessons, two lessons per week for eight weeks. Overall, 192 steps were included, with the intervention agent completing 180 steps of the intervention correctly, which is a treatment integrity of 94%.

Inter-rater agreement data was also collected through observation of the intervention agent by the researcher for each intervention on two separate occasions, for a total of four observations. Inter-rater agreement for the *Number Worlds* intervention was 100% for each observation. Inter-rater agreement for the CCC intervention was 92% for the first observation and 100% for the second observation for an average of 96%.

**Treatment Acceptability**

Treatment acceptability was rated high for both interventions by the intervention agent. Out of 90 possible points, both interventions were given 82 points, 91% treatment acceptability. All of the questions were rated as “agree” or “strongly agree”. The interventions were rated exactly the same and discussion between the research agent and intervention agent illuminated the fact that the questions rated as “agree” instead of “strongly agree” involved the confidence of the intervention agent to use the intervention
and the sustainment of continued growth after the conclusion of the intervention. See Table 2 for overall case study interpretation.

Table 2  
*Case study interpretation summary*

<table>
<thead>
<tr>
<th>Students</th>
<th>Intervention</th>
<th>Intervention Integrity</th>
<th>Effect Size (g-index)</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NW</td>
<td>100%</td>
<td>ES= +0.38</td>
<td>Effective</td>
</tr>
<tr>
<td>2</td>
<td>NW</td>
<td>100%</td>
<td>ES= +0.50</td>
<td>Effective</td>
</tr>
<tr>
<td>3</td>
<td>NW</td>
<td>100%</td>
<td>ES= +0.38</td>
<td>Effective</td>
</tr>
<tr>
<td>4</td>
<td>CCC</td>
<td>88%</td>
<td>ES= +0.50</td>
<td>Effective</td>
</tr>
<tr>
<td>5</td>
<td>CCC</td>
<td>94%</td>
<td>ES= +0.38</td>
<td>Effective</td>
</tr>
<tr>
<td>6</td>
<td>CCC</td>
<td>94%</td>
<td>ES= -0.50</td>
<td>Not Effective</td>
</tr>
</tbody>
</table>
CHAPTER V
DISCUSSION

The purpose of this study was to evaluate the effects of the *SRA Number Worlds* intervention, an empirically-validated packaged intervention program, and CCC, a research-based strategy for improving number sense in first grade students with identified mathematics deficits. This study extends the literature on number sense interventions by comparing the effects of these interventions on student growth outcomes as well as comparing the effectiveness of a costly versus a cost-effective intervention program.

**Review of Relevant Findings**

The original hypothesis that the *Number Worlds* group would make greater gains than the CCC group from the winter to spring benchmark assessment was not clearly proven in this study. The student scores in the *Number Worlds* group increased an average of 13.63 points from the winter to spring benchmark while the students’ scores in the CCC group increased an average of 14.37 points from the winter to spring benchmark assessment, indicating that the CCC group made greater gains on the benchmark assessment. The progress monitoring data; however, indicated that the effect size of the *Number Worlds* intervention was larger than the effect size of the CCC intervention; if the outlying score of Student 6 was removed from the effect size calculations, the effect
size of the CCC intervention would have been larger than the effect size of the Number Worlds intervention. Furthermore, the results of the Mann Whitney $U$ indicated that the Number Worlds intervention had a larger effect on student growth outcomes, but the results were not statistically significant. Both interventions successfully improved student scores on benchmark and progress monitoring measures but only two students in the study, one from each group, met the goal of 29 points. The overall growth outcomes demonstrated in this study support the larger body of research indicating small group tutoring, in addition to core instruction, has a positive effect on math development (Clements & Sarama, 2007; Fuchs et al, 2005; Mong & Mong, 2010; Poncy et al, 2010). The mixed results of the statistical analyses and the non-statistical significance of the data could be attributed to the small sample size of the study; best practices recommends a sample size of at least 30 to produce statistically valid research results in an experimental design (Green & Salkind, 2011; Mertens, 2010).

It should also be noted that Student 6’s individual progress monitoring graph displays a trendline with a steeper slope during the baseline phase than the intervention phase. This data should be interpreted with caution as this student obtained one high score on the progress monitoring measure during the baseline phase. This outlier could be skewing the visual analysis and single case design statistics of this individual student as well as the overall effect size of the CCC intervention. If the outlier is removed, the effect size of the CCC intervention for Student 6 would be 0.67, which is the largest effect size of all the students in this study. This data is suggestive of a performance deficit rather than a number sense skill deficit for this particular student.
Interpretation of Findings

One possible explanation for the outcomes of this study centers on the intervention principles built into both interventions. Fuchs et al. (2005) identified seven principles of effective mathematics interventions; these principles include instructional explicitness, instructional design to minimize the learning challenge, strong conceptual basis, drill and practice, cumulative review, motivators to encourage students to work hard during intervention sessions, and ongoing progress monitoring.

