Using Subitizing as a Math Lesson Warm-up to Improve Automaticity Scores

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Using Subitizing as a Math Lesson Warm-up to Improve Automaticity Scores

A Project Presented to
The Graduate Faculty of
Minnesota State University Moorhead

By

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In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in
Curriculum and Instruction

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ABSTRACT

The purpose of this study was to determine the effect of implementing 10-minute warm-ups before math lessons that included the structuring of numbers to 10 through the use of imaging with fingers, dots, 10-frames, bead, and dice flashes. The end result being an improvement in students’ abilities to compose and decompose numbers in addition or subtraction math facts. The study addressed the questions:

1. Can subitizing increase addition and subtraction automaticity?
2. How does the FastBridge Assessment Tool enable teachers to document how students use numbers flexibly (combining numbers to make another number)?
3. Can subitizing interventions be effective in helping students develop mental strategies for addition and subtraction involving two-digit numbers?

The study compared data between a 1st grade class that received the intervention, and a class that did not. The most significant gains were visible after the implementation of the intervention (Progress Monitor 3 to 4). A two-sample T-test was preformed; the Progress Monitor 3 from the Intervention Group (M=43.5, SD=16.939) to Progress Monitor 4 (M=47.7, SD=18.162) did not differ significantly on levels of extraversion, \(t(1) = .65498, p = .2589\). The Progress Monitor 3 from the Comparison Group (M=20.8, SD=13.751) to Progress Monitor 4 (M=25.7, SD=13.719) had the same result, \(t(1) = .977, p = .1685\). Although the data showed significant gains being documented in Progress Monitor 4, there was not enough evidence to say that the intervention was successful because the change could have been due to natural variability. However, because of the vast difference between the scores of the Intervention Group and the Comparison Group, there seemed to be a positive correlation between subitizing and increased math automaticity.
CHAPTER ONE

General Problem/Issue

In elementary classrooms all over the country, students are learning skills to help them succeed in mathematics. Students are adding and subtracting, making tens and ones, using hundred charts, counting on, composing and decomposing numbers, and the list goes on. A skill that is unknown by name but practiced and applied almost innately, is subitizing. Subitizing is the ability to “suddenly see” a number or amount without counting it one by one (Clements, 1999). Examples of subitizing include looking at dice and automatically knowing there are “3” dots or “6” dots or when students know the amount on a domino without having to touch each dot to count.

As teachers begin to do their lesson plans regarding mathematics, they should consider implementing strategies that build a foundation beginning with subitizing. Incorporating small lessons or warm-ups that include subitizing practice by flashing images with fingers, dots, 10-frames, beads, and dice can be very beneficial in supporting students’ ability to compose and decompose numbers in addition and subtraction facts.

This topic is interesting because it is well-known that children understand and see numbers automatically without having a name for it. Through Pepper and Hunting’s (1998) research, detailing preschooler’s counting and sharing, they suggest that activities as simple as setting the table builds skills that support subitizing. As teachers, there needs to be more background knowledge developed in order to establish a more streamlined approach to expand students’ concept of number sense. Trainings such as Add+VantageMR offer support for teachers, special education staff as well as and interventionists:
Add+VantageMR® (AVMR) Course 2 is a four-day course that includes dynamic, diagnostic, individual assessments in place value, multi-digit addition and subtraction, and multiplication and division strategies. The assessment, organizational, and teaching tools accelerate the educator's ability to recognize the students' current levels of numeracy understanding to make data-driven instructional decisions. AVMR Course 2 is most appropriate for kindergarten through elementary classroom and special education teachers, as well as interventionists who work with children kindergarten through middle school (Add+VantageMR® 2 Course, 2017).

**Subjects and Settings**

**Description of subjects.** Participants in this study will be selected from the population of 31 first grade students at a low-income population school with 50% of students receiving free or reduced lunches. The student body is composed of approximately 94% White, 1% African American, 2% Asian, and 2% identifying as two or more races. This public school has approximately 50% of students receiving free and reduced meals. There are 9 females and 22 males, ranging between the ages of six and seven. In this first-grade population, six students are on Individual Education Plans (IEP). Seven of the individuals are from divorced families, ten are from single parent families, and the rest are from two parent families.

**Selection criteria.** Out of the population, fifteen of these students are in the 2017-2018 first grade class, the other sixteen are in the other 1st grade classroom and will serve as the comparison group. The students in the Intervention Group will receive the intervention, where the other classroom will not. The intention is to compare data between the two classrooms at the end of the action research.
Description of setting. This study took place at a school in a small, rural town of which 50% of the students qualify for free and reduced lunches. The school district houses all 540 Prek-12th graders in a one-story building nestled in the household community. Out of the K-6th graders, the average class size is 20 students. The Elementary uses the Pearson Envision 2015 math curriculum. Below is a breakdown of time allowed for math study, as well as results from MCA testing.

