Intervention Strategies for Exceptional Learners:
Enhancing Learning on Both Ends of the Achievement Gap

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The Number Sense Project is a research study that focuses on the mathematical development of Kindergarteners in a Title 1 school in Rock Island, Illinois. Teacher candidates provide instruction in the Kindergarten classroom to stabilize and increase Kindergarten number sense and mathematic achievement. My focus in this study was to observe how students benefited from these interventions, and how educators can tailor their instruction to accelerate math learning for all students. Interventions are defined by Mellard and Johnson (2008) as an instruction applied to students that are not progressing proportional to their peers. “The intent is to close the achievement and learning gaps and to intervene with an effective curricular and instructional change” (Mellard et al, 2008, 7). In other words, interventions are additional instruction measures to help students. Even though interventions have the best of intentions, Ceci & Papierno (2005) argue that interventions increase the achievement gap, and students performing both above and below target are hindered due to current intervention methods. My findings suggest there is a way to balance interventions in the classroom, and that interventions can be designed to maximize student achievement so the achievement gap is not widened in spite of restricted resources.

For the purpose of my study it is important to note the difference between mathematic learning disability (MLD) and mathematic difficulty (MD), since children in Kindergarten are rarely labeled with a learning disability. A learning disability, as defined by Mazzocco (2007) is “a biologically based disorder characterized by cognitive defects.” On the other hand a difficulty is poor achievement that has many probable causes. In other words, there is no one reason why a student might have a difficulty. The current study focuses on children with Mathematic Difficulty (MD).

In the case of mathematical difficulties (MD) there may be poor number skills, but still a high level of mental ability, certain ideas may just need to be reinforced or altered. On average most students with MD have normal or above normal IQ (Mazzocco, 2007). There are also diverse categories of difficulties. Co-morbid refers to a person that struggles in multiple areas, such as reading and math, while math specific refers to children who only struggle in math. This study focuses on students in both groups, although it should be noted that The Committee on Early Childhood Mathematics (2009) concluded that students with specific MD abilities are able to reach target much faster than students with co-morbid difficulties.

Research notes a specific phenomenon called “The Matthew Effect,” this name is given based on a passage from The Bible in the Book of Matthew. The passage states those who have the most, gain the most and those who have the least, gain very little when given advantages. In the case of intervention, “The Matthew Effect” exists because advantaged children’s original advantage multiplies, while the disadvantaged children gain so little that the effect of the intervention is trifle, and the gap widens over time (Ceci & Papierno, 2005). The study argues the reason behind the gap increase due to the interventions being targeted toward middle and high advantaged students. Ceci & Papierno (2005) suggest that if interventions are focused toward the right subgroups such as students with MD there is potential for high achievement.

While “The Matthew Effect” is noticed in many areas of society, my paper will discuss “The Matthew Effect” in early childhood numeracy and the different levels of ability found in mathematical learning. There is a wide variety of achievement in Kindergarten due to many external and internal factors. My work illustrates how different learners (both high and low achieving) gain numeracy skills, and suggests different intervention practices educators may use to keep high achieving students engaged while the low achieving students gain ground.
The Committee on Early Childhood Mathematics convened by the national Research Council (2009) suggests that children’s performance and number sense in Kindergarten is linked to mathematics’ achievement in later grades (National Research Council, 2009). Along with the performance predictors of achievement, interventions geared toward early number sense help improve students’ mathematical learning outcomes. Currently not many studies have been conducted on students with MD or mathematical interventions in general, even though 4-7% of school age children experience MD (L. Fuchs, Compton, D. Fuchs, Paulse, Bryant & Hamlett, 2005).

The research of L. Fuchs et al. (2005) supports The Committee on Early Childhood Mathematics view that inventions help improve number sense. Fuchs et al. (2005) reported that “preventive tutoring” in reduced MD prevalence by 35%. These research findings suggest the earlier the intervention, the more success the interventions will be in increasing students’ math achievement, and in correcting areas of difficulty.

While students often become bored with subject matter if it is not targeted at their performance level, students with MD perform lower in a variety of areas. Most MD students struggle with beginning number sense concepts, and since early number sense is predictive of later math achievement, these weaknesses translate into later math concepts as well (National Research Council, 2009). Students with MD also struggle in number recognition. For example, students with MD may be able to count out how many “six” is, but when seeing the written number students cannot identify it (Gersten & Chard, 1999). Students with MD also struggle to differentiate number quantities even after instruction and well into Kindergarten, and cannot judge the amount in a small pile automatically (Ramineni & Locuniak, 2009).