Math interventions require a level of explicitness beyond what is necessary during core instruction; teachers must share what the student is expected to learn. The Number Worlds program incorporated this level of explicitness into the teacher script of each lesson; the CCC intervention incorporated explicitness through modeling and immediate corrective feedback throughout each intervention session.

Intervening with struggling students necessitates not only instructional explicitness but also a design that is carefully sequenced. The Number Worlds program followed a very specific scope and sequence designed to teach and consistently review foundational skills before progressing to skills that require the use of the previously learned skills. The CCC intervention did not use a specific scope and sequence but extended the instruction students were receiving in the classroom by extrapolating the underlying foundation skill and teaching the steps to perform the skills in a sequenced and specific manner.

The Number Worlds intervention provided a strong conceptual basis to students by incorporating manipulatives such as number lines, hundreds charts, and pop blocks
into every lesson. The CCC intervention did not provide this principle of effective intervention; it is primarily a drill and practice with corrective feedback intervention.

The principle of drill and practice was evident in both interventions. The *Number Worlds* intervention provided repeated practice of the targeted skills in the warm-up, engagement, and workbook sections of each lesson. The CCC intervention utilized drill and practice as the primary intervention strategy and was heavily incorporated into each intervention session.

Cumulative review is an important principle of intervention as there is a growing body of research that indicates students who struggle in a particular area need to practice a skill in the targeted area more than 30 times before the skill becomes a part of his or her repertoire of skills (Sprick, 2009). The *Number Worlds* program did not explicitly include cumulative review into the daily lessons but cumulative tests were given periodically, giving the instructor an opportunity to assess previously learned skills that required review. While CCC does not include cumulative review as a component of the intervention, it is an adaptable strategy that lends itself to flexibility in intervention set up that could include cumulative reviews. In this study, CCC worksheets were designed each week to include material from the core classroom instruction and every two weeks students completed a CCC worksheet that included all previously practiced skills. However, during the study, this sequence did not occur as anticipated because many of the skills taught in the core curriculum during the eight-week intervention period were similar in nature to each other. For example, at the beginning of the intervention period students completed one-digit subtraction problems, and then moved to two-digit subtraction problems, then two-digit subtraction with regrouping problems. During
cumulative review sessions, mixed problems of regrouping and no regrouping were presented, but the students had to use the same computation skills to complete both types of problems so it wasn’t a true cumulative review.

Motivators were not intentionally built into either intervention at the beginning of the study; however, the intervention agent brought stickers to each intervention session and provided students with a sticker if they remained on task during each intervention session. Positive praise was also used as a motivator for the students in both intervention groups. The students were observed making comments such as “Did I do a good job paying attention so I get a sticker?” and “I’m trying really hard, will I get a sticker?” during observations completed at both the beginning of the intervention phase and toward the end of the intervention phase. Students were also observed smiling and doing a small “fist-pump” under the table when the intervention agent provided feedback such as “Wow, that was a hard one and you really stuck with it” and “Even though your answer was wrong the first time you didn’t give up until you corrected it, way to go”. Other students were also observed congratulating each other when provided praise. It is inferred from these behaviors that both the stickers and the positive praise were motivators that, while not originally built into the intervention plan, occurred because of the style of the intervention agent and should be explicitly built in to future applications of these interventions. Notes on the intervention integrity sheets also indicated that the students enjoyed the intervention time and were motivated to stay on task because of the nature of the small group setting and immediate feedback and attention provided by the intervention agent.
Ongoing progress monitoring is the seventh principle of effective intervention and is already a system built into the participating school’s system of intervention. All students receiving Tier 2 and Tier 3 intervention in this particular setting are progress monitored weekly by classroom teachers. For this study, four of the students were in one classroom (Teacher 1) and two of the students were in a different classroom (Teacher 2). On Fridays Teacher A took all students in the study and administered the AIMSweb progress monitoring probes in a group setting in the school library. There were a few occasions when students were absent, in those cases Teacher A progress monitored those students the following Monday.

Intervention integrity is also a factor that can affect student growth outcomes (Hunley & McNamara, 2010). Throughout this intervention, implementation integrity was high based on treatment integrity checklists completed throughout the intervention phase. Integrity for the *Number Worlds* intervention was 98% overall, with every student attending 100% of the intervention sessions. Integrity for the CCC intervention was 94% overall due to the fact that the 1st grade students had a dress rehearsal for their upcoming school performance so the intervention time for one particular session was cancelled; Student Four was absent for one of the intervention sessions so intervention integrity was 88% for that student. Both interventions were implemented with integrity to all students as treatment integrity for all was above the 80% guideline suggested in the research (Hunley & McNamara, 2010). Inter-rater agreement was also high (NW= 100%; CCC= 96%) based on the 80% guideline suggested in the research literature (Hunley & McNamara, 2010; Daley & Kim, 2010). A formula accounting for natural chance occurrences was not used to calculate inter-rater agreement, but as there was a positive
effect size for all students across all measures this did not interfere with appropriate intervention evaluation outcomes.