- Kindergarten - 45 minutes to 1 hour each day
- First grade - 60 minutes per day is allotted for math study
- Second grade - 60-90 minutes per day
- Third grade - 70 minutes per day (plus 20 min. intervention to 46% of students)
  - Math MCA results for Spring 2016 were –78% passing
  - Math MCA results for Spring 2017 were – 62% passing

Informed consent. Permission was obtained from the Institutional Review Board at Minnesota State University and from the school district to conduct this study. The school district’s IRB procedure was followed to obtain permission to conduct research. This involved receiving permission from the Superintendent of the district as well as from the building principal at the school where the research was conducted. Parents provided written consent.

Protection of human subjects participating in research was assured. Participants and their families were informed of the purpose of the research and any procedures required by the participant, including disclosure of risks or benefits. Confidentiality was protected through the use of pseudonyms without identifying information. The choice to participate or withdraw at any time was outlined both verbally and in writing. Since the study was conducted with 1st graders,
their parents were informed of the nature of the study and they were asked to give their consent for their child to participate in the research.

**Review of Literature**

Building a strong foundation in mathematical skills is not only part of a teachers’ required state standards, but a key to ensuring a student’s success in the real world as an adult. There are numerous instances following math lessons where students retort back with, “When will I ever use this again?” Granted, it rarely happens in the primary grades, however, 1st graders still struggle with understanding the importance of seeing a group of numbers for what it is or making sense of word problems. Pepper & Hunting (1998) believe that young children come to us at the beginning of their schooling with a wealth of knowledge about mathematics already. Teachers need to embrace that prior knowledge by offering numerous opportunities to play and experiment with numbers. The purpose of this study is to determine the effect of implementing 10-minute warm-ups before math lessons that include the structuring of numbers to 10 through the use of imaging with fingers, dots, 10-frames, bead, and dice flashes. The end result being an improvement in students’ abilities to compose and decompose numbers in addition or subtraction math facts. The connection between subitizing and addition and subtraction, is the students’ ability to mentally add on or take away numbers in a problem by “seeing” the metal pictures they create with dots, ten-frames, fingers, etc.

**Definition of terms.** For purposes of this study, the following terms are defined:

Subitizing: to ‘suddenly see’ quantity (Clements, 1999).

Number sense: ability to recognize numbers, understand relationships between numbers, compose and decompose numbers (Bobis, 2008).
Warm-up: implemented intervention strategies for 5 to 10 minutes before the math lesson within the curriculum begins.

Quick-image: an intervention to promote conceptual subitizing (Clements, 1999).

Automaticity: students’ ability to be flexible with numbers and answer addition and subtraction math facts on a computer or Ipad.

FastBridge: “The Formative Assessment System for Teachers (FAST™) system of assessments and online services offers a rigorously-developed, highly efficient, instructionally relevant, easy to implement, and user-friendly solution to gather and process data to guide instruction for K–12 students by providing universal screening and progress monitoring designed to screen, diagnose, monitor and inform instruction” (FastBridge, 2017).

What is Subitizing? Surprisingly, subitizing is a strategy that is integrated into many curricula around the country already. However, few know the term by name. Much research has been discovered that supports and encourages the use of “dot cards.” Using the dots allows students to understand the value without having to figure it out through a numeral (Faulkner & Ainslie, 2017).

When students are able to “see” a collection of items in a quick and almost innate way, their ability to solve and understand challenging mathematical problems increases as they develop their strategies for comprehension. Tsamir, Tirosh, Levenson, Tabach, and Barkai (2015) suggest that teachers, “discuss with children, at their own level, the different uses of various tools and how those tools may be employed in several contexts, thus enhancing children’s disposition to use mathematics along with the necessary critical orientation to choose carefully” (p. 650). A classroom teacher can give students a real-life example, such as, counting out change needed when paying for something, or setting the table and deciding how many more
utensils are needed. Teachers need to incorporate and specifically teach strategies that allow students to have a toolbox of sorts to reach into when encountering a math problem. However, if the strong foundation of numbers isn’t there, then students will struggle to build upon the strategies they will need to comprehend mathematical information. As Pepper and Hunting (1998) suggest, “Children encouraged to become less reliant on perceptual information and more reliant on internal methods will develop more sophisticated schemes that, in turn, will allow them to extend their knowledge to deal with new and more challenging situation” (p. 181). In the classroom, students who can visualize a ten-frame, and count on 3 more to know that \( 7 + 3 = 10 \), will benefit far more than the students that are trying to use their fingers or draw out their own counters.

Thunder and Demchak (2016) compare mathematical education to that of literacy in that a reading program has a balance of components that gives students an understanding of all the elements regarding reading and writing. They suggest that, “The Math Diet for students in kindergarten through fifth grade includes five components: 1. Counting 2. Subitizing 3. Conceptual understanding 4. Strategic competence 5. Procedural fluency” (p. 389). Breaking apart these concepts allows teachers to be more focused in their teaching and make decisions about curriculum to enhance students’ mathematical knowledge.

**Importance of developing number sense.** It is well known that reading to young children dramatically increases their likelihood of having success as readers themselves as they go through their schooling. But what about mathematical strategies? How do parents and educators support the early development of mathematical skills? Anderson, Anderson, and Shapiro (2004) conducted a study that focused on the mathematical learning that took place
while caregivers and children shared a story together. They suggest that, “. . . storybook reading can be a valuable context for learning and teaching mathematics . . .” (p. 5).