As children continue in Kindergarten and first grade their weaknesses in number sense broadens into more areas. Students with weak performance and little improvement will continue to perform poorly. This poor performance affects new areas such as number combinations (3+3), and story problems as the Kindergarten progresses and moves into other grade levels as well. In first grade, students with MD struggle with verbalizing their procedure to enact math algorithms such as addition and subtraction, including regrouping. The weakness in regrouping has been linked to a previous misunderstanding of place value concepts. Due to the coexisting problems, students with MD also struggle with automatic retrieval of number facts (Jordan, Hanich, Uberti, 2003).

Students with MD tend to rely on backup strategies instead of automatic recall of simple number combinations, which their peers are using. The most common back up strategy used by students is finger counting, or manipulative use. This rarely benefits students with MD. In Gersten, Jordan & Flojo’s (2005) study when they chose to use finger counting they were wrong half of the time, when they used verbal counting and manipulatives they were incorrect one third the time. This can be correlated to the fact students with MD cannot organize their counting successfully (Gersten, et al., 2005).

Students that are performing above target also use backup strategies, but for a different reason. Siegler (1988) as mentioned by Jordan and Montini (1997) refer to students that perform on or above target due to back up strategies as “perfectionists” (633). “Perfectionists” perform either on target or above target but use back up strategies more often than their peers. Jordan & Montani (1997) believe this is due to “perfectionists” being less willing to take risks. However, students performing above target perform backup strategies more skillfully and successfully compared to students with MD.
The Matthew Effect is a possible unforeseen unintentional effect of educational intervention. Since educators agree that they should strive to shrink the education gap, it is important for teachers to find strategies that keep high achieving students engaged while bolstering the achievement of low achieving students. The goal of this study is to introduce ways for this to be accomplished in the area of number sense and early numeracy skills. The suggestions for practice presented in this paper are derived from my work in a Kindergarten classroom during the 2009-2010 school year, and the interpretation is aided by current literature on early childhood numeracy. The next section provides a summary of the practices suggested by the current literature and is followed by my interpretation of the data I collected on implementing interventions during the 2009-2010 school year.

Early Numeracy Interventions: A Literature Review

With deficits in several areas, research conducted on intervention strategies has been brief, but widespread. When instructing students with MD, there is a flow to the instruction that educators need to be aware of and implement. When instruction strategies follow this particular order Griffin (2007) noticed an increased understanding in early number sense. Educators should begin instruction using real world numbers with which students are familiar. For example, an educator could use cookies to have children understand how many a certain number is, decide who has more, or understand the concept of a half. In this way, students can see a relevant application and gain a concrete idea of a particular vocabulary or number.

While instructing, students should be given adequate time to discuss and talk using math words and concepts. Students should count aloud and/or explain the procedure they used, and verbally manipulate the problem. This gives students a stronger link between oral words, numerical symbols, and provides a strong foundation for math symbols. Once the concrete foundation for math language has been formed, educators can gradually introduce formal symbols while students use the language. This allows for students to have an understanding of the concept in their own words before symbols are introduced (Griffin, 2007).

Consequently, it should be noted that the key to enacting this flow is to start at the student’s level of current understanding. A student may not be able to discuss the process, but instead may need to begin counting with manipulatives before any new ideas are introduced. The instruction should also progress at the rate and order of understanding based on the student. For example, a student may be counting and from counting moves naturally to simple addition with manipulatives instead of the one more/ one less concept. The order suggested by this intervention design provides a rough framework, but requires educators to know and read their students as students advance (Griffin, 2007).

The previously mentioned intervention provides a blueprint for how to implement instruction for early number sense, but it does not provide specific strategies for what the instruction should entail. One of the major topics intervention should focus on is counting strategies. If students are not counting properly, they cannot form connections to higher level math concepts such as number combinations, more, less, and simple addition. When counting is done with an understanding of one-to-one correspondence a link is made between a problem and solution, which translates into a deeper understanding of math (National Research Council, 2009). To help students enact counting procedures, educators need to show them a variety of options for counting, and model proper counting procedures by guiding students through the “how” of counting. After students discover the “how” they should begin to explain counting and
other math concepts in their own words. While the educator introduces the math vocabulary and the student is asked to apply those to learning situations (Gersten et al. 2005). Just as students need to communicate, educators need to have open lines of communication with others as well. Keeping students, parents, and educators informed with the students’ specific performance has been shown to increase student achievement in math by .68 SD units (Baker, Gersten & Lee, 2002).