Although none of the participants met the spring benchmark goal of 37 points on the M-COMP, the students were making growth toward closing the achievement gap. The limited effects of this intervention could be contributed to the relatively short intervention period. There is variability in the research on the suggested duration of interventions to produce robust outcomes and federal mandates are vague on duration requirements. Yurick, Cartledge, Kourea, and Keyes (2012) documented research suggesting 5-18 hours of intervention produced optimal student growth outcomes regardless of the type of intervention or the skill deficit the intervention targeted. Allain & Kukic (2008) cited research indicating the need for 30 weeks of Tier 2 intervention for struggling students to meet grade level expectation. The participants in this study received the intervention for eight weeks, approximately eight total hours.

**Limitations**

Although this study provides a contribution to the greater body of research on effective Tier 2 interventions for mathematical number sense, there are several limitations that should be noted. First, although both of these interventions were identified in previous research studies and literature reviews to improve basic number sense skills (Griffin, 2004; Griffin, 2005; Kroeger et al., 2012; Mong & Mong, 2010; Skinner, 1997), the assessment measures used to identify students for participation as well as to monitor progress measure only computational skills and are not an inclusive measure of combined number sense skills. This speaks directly to the internal validity of the study; even though computational skills increased based on both progress monitoring and benchmark
data, it cannot be inferred that there was an improvement in all number sense skills. A measure such as The Number Sense Brief (NSB; Jordan, Kaplan, Raminenui, & Locuniak, 2009) could measure number sense more thoroughly, but the M-COMP was used due to the availability as well as the comparative data available for the local normative sample. Therefore, the results of this study are limited in their generalizability to number sense skills other than the mathematical computation skills measured in this current study. Second, the sample size significantly limits the external validity of this study. Participants were chosen by an attained cutoff score on an assessment measure and thus were not randomly selected. Although students were randomly assigned to intervention groups all students were identified as deficient in math computation skills. The sample size was also very small in this study so nonparametric and single case statistics were utilized instead of parametric statistics. Best practices recommend a sample of at least 30 participants in each group for an experimental design to produce statistically valid results (Mertens, 2010). The sample was also a mostly homogenous; while there was diversity with regard to gender and socioeconomic level of the participants, there was homogeneity with regard to ethnicity, setting (i.e. urban, suburban), classroom instruction, grade, and exposure to core curriculum. Finally, there was no control group included in this study, which allowed no method of comparison for the progress students were making without exposure to these interventions. There may have been factors outside of the intervention effect contributing to growth on student outcomes such as an improvement in timed test taking skills or improved Tier One instruction in the general education classroom.
Implications for Practice

The results of this study provide several implications for practice that could be incorporated into educational programming for students with deficits in mathematics. Number Worlds and CCC were both demonstrated to have a positive effect of 1st graders math computational skills and while additional studies are needed to indicate whether these interventions will eventually close the achievement gap for all students, one student in each intervention group did close the achievement gap just during this eight week study. This indicates that supplemental instruction at the Tier 2 level can produce positive outcomes, even in a relatively short amount of time. Given the results of this study, schools should consider a variety of options for providing intervention to struggling students. In this study a paraprofessional with no previous intervention training was utilized to provide high quality supplemental instruction at a Tier 2 level in place of an intervention specialist or mathematics specialist. This indicates that a variety of school staff, with efficient training in specific intervention implementation, could be used to provide research-based intervention to struggling students. Furthermore, the results of this study, while indicating a slightly larger effect size in the group receiving the *Number Worlds* intervention, demonstrated comparable growth outcomes between the groups. This suggests that utilizing research-based strategies in conjunction with the core content could produce outcomes similar to costly packaged intervention programs.

Future Research

Future research should replicate this design with a larger sample size including a truly randomized sample selection to determine statistical significance. Additionally a control group should be added to future studies to compare the intervention effects with
the growth outcomes of students not exposed to the interventions. Longitudinal studies are also warranted to monitor the math performance of students who have exited these particular Tier 2 interventions as well as the maintenance of computational skills and the transfer of these skills across increasingly complex math concepts. Lastly, replication studies should include students with multiple heterogeneous factors such as ethnicity, socioeconomic level, grade level, setting (i.e. urban, suburban, rural) to determine generalization of effectiveness to the larger population.
REFERENCES


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APPENDICES

APPENDIX A

Measures

Sample M-COMP progress monitoring probe

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</table>
APPENDIX B

Treatment Integrity and Acceptability

Treatment Integrity Checklist

Treatment Integrity Checklist - Number Worlds

Intervention agent ___________ Date ________ Location ____________
Start Time _______ End Time ________ Lesson ________

1. Use the rating items below to indicate which parts of the lesson were completed.

   • Warm up was completed. Y  N
   • Engage was completed. Y  N
   • Workbook pages were completed. Y  N
   • Reflect was completed. Y  N
   • Assess was completed. Y  N

2. **Student behaviors.** Did the students behavior appropriately during the session? Y  N
   If not, what problem behavior (s) were observed?