Number sense is an ability that develops early in a child’s life. Children are able to see one, two, and three objects easily, without counting out each one by one. For example, if you asked a toddler to give you one toy, most will grab one and put in your hand. Or if you asked for two cookies, a child could comply. As an educator, having students with a solid number sense makes my job that much easier. However, having students with a fragmented or nonexistent sense of numbers can be challenging and almost frustrating. There are children in classrooms that cannot tell you automatically that they have five fingers on each hand or ten fingers all together. Other children struggle to verbalize what number comes after 10, 15, 21, etc. Teachers have to almost rethink some of our strategies in teaching number sense in order to address the needs of students and accurately develop number sense concepts (Cain & Faulkner, 2011).

Pepper and Hunting (1998) suggest that the more students can internalize methods of numeracy, the more prepared they will be for new and difficult mathematical challenges. This suggestion rings true for me. Being a 1st grade teacher, it is easy to see the students that math comes to naturally. They are the students that can look at a picture and instantly know there are five hats, see three more and count on six, seven, eight to tell that altogether there are eight.

Wagner and Davis (2010) go on to state that, “It is important that learners develop a feeling for numbers, which includes a sense of what numbers are and what they can do” (p. 39).

McMullen, Hannula-Sormunen, and Lehtinen (2015) developed a study that supported recent research that, “. . . early natural number knowledge is a predictor of later rational numbers conceptual knowledge . . .” (p. 813). It cannot be stressed enough that students exposed to
number concepts early on will have greater success in and out of the classroom with mathematical ideas.

**Teacher Knowledge of Students’ Math Conceptions**

Teachers need to be knowledgeable about students’ abilities with mathematical concepts as soon as possible. The students who are struggling need to be identified right away to provide the necessary interventions and accommodations. Clayton and Gilmore (2015) state, “To provide suitable educational support for individuals with mathematics difficulties, it is essential that researchers and educators first have a detailed and accurate understanding of the skills and underlying processes that are important for learning and performing mathematics” (p. 759).

Teachers also need to reflect upon their own teaching and ask themselves if there are other strategies they could incorporate to build upon the foundation of number sense. Bobis (2008) stresses the benefits of using dice, dominoes, dot cards, and ten-frames when developing students’ ability to see numbers (subitize) and in turn improve their knowledge of addition and subtraction facts. Tsamir, Tirosh, Levenson, Tabach, and Barkai (2014) go on to support that teachers’ understanding of students’ mathematical knowledge is essential for developing and carrying out interventions. However, it was also noted that teachers may need support themselves as they determine the programs that would be the most beneficial. It is also crucial that teachers have the ability to implement interventions with fidelity as well as use research-based instructional strategies.

There are numerous activities and strategies using subitizing available for teachers to use and implement in their classrooms that will improve mathematical knowledge. Clements (1999) gives some activities that are appropriate for students in the elementary grades:

*Have students construct a quick-image arrangement with manipulatives.
*With cards, play a matching game. Show several cards, all but one of which have the same number. Ask children which card does not belong.

*Play concentration games with cards that have different arrangements for each number. For a version of this game and other helpful activities, see Baratta-Lorton (1976).

*Give each child cards with zero through ten dots in different arrangements. Have students spread the cards in front of them. Then announce a number. Students find the matching card as fast as possible and hold it up. Have them use different sets of cards, with different arrangements, on different days. Later, hold up a written numeral as their cue. Adapt other card games for use with these card sets (see Clements and Callahan [1986]).

*Place various arrangements of dots on a large sheet of poster board. With students gathered around you, point out one of the groups as students say its number as fast as possible. Hold the poster board in a different orientation each time you play (pp. 403-404).

Looney and Carr (2016) also offer a strategy that involves pictures of different finger image combinations to subitize. Students were excited and up for the challenge of trying to figure out the total number of fingers by making fives and tens through combining hands together. Looney and Carr go on to express that, “This seemingly simple routine proved to be a powerful opportunity for mathematical discourse and the development of multiple mathematical concepts, allowing all students to participate at their own level of understanding (p. 537). It just goes to show that developing number sense concepts and strategies doesn’t need to be difficult, time consuming or frustrating. It involves understanding what your students already know and what concepts they are struggling with. Teachers can simply modify and add short blocks of time for practice with these interventions and strategies to further students’ understanding in number sense, with the end goal of improving their ability to solve addition and subtraction facts.
Lehtinen, Hannula-Sormunen, McMullen, and Gruber (2017) stress that there needs to be “deliberate practice” of mathematical skills within the classroom as well as feedback to the students about which skills they are strong or weak in.

Rawding (2017) also encourages the use of quick-images to enhance students’ knowledge of numbers as a whole. Her strategies are similar to that of Clements (1999) in that images should be shown fast and that it can be a fun and very engaging activity. Rawding goes one step further to add detailed questions following a quick-image to gets students familiar with math discussions:

- Who sees it another way? How?
- Give a number model to match the picture.
- What’s another number model?
- What is the same or different? (2017, p. 320)

MacDonald and Shumway (2016) reiterate the importance of using games or activities that include subitizing because it allows students to talk about what they are “seeing” and develop discussion about mathematical concepts. These games can also be a way to assess students and their understanding of numbers and spatial arrangements.