Another intervention strategy is the use of technology in the classroom. There has been a strong correlation between children’s academic achievement and computer activities. Children as young as three have benefited from technological activities. Computer games and technology can be design to solidify concepts that are related. In this way computer games can be considered a two way advantage. Computers, “fosters deep conceptual thinking and cognitive play” which benefits and enhances student achievement (National Research Council, 2009, pg 252). Computers also provide an alternative option to whole class instruction and worksheets, which appeals to different learners, and are more individualized for the student (Gersten et al., 2005).

Lastly, another intervention strategy researched is peer assisted learning. Peer assisted learning generally is defined as two students working together where one student takes on the roll of a mentor or tutor. In some cases, however, peer assisted learning can be two students learning about the same topic, but helping each other create a strong understanding and connections with the topic at hand. The benefits of peer assisted learning are widespread for all students. For students performing above target, they take on new role in the classroom and enhance their understanding of a topic by explaining it in different ways. For students performing below target, it helps them understand a topic better as their peers provide feedback. With this feedback and guidance there is a strong connection between peer assisted learning and students’ computational abilities, leading to a more solidified number sense (Baker et al., 2002).

The research provides valuable insight into math difficulties and early intervention. There also is a beginning discussion of what strategies work for different types of learners. What remains to be discussed is how to target instruction for learners above and below target level. Finding ways to gear instruction to all students in the classroom, and how to divide time between students will create an invaluable resource that will greatly enhance student achievement. The research is underdeveloped in terms of interventions for above target learners, and instruction time needed. Finding a way to accelerate achievement without increasing the achievement gap due to poorly targeted intervention methods will be developed as research increases in the area. It will also build upon current research and enhance instruction and achievement in the classroom.

The Program

The Kindergarten Number Sense Project is a pilot program designed by Professors Egan and Hengst in fall of 2009. The program is designed to provide Kindergarten students at Longfellow Elementary School with intervention techniques to help enhance and solidify math knowledge. These interventions take place during what the National Research Council (2009) describes as the critical years of math development. The Professors worked closely with six teacher candidates and teachers to create mini-lessons to help students comprehend math concepts. The teacher candidates used the new math curriculum, Math Trailblazers (© 2008, Kendall/Hunt), to guide the lesson directions. Each month a new set of objectives is listed by the Math Trailblazers text and teacher candidates designed their mini-lessons to reach those objectives, based on student ability level, and previous assessment data on the student. After
each mini-lesson was completed the teacher candidate noted the student’s progress or reaction to the lesson that day and modified their future lessons based on their observations. The Number Sense Project’s two main goals are (1) to enrich the teacher education experience at Augustana and (2) to positively impact mathematics learning among the elementary students. Teacher candidates, professors, and Kindergarten teachers also collaborated to create computer software for classroom use, which will be discussed later in the paper.

Kindergarten students were also assessed to monitor progress using two assessments, the Math Trailblazers’ assessment and the early childhood numeracy assessments developed by Kathy Richardson (2002) Counting Objects and Changing Numbers. The Math Trailblazers’ assessment reports on a student’s ability to count forward to thirty, backward from ten, cardinality (knowing the last number counted represents to total number in a set), and organization of counting. The Richardson assessments demonstrate a student’s ability to count a set of objects, count out a pile of objects, determine how many a pile has when one is added or taken away. Students also use simple addition and subtraction to change from one number to another, for example 5 to 7. That is, if a child is given a pile of 5 objects they are asked, “What is needed to be done to the pile to become 7 objects instead?” Below target learners are students who are in need of instruction in one or more areas on the assessments. A student is identified as “needing instruction” if they are unable to perform the task or struggles a great deal while attempting the task. Students performing on target are proficient in the areas of each assessment (that is if a child can perform a task with a high degree of accuracy.) Those performing above target (That is if a child can easily perform beyond what the assessment asks, for example a child is asked to count out 10 counters but counts to 30 instead) were proficient in all areas and had moved on to more advanced subject matter or higher grade level content. This paper enhances the discussion of different intervention practices and their effect on the achievement gap. The suggested practices provide the appropriate level of challenge for each child, but also to accelerate the learning of the students who struggle the most in mathematics.