3. **Additional observations.** Please note other noteworthy details about the observation
   (e.g. noise level of the tutoring location, degree of student motivation, unexpected
   interruptions.)

4.
Treatment Integrity Checklist- CCC

Intervention agent __________________________ Date ________ Location

Start Time _______ End Time _______ Skill _______

Circle yes or no for the following questions:

1. Materials

   • Did the teacher provide training sheets of 10 mathematics problems, with the
     problems listed down the left side and the answer provided for each problem? Y N

   • Did the school or classroom teacher provide a 3 x 5 Index Card? Y N

   • Did the school or classroom teacher provide pencils? Y N

2. Procedure

   • Did the teacher give the student training sheets? Y N

   • Was a session conducted using the following CCC ® procedure? Y N
     a. The student silently reads the first problem and answer on the training sheet on the left
        side of the paper. Y N
     b. Cover the problem with an index card Y N
     c. Write the problem and answer from memory on the right side of the page Y N
     d. Uncover the problem and answer on the left side to check the written response Y N
     e. Evaluate the response Y N

3. Evaluation

   • If the student has the correct answer, were they instructed to proceed to the next
     problem? Y N

   • If incorrect, was the student instructed to repeat the procedure until the problem is
     correct? Y N

4. Student behaviors.

   Did the student behavior appropriately during the session? Y N
   If not, what problem behavior (s) were observed?

5. Additional observations.

   Please note other noteworthy details about the observation (e.g. noise level of the
   tutoring location, degree of student motivation, unexpected interruptions.)
## Treatment Acceptability

### Treatment Acceptability Questionnaire

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<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Slightly Disagree</th>
<th>Agree</th>
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(Please indicate ratings by printing or typing an “X” in the appropriate parentheses.)

1. This is an acceptable intervention for the child's achievement behavior.  
2. Most teachers would find this intervention appropriate for the child's achievement problem.  
3. I would suggest the use of this intervention to other teachers.  
4. I would be willing to use this intervention in the classroom setting.  
5. I believe I have sufficient understanding of the intervention.  
6. The intervention would not result in negative side effects for the child.  
7. The intervention would not result in negative effects for other children in the child’s classroom.  
8. The intervention would be appropriate for a variety of children.  
9. The intervention is consistent with those I have used in classroom settings.  
10. I am confident in my ability to use this intervention.  
11. The intervention is a fair way to handle the child’s achievement problem.  
12. The intervention is reasonable for the achievement problem described.  
13. The intervention would improve the child’s achievement to the point that it would not noticeably deviate from other classmates’ behavior.  
14. Soon after using the intervention, the teacher would notice a positive change in the
achievement problem.

15 The child’s achievement will remain at an improved level even after the intervention is discontinued.

16 Using the intervention should not only improve the child’s achievement in the classroom, but also elsewhere (e.g., other classrooms, home).

17 The intervention should produce enough improvement in the child’s achievement so that it no longer is a problem in the classroom.

18 Other skills related to the achievement problem also are likely to be improved by the intervention.

Please note perceived strengths of this intervention:

Please note perceived weaknesses of this intervention:

APPENDIX C

Intervention Material

Sample Number Worlds Lesson
Constructing Whole Numbers

Lesson 1

Key Idea
Dice Set Cards can help you see numbers to 10.

Try This
Write the numeral that tells you the number of dots shown on each card.

Complete the Dice Set Cards to show each number.

Practice
Draw a line to match each card with the number it shows.

Reflect
Put a Dice Set Card that shows 3 next to another Dice Set Card that shows 5. What number do these two cards make?

3 Reflect

Extended Response
Review students' answers to the Reflect prompt at the bottom of student page 3.

- How did you figure that out?
- Do the dot-set patterns remind you of anything?

Real-World Application
Many board games use dot cubes to advance a certain number of spaces on the board. A dot cube has a visual dot representation of numbers 1-6. After becoming familiar with dot cubes, people can usually interpret the dot-set patterns automatically to determine the number it shows without counting.

Allow students to examine a Dot Cube. They can practice rolling the Dot Cube and naming the number it shows.

4 Assess

Informal Assessment
Use the Student Assessment Record, Assessment, page 100, to record informal observations.

Computing
Concentration
Did the student:
- respond accurately?
- respond quickly?
- respond with confidence?
- self-correct?
Placement Test

Circle the letter of the correct answer.