**Statement of the Hypothesis**

When subitizing (structuring numbers to 10 by flashing images of dots, beads, fingers, 10-frames, and dice) is introduced to students with various instruments, students will improve their abilities to compose and decompose numbers and as a result improve their Automaticity score on the FastBridge assessment benchmarks. My prediction is that the Intervention Group will perform better on the automaticity assessments than the Comparison Group, who will not be receiving subitizing interventions.
CHAPTER TWO

Research Questions

As a 1st grade teacher, I see students that struggle with numbers, counting, adding on, seeing a whole, patterns, and the like. Students are coming into 1st grade without the background knowledge of 5 and 10 relationships and that makes teaching addition and subtraction very difficult. The goal at the end of 1st grade is to have students be able to get past the “counting on” thinking, to be flexible with what makes a number, talk and explain math thinking, and use the most effective “thinking” to figure out math.

I was curious as to how we could develop these skills in students through the use of interventions. I formulated some research questions to begin to develop my thinking:

1. Can subitizing increase addition and subtraction automaticity?
2. How can the FastBridge Assessment tool enable teachers to document how students use numbers flexibly (combining numbers to make another number)?
3. Can subitizing interventions be effective in helping students develop mental strategies for addition and subtraction involving two-digit numbers?

Answering the above questions would allow for a greater understanding in students’ ability and give teachers a baseline for their instruction. Data from these questions will also aide in the development of appropriate interventions for individual, small-group, or whole-group.

Research Plan

Methods and rationale. After benchmarking took place during the first two weeks of school, through the Formative Assessment System for Teachers (FAST) tool, each student had a baseline Math Automaticity score. All students in the Intervention Group received the warm-up
activity and students in the Intervention and Comparison Groups were progress monitored monthly, with a benchmark in January and May.

The Formative Assessment for Teachers (FAST) system of assessments and online services was used as the measuring instrument. The test was designed to gather and process data to guide instruction for K-12 students by providing universal screening and progress monitoring designed to screen, diagnose, monitor, and inform instruction. FastBridge Automaticity is an evidence-based assessment used to screen and monitor students’ progress. Each assessment is designed to be highly efficient and help inform instruction. Automaticity is used to universally screen all students up to five times per year, with more assessments available for progress monitoring. Benchmark standards are built into the system to assist in determining which students are at risk of academic failure, on target, or who may need enrichment instruction. Reports provide information on student’s strengths and areas of difficulty relating to numeracy and provide useful information to plan and drive instruction. Reports on student progress are available instantly, speeding up the process for differentiated instruction for teachers. Progress monitoring in Automaticity was quick, easy, and flexible. The data from progress monitoring can help evaluate instructional effects and determine if differentiated instruction or interventions are effective.

**Intervention Group.** One of the first-grade classrooms served as the Intervention group and received subitizing activities before daily math lessons begin. The intervention took approximately 5 to 10 minutes. The intervention included various activities that promoted “seeing numbers,” being able to know how many dots there are, verbalize the number, show the number with fingers or written, as well as add on to make 10, 20, etc. This group was
benchmarked in January, and progress monitor data points were collected in February and March.

**Comparison Group.** Students in the other first-grade classroom did not receive the subitizing intervention and served as the Comparison Group. This group was benchmarked in January, and progress monitor data points were collected in February and March.

**Schedule.** The benchmark data for Math Automaticity was already documented from the beginning of the year, as well as monthly progress monitoring. Another benchmarking occurred in January. The Intervention group received the intervention after the February Progress Monitor. Progress monitor data points were collected in March.

**Ethical issues.** No ethical issues arose during the process of the Action Research.
CHAPTER THREE

Data Analysis and Interpretation

Description of Data

The purpose of this study was to determine the effect of implementing 10-minute warm-ups before math lessons that included the structuring of numbers to 10 through the use of imaging with fingers, dots, 10-frames, beads, and dice flashes. The subitizing intervention was implemented for 5 to 10 minutes before beginning the math lesson from the curriculum. The end result being an improvement in students’ abilities to compose and decompose numbers in addition or subtraction math facts. The study compared data between a 1st grade class that received the intervention, and a class that did not.

Method of Analysis

Participant Data

For this study, I selected one first grade classroom to perform an intervention with, which included 15 students, while I left the other classroom for my Comparison Group, 16 students. Our district uses The Formative Assessment System for Teachers (FAST™) system of assessments, an online service for gathering benchmark data and progress monitoring. I compared four Progress Monitor data points. Progress Monitor 1 in September, Progress Monitor 2 in November, Progress Monitor 3 in January, February the Intervention began, and the final Progress Monitor in March, when the Intervention concluded (see Table 1).
The intervention included various activities that promoted “seeing numbers,” being able to know how many dots there were, verbalizing the numbers, showing the number with fingers or writing it, as well as adding on to make 10, 20, etc. Students were given a quick-image of a ten-frame, dice pattern, or finger sequence, meaning that I quickly showed students the image and they had to verbalize what they saw (see APPENDIX D). I also followed up with the question, “How many more do you need to make 10?”