Methods

The Kindergarten Number Sense project began in fall of 2009. Thirty two teacher candidates that were concurrently enrolled in the course, “Teaching Mathematics in Elementary School” worked in pairs to instruct triads of Kindergarteners as part of their course requirements. The pairs of teacher candidates were able to tailor lessons to meet the students’ needs as student were assessed and then grouped based on ability. Two-thirds of the students were assessed and videotaped in the beginning of August by the professors, and teacher candidates assessed the other third of the students in late August. Both groups were assessed using the Richardson (2002) Counting Objects assessment. These files were saved on a site that could be accessed by students of the course and professors. These files provided each student’s starting point to evaluate progress.

After the first term six teacher candidates were hired to continue working with the Kindergarteners, with three in each classroom. In the classroom focused on in this paper, the three teacher candidates worked with students either in pairs or individually three times a week, meeting with each pair or individual for fifteen to twenty minutes at a time. The teacher candidates were given the Math Trailblazers’ curriculum and activities as guides for the mini-lessons they planned and had the freedom to construct their own lessons from this based on what their student(s) needed. If an education student was having difficulty with an individual or a pair
of students, they were able to have another research assistant work with them to see if the Kindergartener worked better with another research assistant. This was done so that each research assistant worked with each student at least once, but each research assistant had several specific “focus students” while other students were rotated. Most of the time students rotated when pairs were switched due to ability level or progress, other times it was strictly based on a child responding positively to a particular teacher.

Two research assistants applied for funding from Augustana College and, after funding was granted, began to take video of their specific focus students. The video was later analyzed to note any specific phenomena beneficial to the research assistant’s topic. At the end of the year (May 2010) the student researchers did a final assessment on each student. The Math Trailblazers’ and Richardson (2002) assessments were both used; however, counting to 100 by ones and tens was added to the Math Trailblazers’ assessment. If students were able to complete all of the Richardson Counting Objects assessment they were also assessed using the Richardson Changing Numbers assessment which involved number recognition, understanding of number order, and addition and subtraction knowledge.

Beginning in June 2010, the two research assistants began to collect previous literature on their specific topic. This literature viewed used to provide background and enhance findings. After investigating previous research, the research assistants analyzed video from the 2009-2010 school year. The video was looked at for specific methods used by the teacher candidate or student that provided insight into their particular topic. The video was then coded noting the time and event that happened. In this case events focused on how students went about solving a problem, what strategies they used, and what was used to help students grasp concepts with which they were struggling. Frequent occurrences of behavior were investigated by watching all videos multiple times. The research was then synthesized to make a logical suggestion of methods to be used by teachers, and methods used by students.

Student Assessment Results

The following page contains a chart of the student’s assessment results at the beginning and end of the year Counting Objects, and Changing Numbers assessments.

<table>
<thead>
<tr>
<th>Scoring Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counting a given quantity: Are students able to count a set of objects using one-to-one correspondence?</td>
</tr>
<tr>
<td>Counting out a Quantity: Can students create a pile of objects when given a number?</td>
</tr>
<tr>
<td>One More/One Less: Can a student identify what number is one more or less than a given number?</td>
</tr>
<tr>
<td>Tells if more or less is needed: Can a student tell if more or less is needed to change the number?</td>
</tr>
<tr>
<td>Changes Number: Student successfully adds or takes away the correct amount to make the new number</td>
</tr>
<tr>
<td>Ready to Apply (A) Counts confidently and accurately/knows without counting</td>
</tr>
<tr>
<td>Needs Practice (P): loses track checks and rechecks/ knows some</td>
</tr>
<tr>
<td>Needs Instruction (I): Has difficulty with one-to-one /Guesses</td>
</tr>
</tbody>
</table>