1 Which number is thirteen?
   19  13  18  16
   A  B  C  D

2 Which set of numbers is ordered from biggest to smallest?
   A 12, 56, 29
   B 23, 48, 17
   C 38, 45, 61
   D 72, 61, 53

3 Which answer is the same as 3 + 5 + 7?
   A 7 tens and 5 ones
   B 3 tens and 7 ones
   C 1 ten and 5 ones
   D 1 ten and 7 ones

4 Which numbers are missing from this sequence?
   35 36 37  ___  ___  40 41 42  ___
   A 43, 44, 45
   B 89, 10, 11
   C 38, 39, 43
   D 38, 39, 40
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APPENDIX D

IRB Material and Consent Letters

IRB Form

APPLICATION FOR EXEMPTION

Instructions
Please use this form for your Institutional Review Board (IRB) application by directly entering information into each section or copying and pasting into the appropriate sections from your own document. Please direct all QUESTIONS and submit all APPLICATION MATERIALS Electronically to IRB@UDayton.edu.

~NO HARD COPY APPLICATIONS WILL BE ACCEPTED~

1a. DATE OF SUBMISSION: 3/14/2013

1b. PRIMARY INVESTIGATOR INFORMATION

Name: Rachel Kunert
Department: Department of Counselor Education and Human Services
Contact Phone: (937) 726-7652 Email: rachelkunert@gmail.com
Position in University (if student, must indicate faculty sponsor): student
  Faculty Sponsor Name: Dr. Elana Bernstein
  Faculty Sponsor Department: Department of Counselor Education and Human Services
  Faculty Sponsor Contact Phone: (937) 229-3624 Email: ebernstein1@udayton.edu

2. PROJECT TITLE: NUMBER SENSE INTERVENTION: A COMPARISON OF A PACKAGED PROGRAM AND A RESEARCH-BASED STRATEGY

3. PROJECT TIME FRAME – Anticipated beginning and ending dates of Research Project:
4. PROJECT EVALUATION - Please Check ALL of the following that apply.

Target Populations Include:

☐ Athletes
☐ Children 0-12 (Parental Consent required)
☐ Children 13-18 (Parental Consent required)
☐ Developmentally disabled
☐ Elderly
☐ Elected officials
☐ Mentally ill
☐ Non-English speaking persons
☐ Military personnel
☐ Persons convicted of a crime
☐ Persons in treatment for a physical, mental, or emotional ailment
☐ Persons on parole
☐ Persons over the age of 18 ONLY
☐ Persons with English as a second language
☐ Physically impaired
☐ Political appointees
☐ Pregnant women
☐ Prisoners
☐ Teachers
☐ UD staff
☐ UD students
☐ College Students (non-UD)
☐ Victims of crime

Site of Data Collection:

☐ Classroom
☐ Health care facility
☐ Public place
☐ Off-campus
☐ Military or government-operated installation
☐ Non-UD campus
☐ UD campus
☐ Other – Specify:

Type of Data Collected/Method of Storage:

☐ Archives
☐ Audio-recordings will be made (must be noted in consent document!)
☐ Collection of existing data or records
☐ Data will be collected anonymously
☐ Data will be kept confidential
☐ Data will be linked to participants through code numbers
☐ Data will be linked to participants through pseudonyms
☐ Data will be stored anonymously
☐ During the data collection, participants will be deceived
☐ Medical records (HIPAA releases and HIPAA Training may be required)
☐ Photographs will be taken (must be noted in consent document!)
☐ Publicly available data
☐ Specimens or data collected for non-research purposes
☐ Participant data will be stored with participant’s identity
Video recordings will be made (must be noted in consent document!)

Instrument/Method of Data Collection:
- Deception will be used
- Focus groups
- Includes follow-up contact with participants
- Includes interaction with children
- Includes observation of children
- Interviews – e-mail/text/on-line
- Interviews – face to face
- Interviews -- telephone
- Non-UD personnel will collect data
- Observation of public behavior
- Oral History
- Psychological tests
- Questionnaires
- Cognitive Performance Tests
- Physical Performance/Endurance Tests
- Research on established educational practices, using normal educational practices
- Students will collect data
- Participants will be compensated
- Surveys - anonymous
- Surveys – online
- Surveys - paper
- Uses educational or aptitude tests
- Use of physiological devices

Reason for Research:
- Faculty/Staff research
- Undergraduate honors thesis
- Undergraduate research
- Graduate research – masters thesis
- Graduate research – doctoral dissertation
- Graduate research – non-thesis
- Classroom project
- Other reason for research (specify)

Does Your Research Involve Any of the Following Topics?
- Alcohol use
- Drug use
- Emotional stress
- Illegal activities
- Gambling
- Law enforcement
- Public welfare programs
- Sexual habits
- Sexual orientation

5. PROJECT STAFF
Please list personnel, including students, who will be working on this protocol (insert additional rows as needed). This includes anyone who interacts with participants or handles non-anonymous data. All personnel conducting non-exempt research must have completed CITI Program Training in Human Research Protections within the past three years.
**Name, Title & Degree**

<table>
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<tr>
<th>Name</th>
<th>Role</th>
<th>Date of CITI Training</th>
</tr>
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<tbody>
<tr>
<td>Rachel Kunert, student, M.S.</td>
<td>graduate student</td>
<td>January 2013</td>
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6. **RESEARCH ABSTRACT** - In two or three sentences, provide a brief description in LAY language of the aims of this project.