Research Questions 1-3

Research Question 1: Does subitizing increase addition and subtraction automaticity?

In order to look more deeply into student data from the Intervention Group, I picked numbers from a hat that corresponded with each student. I then looked to the Progress Monitor data points to compare scores across the timeline. As I reviewed the data from my randomly selected students (see Table 2), I saw that they all made the most significant gains after Progress Monitor 3, when the subitizing intervention was implemented. During a Progress Monitor,
students are given four minutes to complete as many addition and subtraction problems as they can and their scores are calculated and reported as items correct per 10 minutes. The Benchmark goal for the end of the year is 40.

Granted, other factors may have also come into play, such as, student maturity, small group sessions, comfort level/relationship, increased rigor of our district curriculum, and success of other interventions students were receiving. Other factors may have played a role; however, I believe that the intervention may have had a more relevant impact because of the vast difference between the scores of the Intervention Group and the Comparison Group (see Table 3). Based on the data I collected through this study, there seemed to be a positive correlation between subitizing and increased math automaticity.

Table 2

*Individual Student Data Before and After Intervention*

<table>
<thead>
<tr>
<th>Student #</th>
<th>Progress Monitor 1</th>
<th>Progress Monitor 2</th>
<th>Progress Monitor 3*</th>
<th>Progress Monitor 4</th>
<th>Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>20</td>
<td>5</td>
<td>35</td>
<td>32</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>12</td>
<td>20</td>
<td>38</td>
<td>30</td>
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<tr>
<td>6</td>
<td>3</td>
<td>18</td>
<td>30</td>
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<td>45</td>
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<td>9</td>
<td>3</td>
<td>15</td>
<td>13</td>
<td>35</td>
<td>32</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>8</td>
<td>30</td>
<td>58</td>
<td>55</td>
</tr>
<tr>
<td>Combined</td>
<td>20</td>
<td>73</td>
<td>98</td>
<td>214</td>
<td>194</td>
</tr>
</tbody>
</table>

*Note.* The Intervention was implemented after Progress Monitor 3.
Table 3

*Individual Student Data from Comparison Group*

<table>
<thead>
<tr>
<th>Student #</th>
<th>Progress Monitor 1</th>
<th>Progress Monitor 2</th>
<th>Progress Monitor 3</th>
<th>Progress Monitor 4</th>
<th>Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>23</td>
<td>18</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>6</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>5</td>
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<td>11</td>
<td>0</td>
<td>25</td>
<td>20</td>
<td>28</td>
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<tr>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Combined</td>
<td>8</td>
<td>59</td>
<td>69</td>
<td>80</td>
<td>72</td>
</tr>
</tbody>
</table>

Also, during my research I found that there were many positive things to be said about the relationship between the ability to subitize successfully and understanding and comprehending mathematical problems. The more tools that students are able to access independently while learning math, the better. As Pepper and Hunting (1998) suggest, “Children encouraged to become less reliant on perceptual information and more reliant on internal methods will develop more sophisticated schemes that, in turn, will allow them to extend their knowledge to deal with new and more challenging situation” (p. 181). In the classroom, students who can visualize a ten-frame, and count on 3 more to know that $7 + 3 = 10$, will benefit far more than the students that are trying to use their fingers or draw out their own counters.

*Research Question 2: How does the FastBridge Assessment Tool enable teachers to document how students use numbers flexibly (combining numbers to make another number)?*

It amazed me how fast my 1st graders caught on to the ten-frames. They could tell me instantly how many dots there were and how many more they needed to get to ten. The dice and dominos took just a bit longer, as they had to essentially put together two different parts. My goal for students was to be able to come back to these visual images when they are dealing with mathematical problems and “see” the number and be able to add on to it or take away from it.
The FAST Assessment for Math Automaticity was a very effective tool in gathering data in students’ ability to use addition and subtraction. Figure 1 shows an individual report from the January Progress Monitor. On the left it gives me the type of problem that was given, in the middle how many items were correct and the total number of questions, as well as the individual students’ accuracy. At the bottom you see the total number of questions answered, how many were correct, accuracy, and how many questions were correct per 10 minutes. The last component of the report shows the student responses, which allows me to see which problems they answered correct or incorrectly. This feature enables teachers and interventionists to see if the mistake was due to incorrectly typing in the answer, sign reversal, or simply getting it wrong. I can see that the student below struggles with subtracting a one-digit number from a two-digit number to 20, which allows me to modify my small group instruction.
To show a lower performing student, see Figure 2. The report shows teachers and interventionists that this student struggled in all areas. The responses at the bottom let us know that the student imputed numbers in reverse order and was unable to recognize the addition and subtraction signs some of the time.
All of the information is vital to have to address during small group and intervention time. All participants showed improvement from the first Progress Monitor to the 4th. The areas of needed growth will differ from student to student, but some common themes were evident. Numerous students switched the signs, added when it called for subtraction and vice versa. Another shared challenge was numeral reversal, 81 for 18, for example.
Research Question 3: What differences are evident between groups that receive subitizing interventions versus those that do not?

Structuring numbers 0 to 10 in a 5 to 10-minute warm-up through the use of imaging with fingers, 10-frames, dominos, and dice flashes, was a simple and effective way to increase math automaticity. Table 4 shows the sequence that was followed to implement the intervention. The intervention was implemented to the whole-group every day as students were coming to the rug to begin math.

Table 4
*Intervention Sequence*

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Students were asked to show numbers on their fingers. “Can you show me six fingers?” Similarly, 9, 7, 10, 8. I looked for students who could raise the five fingers simultaneously, and then raise the rest of their fingers sequentially.</td>
</tr>
<tr>
<td>Fingers</td>
<td></td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Fingers Image" /></td>
</tr>
<tr>
<td>Tuesday</td>
<td>Ten-frame cards were flashed (displayed for approximately half a second) in random order. “Tell me how many dots you see. How many more do you need to make 10?”</td>
</tr>
<tr>
<td>10-Frames</td>
<td></td>
</tr>
</tbody>
</table>
### Wednesday

**Dominoes**

Cards with domino patterns were shown to students. “Tell me how many dots you see. What does the four pattern look like? Can you show me in the air?”

### Thursday

**Dice Flashes**

Spatial configuration cards, dots displayed in a “dice” pattern were flashed (displayed for approximately half a second) to students.

“How many dots did you see?”

### Friday

**10-Frames**

Ten-frame cards were flashed (displayed for approximately half a second) in random order.

“Tell me how many dots you see. How many more do you need to make 10?”

---

My students were able to mentally add on and take away numbers in a problem by “seeing” the mental pictures they created with dots, ten-frames, fingers, etc. By looking at the information in the tables below, I saw the most significant gains after I implemented the intervention (Progress Monitor 3 to 4).
In Figure 3 and Table 5, Combined Class Totals, you can see the progression of totals between the Intervention Group and the Comparison Group. Progress Monitor 1 took place at the beginning of the year, 2 in the late fall, 3 Winter, and the final Progress Monitor in March. The first Progress Monitor showed both classes with very similar totals, Comparison Group with 67 and Intervention Group 65. In the 2nd, Intervention Group pulled ahead by 12 points. In Progress Monitor 3, Intervention Group stayed ahead by 37 points. After Progress Monitor 3 the
subitizing intervention began. The final Progress Monitor showed Intervention Group ahead by 327 (see Table 6).

Table 6

*Comparing Final Progress Monitor between Intervention Group and Comparison Group*

<table>
<thead>
<tr>
<th>Intervention Group Student #</th>
<th>Progress Monitor 4 Score</th>
<th>Comparison Group Student #</th>
<th>Progress Monitor 4 Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student 1</td>
<td>48</td>
<td>Student 1</td>
<td>33</td>
</tr>
<tr>
<td>Student 2</td>
<td>35</td>
<td>Student 2</td>
<td>23</td>
</tr>
<tr>
<td>Student 3</td>
<td>30</td>
<td>Student 3</td>
<td>No Data</td>
</tr>
<tr>
<td>Student 4</td>
<td>25</td>
<td>Student 4</td>
<td>18</td>
</tr>
<tr>
<td>Student 5</td>
<td>38</td>
<td>Student 5</td>
<td>45</td>
</tr>
<tr>
<td>Student 6</td>
<td>48</td>
<td>Student 6</td>
<td>35</td>
</tr>
<tr>
<td>Student 7</td>
<td>53</td>
<td>Student 7</td>
<td>8</td>
</tr>
<tr>
<td>Student 8</td>
<td>73</td>
<td>Student 8</td>
<td>5</td>
</tr>
<tr>
<td>Student 9</td>
<td>35</td>
<td>Student 9</td>
<td>45</td>
</tr>
<tr>
<td>Student 10</td>
<td>65</td>
<td>Student 10</td>
<td>38</td>
</tr>
<tr>
<td>Student 11</td>
<td>25</td>
<td>Student 11</td>
<td>28</td>
</tr>
<tr>
<td>Student 12</td>
<td>58</td>
<td>Student 12</td>
<td>33</td>
</tr>
<tr>
<td>Student 13</td>
<td>88</td>
<td>Student 13</td>
<td>3</td>
</tr>
<tr>
<td>Student 14</td>
<td>61</td>
<td>Student 14</td>
<td>38</td>
</tr>
<tr>
<td>Student 15</td>
<td>30</td>
<td>Student 15</td>
<td>23</td>
</tr>
<tr>
<td>Student 16</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Combined Class Total</td>
<td>712</td>
<td>Combined Class Total</td>
<td>385</td>
</tr>
</tbody>
</table>
Figure 4 displays the mean average of the combined class totals. Comparison Group showed a steady increase throughout the Progress Monitors, 4.18 - 16.18 - 20.70 - 25.66.

Intervention Group also showed an increase throughout, with the most significant gains being made between Progress Monitor 3 and 4, 4.33 - 22.58 - 25.93 - 47.46.