   **Response:** The aim of this project is to compare the outcomes of 1st grade students' number sense skills when participating in a purchased, scripted, packaged program versus participating in an intervention utilizing a research-based strategy that corresponds with the classroom curriculum. Group A will participate in the Number Worlds packaged intervention program and Group B will participate in the Cover-Copy-Compare intervention group.

7. **RESEARCH QUESTION OR HYPOTHESIS** – In one or two sentences, describe the question you hope to answer with your research?

   **Response:** Is there a difference between the outcomes for 1st grade students participating in the Number Worlds intervention and 1st grade students participating in the cover-copy-compare intervention?

8. **STUDY POPULATION AND RECRUITMENT** - Describe the study population making sure to address the following: inclusion and/or exclusion criteria, numbers of participants, how will participants be approached and recruited, attach electronic copies of advertisements/brochures used for recruitment.

   **Response:** Students will be recruited based on scores from the Winter benchmark of the AIMSweb math computation assessment. The students with scores in the bottom 10% of the grade level will be targeted for participation. Six participants will be selected in all and parent consent for participation will be gathered using phone calls and signed consent forms.

9. **PROCEDURES/METHODS** - Describe procedures involving human participants for this protocol. Include electronic copies (if possible) of all surveys and outcome measures used.

   **Response:** Students will participate in the intervention, the Number Worlds intervention for Group A and the Cover-Copy-Compare intervention for Group B, 2 days a week, 30 minutes a day for eight weeks. Progress will be monitored by the classroom teacher using the AIMSWeb math computation progress monitoring tool. Previous data in the form of previous progress monitoring scores for baseline and winter benchmark scores will also be utilized.

10. **RISKS AND BENEFITS** - Describe the risks to participants (risks listed here should be included in the consent document. What steps will be taken to minimize risks? Describe any direct benefits to participants (if any). Describe any potential future benefits
to this class of participants. Under what circumstances would participation be terminated?

Response: There will be minimal risk to participants as small group intervention is a common practice at this particular elementary site. Risks may include disappointment about missing class activities occurring during the intervention time. Benefits may include growth in number sense skills which will allow students to access classroom instruction more easily as well as build the foundation for engaging in higher level math skills in the future. Termination in the study would also occur if the student moved from the district or at the request of the parent.

11. CONFEIDENTIALITY/DATA MANAGEMENT - How will participant data and responses be managed, stored and reported? How will participant identity and confidentiality be protected? Will participants be audio taped, photographed or videotaped during this study?

Response: Students will not be audio taped, photographed, or videotaped during the study. Data will be linked to student names in the AIMSweb data management system, as is typical for all students in the district being progress monitored regardless of participation. In the research study data analysis, students' data will be reported using numbers 1-6, assigned randomly at the onset of the study. The list of names and corresponding numbers will only be viewed by the researcher. Identity will be protected using the assignment of numbers instead of names and confidentiality will be protected by keeping student data in a password protected data management system.

12. ATTACHMENTS/APPENDICES. These can be sent by email to IRB@udayton.edu. (Check all that apply)

- Consent forms will be used and are attached for review (Use UD consent form template; for anonymous surveys, use introduction template only).
- Additionally, child assent forms will be used and are attached. (check if applicable and attach form)
- If you will be accessing or gathering personal health information include HIPAA authorization form or use UD’s HIPAA template.
- Consent forms will not be used (Must justify request for waiver).
- Advertisements used to recruit participants (email, brochure, fliers, etc.)
- Survey or questionnaire to be used in this research.

13. OTHER APPROVALS - CHECK ALL that apply and submit copies with application

- Has this protocol been submitted to any other IRBs? If so, please list along with protocol title, number, and expiration date.
- If you will be collecting data OFF-CAMPUS, you will need to provide documentation of approval by an administrator at that site (e.g., school principal). This can be sent by email to IRB@udayton.edu.
- If you are a STUDENT, you will need to provide documentation that your faculty advisor (1) has read your IRB application, and (2) approves of the research as proposed. This can be sent by email by the faculty advisor to IRB@udayton.edu.
14. IS THIS PROJECT EXTERNALLY FUNDED?  (If so, please indicate the funding source)
   Response: no
District Consent Form

PERMISSION TO CONDUCT RESEARCH IN SCHOOL BUILDING

TITLE OF STUDY: NUMBER SENSE INTERVENTION: A COMPARISON OF A PACKAGED PROGRAM AND A RESEARCH-BASED STRATEGY

You are asked to participate in a research study conducted by Rachel Kuentz from the University of Dayton. Your participation in this study is voluntary. Read the information below and ask questions about anything you do not understand, before deciding whether or not to participate.