Table 7
Mean Average of Combined Class Totals

<table>
<thead>
<tr>
<th>Progress Monitor</th>
<th>Intervention</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor 1</td>
<td>4.333333</td>
<td>4.1875</td>
</tr>
<tr>
<td>Monitor 2</td>
<td>22.583333</td>
<td>16.1875</td>
</tr>
<tr>
<td>Monitor 3</td>
<td>25.93333</td>
<td>20.8</td>
</tr>
<tr>
<td>Monitor 4</td>
<td>47.7</td>
<td>25.7</td>
</tr>
</tbody>
</table>

A two-sample T-test was performed and the results can be found in Table 7. The Progress Monitor 3 from Intervention Group (M=43.5, SD=16.939) to Progress Monitor 4 (M=47.7, SD=18.162) did not differ significantly on levels of extraversion, $t(1) = .65498$, $p = .2589$. The
Progress Monitor 3 from Comparison Group (M=20.8, SD=13.751) to Progress Monitor 4 (M=25.7, SD=13.719) had the same result, $t(1) = .977, p = .1685$. Although my data shows significant gains being documented in Progress Monitor 4, there is not enough evidence to say that the intervention was successful because the change could have been due to natural variability.

Table 8
Results of two-sample T-test

<table>
<thead>
<tr>
<th></th>
<th>Progress Monitor 3</th>
<th>Progress Monitor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention Group Mean</td>
<td>25.9</td>
<td>47.7</td>
</tr>
<tr>
<td>Comparison Group Mean</td>
<td>20.8</td>
<td>25.7</td>
</tr>
<tr>
<td>Intervention Group Standard Deviation</td>
<td>16.939</td>
<td>18.162</td>
</tr>
<tr>
<td>Comparison Group Standard Deviation</td>
<td>13.751</td>
<td>13.719</td>
</tr>
</tbody>
</table>

To see the growth of individual students (Figure 5 and Table 9), I randomly selected 5 students from my class. Student 2 began with 3 points, went to 20, declined in the 3rd Progress Monitor to 5, but improved for the final to 35. Student 5 had a steady increase from 8 - 12 - 20 - 38. Student 6 also showed an incline, 3 - 18 - 30 - 48. Student 9 took a small decline after Progress Monitor 2, 3 - 15 - 13 - 35. Student 12 made great gains after Progress Monitor 2, 3 - 8 - 30 - 58.
All students showed the most growth between Progress Monitor 3 and 4, when the intervention was implemented.
Conclusions

Throughout this study, I observed my students being excited and competitive about subitizing! They were focused and attentive when I began the intervention, because they knew they weren’t going to be able to see the image for very long. I also made it a competition to see who could remember the special name for being able to see the counters on the ten-frame and automatically know what number it was without counting them one-by-one. They were very intrigued, and after the first couple days of getting, “scuba,” “tuba” or “subtraction,” they couldn’t wait to tell me, “subitizing!” Even during conferences, while explaining my research to parents, I was able to ask them and they could impress their parents with a big, unknown word.

When comparing the benchmark data to the progress monitors, I found that most students made great gains, which was the goal of my intervention. Bobis (2008) was also a great believer in the benefits of using dice, dominoes, dot cards, and ten-frames when developing students’ ability to see numbers (subitize) and in turn improve their knowledge of addition and subtraction facts. The students who were reflected as high or some risk made significant gains as well. There were 9 students who received 0 to 3 points on their benchmark assessment at the beginning of the year. At the March Progress Monitor, those same students made on average, an improvement of 41.44 points. The 2 highest scoring students from the beginning of the year, scoring 10 and 20 points, made an average gain of 65.5 points on the March Progress Monitor. 3 students scored in the middle, with 8 points. Those students made an average gain of 36.33 points. I was amazed and impressed by their focus and determination. As teachers, we have to almost rethink some of our strategies in teaching number sense in order to address the needs of students and accurately develop number sense concepts (Cain & Faulkner, 2011).
All of the students were excited to see their gains and the graph that showed how many more points they were able to get from the beginning of the year to now. Tsamir, Tirosh, Levenson, Tabach, and Barkai (2014) support that teachers’ understanding of students’ mathematical knowledge is essential for developing and carrying out interventions. Students were able to see the benefit and the end result of their hard work through the increase in their scores and how they made their graph “go up!”
CHAPTER FOUR

Action Plan

After researching and performing interventions that involved getting students to subitize on a daily basis, I saw the value in having students use mental imaging as a strategy for math automaticity. I plan to continue using subitizing before my whole-group math lessons, as well as incorporating it into my small-group lessons. Next year, I will begin right away with subitizing interventions with my new first graders. I feel that there are many more strategies that can involve subitizing in their daily routine so I will continue researching and implementing those ideas.

If I were to conduct this study again, I would be sure that both groups, Intervention and Comparison, performed Progress Monitors monthly in order to collect more samples of data. I would also ensure that the Progress Monitors were performed in the same matter. This study allowed for Progress Monitors to be performed whole-group, small-group, or with the Interventionist. In order to be consistent, in the future, I would keep the Progress Monitors to the small-group setting.