PURPOSE OF THE STUDY

The purpose of this study is to compare the progress first-grade students make in number sense skills when they receive intervention using either the SRA Number Worlds program or the Cover-Copy-Compare intervention.

EXPECTED DURATION OF THE STUDY

The study will last approximately eight weeks.

PROCEDURES

Participants in this study will be chosen using the results from the AIMSweb math computational assessment given to all students at Hadin Elementary in the fall, winter, and spring. The six students with the lowest scores on this assessment are chosen for this study. Three of these students will be randomly assigned to the SRA Number Worlds intervention and three students will be assigned to the Cover-Copy-Compare intervention. Students in the intervention groups will receive Math instruction in the classroom and an additional 30 minutes of Math intervention two days a week. Intervention will begin after an initial three week period to collect data on improvement in math computation scores before the intervention is provided. Progress will be monitored weekly using the AIMSweb M-COMP progress monitoring probes.

POTENTIAL RISKS AND DISCOMFORTS

There are minimal risks for students. Potential risks and discomforts to the intervention groups may include missing other activities in the classroom such as computer lab time, silent reading time, or enrichment activities in the classroom during intervention time.

ANTICIPATED BENEFITS TO PARTICIPANT

Benefits to students participating in this research study are possible improvements in math computation skills.
CONFIDENTIALITY

When the results of the research are published or discussed in conferences, no information will be included that would reveal the identity of the participants or district. All participants in the study will be assigned a number and all data and written reports will refer to the participant's number, not the student's name. The name of the school will not be used in the study or written report, only a general description of the location of the district such as "a rural school district located in the Midwest United States". All records will be stored in a secure location and access will only be granted to the researcher, research supervisor, school administration, and first grade classroom teachers.

IDENTIFICATION OF INVESTIGATORS

If you have any questions about this research, please contact one of the investigators listed below.

Rachel Cunert, Principal Investigator, University of Dayton, Department of Counselor Education and Human Services, 937-226-7652, rachellcunert@gmail.com.

Dr. Elana Bernstein, Faculty Advisor, University of Dayton, Department of Counselor Education and Human Services, 937-229-3624, ebernstein1@udayton.edu.

Permission to Conduct Research

I have read the information provided above. I have been given an opportunity to ask questions and all of my questions have been answered to my satisfaction. I have been given a copy of this form. I understand that the researcher listed above will be available to answer questions about intervention procedures throughout this intervention study. I understand that any child may refuse to participate or the researcher may remove him from the study at any time without penalty.

Principal Name (please print)  

Signature of Principal  

Date 3/6/13
Parent Consent Form

UNIVERSITY OF DAYTON - CONSENT TO PARTICIPATE IN RESEARCH

TITLE of STUDY: NUMBER SENSE INTERVENTION: A COMPARISON OF A PACKAGED PROGRAM AND A RESEARCH-BASED STRATEGY
You are asked to allow your child to participate in a research study conducted by Rachel Kunert from the University of Dayton. Your child’s participation in this study is voluntary. Read the information below, and ask questions about anything you do not understand, before deciding whether or not your child will participate.

PURPOSE OF THE STUDY
The purpose of this study is to compare the progress first-grade students make in number sense skills when they receive intervention using either the SRA Number Worlds program or the Cover-Copy-Compare intervention.

PROCEDURES
Participants in this study will be chosen using the results from the AIMSweb math computation assessment given to all students at Hardin Elementary in the fall, winter, and spring. Three of these students will be randomly assigned to the SRA Number Worlds intervention and three students will be assigned to the Cover-Copy-Compare intervention. Students in the intervention groups will receive Math instruction in the classroom and an additional 30 minutes of Math intervention two days a week. Intervention will begin after an initial four week period to collect data on improvement in math computation scores before the intervention is provided.

POTENTIAL RISKS AND DISCOMFORTS
Potential risks and discomforts to the intervention groups may involve missing other activities in the classroom such as computer lab time, silent reading time, or enrichment activities in the classroom during intervention time.

ANTICIPATED BENEFITS TO PARTICIPANTS
Benefits to students participating in this research study are possible improvements in math computation skills.
CONFIDENTIALITY

When the results of the research are published or discussed in conferences, no information will be included that would reveal you or your child’s identity. All participants in the study will be assigned a number and all data and written reports will refer to the participant’s number, not the student’s name. The name of the school will not be used in the study or written report, only a general description of the location of the district such as “a rural school district located in the Midwestern United States”. All records will be stored in a secure location and access will only be granted to the researcher, research supervisor, school administration, and first grade classroom teachers.