I also plan on looking into receiving the AVMR training that would give me formalized math intervention resources. There is summer programming available, and I feel that in order to keep current on subitizing interventions, this training program would be highly beneficial. I plan to continue the math dialogue with our Interventionist to share ideas and strategies that are in the best interest of students and other staff members.
CHAPTER FIVE

Plan for Sharing

Throughout this study, I was very vocal about what I was doing in my classroom. “Subitizing? What’s that?” I would hear my colleagues say. They were very curious, and I was more than happy to share my intervention with them, and even more excited to show them my results. I discussed the study with the Interventionist that prompted me with the idea in the first place the most. She was able to give me the many strategies that I implemented and was impressed with my results as well. The biggest factor that impressed colleagues was the difference between the class that received the intervention and the class that did not. They were pleasantly surprised to hear that the intervention was simple, and easy to implement before lessons. Many teachers are hesitant to begin something different because they are afraid of the time commitment and how it might take away from their regular lessons. I was able to assure them of the ease it took for this intervention, and how flexible it could be to extend as well as implement in a small-group setting.

Going forward, I will be able to use the data from this study to encourage and guide other teachers, staff, and administration in the area of math interventions. I know that the interventionist that sparked this idea will be very interested in my methods and strategies of implementation. I would be more than happy to discuss the results of my study with anyone struggling to come up with an intervention to assist in math automaticity. I can see myself leading discussions with colleagues that would gather ideas of ways to extend subitizing in whole or small-groups. These discussions could occur during late-starts or grade-level PLC’s. I believe other teachers and staff members will appreciate the first-hand experience I can offer and the knowledge that I’ve seen growth from all students.
REFERENCES


APPENDIX A

District Approval Form

January 12, 2018

To Whom It May Concern,

This letter is to grant Meagan Ferris permission to conduct an action research study at Verndale Public School during the 2017-2018 academic year. I understand that this study poses no risk to those persons involved or to the Verndale Public School District. I also understand that all information received will be kept confidential and will only be used for purposes of this study.

Sincerely,

[Signature]

Paul Brownlow
Superintendent, Verndale Public School
APPENDIX B

Parental Consent Form

Consent Form

Participation in Research

Title: Using Subitizing as a Math Lesson Warm-up to Improve Automaticity Scores

Purpose: The purpose of this research is to determine whether using flashes of ten-frames, dice, dots, and beads will improve students’ ability to compose and decompose numbers in addition and subtraction math facts.

Study Information: This study will compare the use of the subitizing (ten-frame flashes) as a warm-up before a math lesson begins to beginning a math lesson without the intervention. Data has been collected from all 1st grade students during the Winter Benchmark. During the intervention, progress monitoring will occur for both classes.

Time: The participants will complete this study during the regular school day. This study will take place during the winter and spring of 2018. Students included in the intervention will receive it for 5 to 10 minutes prior to a math lesson each day.

Risks: Participation in this study requires students to be involved in the warm-up intervention prior to the math lesson. While the purpose of the study is to improve student engagement, the outcome of the study is unknown. Increased Math Automaticity scores are not guaranteed to the participant.

Benefits: Participation may help improve participant’s ability to compose and decompose numbers in addition and subtraction math facts. This study may also help students improve math achievement.

Confidentiality: Participant’s identity will not be shared with anyone beyond the principal investigator, Ximena Suarez-Sousa, and the co-investigator, Meagan Ferris. All individual information will be recorded and tracked under an identification number and not the participant’s name.

Participation and withdrawal: Participation in this study is optional. Students can choose not to participate or choose to withdraw at any time without any negative effects on grades, relationship with the instructor, or relationship with Verndale Public School.
APPENDIX B, continued

Contact: If you have any questions about the study, you may contact any of these people:

Meagan Ferris
Co-investigator
Ph. 218.445.5184
Email: mferris@verndale.k12.mn.us

Ximena P. Suarez-Sousa, Ph.D.
Principal Investigator
Assistant Professor, School of Teaching and Learning, Lommen 211C
College of Education and Human Services
Minnesota State University Moorhead
Ph. 218.477.2007
Email: suarez@mnstate.edu

Any questions about your rights may be directed to Lisa Karch, Ph.D., Chair of the MSUM Institutional Review Board, at 218-477-2699 or by lisa.karch@mnstate.edu. You will be given a copy of this form to keep.

"I have been informed of the study details and understand what participating in the study means. I understand that my child’s identity will be protected and that he/she can choose to stop participating in the study at any time. By signing this form, I am agreeing to allow my child to participate in the study. I am at least 18 years of age or older."

________________________
Name of Child (Print)

________________________
Signature of Parent/Guardian

________________________
Date

________________________
Signature of Investigator

________________________
Date

411 Southwest Brown Street * Telephone 218-445-5184 * Fax 218-445-5185 * Tax Exempt No. 8631596
APPENDIX C

Method of Assent

I explained to the 1st grade students that “your parents have given consent for you to participate in a research project that I am conducting, but you have a choice on whether you do or do not participate. If you do not wish to participate, there will be no effects on your grade. This is completely voluntary. The only effect of this study is to help me decide if adding this intervention is beneficial in improving Automaticity scores. You will participate in class as usual, with the new intervention in place. I will study the progress monitoring data to see if the new intervention helped improve your Automaticity scores. Are there any questions?”
APPENDIX D

Subitizing Instruments

Ten-frames
APPENDIX D, continued

*Dominos*
APPENDIX D, continued

*Dice Cards*
APPENDIX D, continued

*Fingers*