PARTICIPATION AND WITHDRAWAL

Your child’s participation in this research is voluntary. If you choose for your child not to participate, that will not affect your relationship with Hardin Elementary or other services to which you or your child are otherwise entitled. If you decide for your child to participate, you are free to withdraw your consent and continue participation at any time without prejudice or penalty. The researcher may withdraw your child from participating in this research if circumstances arise which warrant doing so.

IDENTIFICATION OF INVESTIGATORS

If you have any questions about this research, please contact one of the investigators listed below.

Rachel Kunert, Principal Investigator, University of Dayton, Department of Counselor Education and Human Services, 937-726-7652, rachelkunert@gmail.com.

Dr. Elana Bernstein, Faculty Advisor, University of Dayton, Department of Counselor Education and Human Services, 937-229-3624, ebernstein1@udayton.edu.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights or your child’s rights as a research participant, you may contact the Chair of the Institutional Review Board (IRB) at the University of Dayton: Dr. Mary Connolly, (937) 229-3493, Mary.Connolly@notes.udayton.edu.

SIGNATURE OF PARENT (or legal guardian)

I have read the information provided above. I have been given an opportunity to ask questions and all of my questions have been answered to my satisfaction. I have been given a copy of this form. I understand that I may revoke consent at any time. I certify that I am at least 18 years of age.
Name of Child (Participant -please print) ______________________________________________

Name of Parent or Guardian (please print) ______________________________________________

Address _______________________________________________________________________

Signature of Parent or Guardian ______________________________________________________ Date ____________
APPENDIX E

Intervention Training Materials

*Number Worlds PowerPoint presentation*

*Number Worlds Training*

November 13, 2009
Vestavia Hills Board of Education
Vestavia Hills City Schools
Re-presented by: Rachel Kunert March 2013
The Lands of Number Worlds

A Prevention/Intervention Program

Teacher’s Edition
Page T6
Number Worlds Levels

Prevention

Levels A – C
(30 Sequential Weeks for Each Level)

Intervention

Levels D – H
(4 weeks for each unit)

Number Sense; Algebra; Arithmetic; Fractions, Decimals, and Percents; Geometry; Data Analysis; Problem Solving

Weekly Overview

Background provides a refresher of the math principles relevant to the chapter.

How Children Learn offers insight into how children learn and gives research based teaching strategies.

Skills Focus outlines the skills that will be covered throughout the week.

Teaching for Understanding provides the big ideas of the chapter.

Math at Home extends learning to provide extra practice students need and encourage support at home.

Math Vocabulary and English Learners outline vocabulary for the chapter and defines vocabulary in English and Spanish to improve students’ understanding of concepts.
Weekly Planner

**Weekly Planner** includes objectives that explain how the key concepts are developed lesson by lesson and which resources can be used with each lesson for quick and easy teacher preparation.

**Lesson Structure**

**Warm Up**
Cumulative review
Computation practice
Skills assessment

**Engage**
Heart of the lesson instruction
Introduce and develop concepts with engaging activity cards
Suggestions for differentiating instruction

**Reflect**
Help students summarize their understanding.

**Assess**
Summarize and analyze evidence of student understanding.
Assessment

Informal Assessments
Rubric Checklists
Day-to-Day Observations
Engage Activities
Warm-Up Activities

Formal Assessments
Placement Tests
Weekly Tests
Unit Tests (Open Response or Multiple-Choice Format)
Cumulative Reviews (Levels A-C)
Number Knowledge Test

Review and Assess
Lesson 5 of every chapter is the formal review and assessment.
Includes suggestions for differentiating instruction based on student results.

Assessment Book
Placement Tests
Identify where students should begin the Number Worlds curriculum

Number Knowledge Test
Measures students’ intuitive knowledge of number

Weekly Tests
Student comprehension is assessed every five lessons

Cumulative Reviews/Unit Tests
For units A-C, cumulative reviews every six weeks and for units D-H, units tests evaluate concept acquisition in multiple choice and/or open response formats.
Levels D-H

Complete the first page of the Unit Placement Test—Number Sense. Does the student score at least 75%?

Yes! Administer the Unit 1 Test for the next level up.

No! Administer the Unit 1 Test for the previous level.

Find the lowest level in which the student scores at least 75% on the Level Unit 1 Test.

You could then repeat the above process for the Unit 2 Placement Test at a given level to find the correct Unit 2 placement for the student. Then repeat for each of the six units.

The best practice is to assess a student’s knowledge of the entire level of content and to place him or her in the first unit in which he or she begins to show difficulty.

Questions? Answers? Comments?