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1 All assessments and scoring were based off of Kathy Richardson (2002) Counting Objects and Changing Numbers assessments. See references for full information.
<table>
<thead>
<tr>
<th>Name</th>
<th>Beginning Year Counting Objects</th>
<th>End of the Year Counting Objects</th>
<th>Changing Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>Counting a Given Quantity: To 12 (I)</td>
<td>Counting a Given Quantity: To 32 (A)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Counting a Quantity Out: To 5 (I)</td>
<td>Counting a Quantity Out: To 18 (P)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More in Sequence: From 5 (I-)</td>
<td>One More in Sequence: From 9 (I)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One Less in Sequence: From 9 (I-)</td>
<td>One Less in Sequence: From 13 (I)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More One Less out of Sequence: From 18 (I)</td>
<td>One More One Less out of Sequence: From 18 (I)</td>
<td></td>
</tr>
<tr>
<td>Jamie</td>
<td>Counting a Given Quantity: To 7 (I)</td>
<td>Counting a Given Quantity: To 12 (A)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Counting a Quantity Out: To 5 (I)</td>
<td>Counting a Quantity Out: To 9 (P)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More in Sequence: From 5 (I)</td>
<td>One More in Sequence: From 9 (I)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One Less in Sequence: From 9 (I)</td>
<td>One Less in Sequence: From 13 (I)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More One Less out of Sequence: From 10 (I)</td>
<td>One More One Less out of Sequence: From 18 (I)</td>
<td></td>
</tr>
<tr>
<td>Will</td>
<td>Counting a Given Quantity: To 32 (A)</td>
<td>Counting a Given Quantity: To 32 (A)</td>
<td>Tells if More or Less is Needed: Past 10 (A)</td>
</tr>
<tr>
<td></td>
<td>Counting a Quantity Out: To 18 (A)</td>
<td>Counting a Quantity Out: To 18 (A)</td>
<td>Changes Number: To 15 (A)</td>
</tr>
<tr>
<td></td>
<td>One More in Sequence: From 18 (A)</td>
<td>One More in Sequence: From 18 (A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One Less in Sequence: From 22 (A)</td>
<td>One Less in Sequence: From 22 (A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More One Less out of Sequence: Past 100 (P)</td>
<td>One More One Less out of Sequence: Past 100 (A)</td>
<td></td>
</tr>
<tr>
<td>Michelle</td>
<td>Counting a Given Quantity: To 12 (A)</td>
<td>Counting a Given Quantity: To 32 (A)</td>
<td>Tells if More or Less is Needed: Past 10 (A)</td>
</tr>
<tr>
<td></td>
<td>Counting a Quantity Out: To 9 (A)</td>
<td>Counting a Quantity Out: To 18 (A)</td>
<td>Changes Number: To 15 (P)</td>
</tr>
<tr>
<td></td>
<td>One More in Sequence: From 9 (A)</td>
<td>One More in Sequence: From 18 (A)</td>
<td></td>
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<td></td>
<td>One Less in Sequence: From 13 (A)</td>
<td>One Less in Sequence: From 22 (A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More One Less out of Sequence: From 18 (P)</td>
<td>One More One Less out of Sequence: Past 100 (A)</td>
<td></td>
</tr>
<tr>
<td>Brian</td>
<td>Counting a Given Quantity: To 7 (I)</td>
<td>Counting a Given Quantity: To 12 (P)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Counting a Quantity Out: To 5 (I)</td>
<td>Counting a Quantity Out: To 9 (P)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More in Sequence: From 5 (I-)</td>
<td>One More in Sequence: From 5 (P)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One Less in Sequence: From 9 (I-)</td>
<td>One Less in Sequence: From 9 (P)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More One Less out of Sequence: From 5 (I-)</td>
<td>One More One Less out of Sequence: From 18 (I)</td>
<td></td>
</tr>
<tr>
<td>Marie</td>
<td>Counting a Given Quantity: To 21 (A)</td>
<td>Counting a Given Quantity: To 32 (A)</td>
<td>Tells if More or Less is Needed: Past 10 (A)</td>
</tr>
<tr>
<td></td>
<td>Counting a Quantity Out: To 18 (A)</td>
<td>Counting a Quantity Out: To 18 (A)</td>
<td>Changes Number: To 15 (P-)</td>
</tr>
<tr>
<td></td>
<td>One More in Sequence: From 18 (P+)</td>
<td>One More in Sequence: From 18 (A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One Less in Sequence: From 22 (P+)</td>
<td>One Less in Sequence: From 22 (A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More One Less out of Sequence: To 20 (P)</td>
<td>One More One Less out of Sequence: Past 100 (P)</td>
<td></td>
</tr>
<tr>
<td>Mike</td>
<td>Counting a Given Quantity: To 7 (A)</td>
<td>Counting a Given Quantity: To 32 (A)</td>
<td>Tells if More or Less is Needed: Past 10 (A)</td>
</tr>
<tr>
<td></td>
<td>Counting a Quantity Out: To 5 (A)</td>
<td>Counting a Quantity Out: To 18 (A)</td>
<td>Changes Number: To 9 (P)</td>
</tr>
<tr>
<td></td>
<td>One More in Sequence: From 5 (A)</td>
<td>One More in Sequence: From 18 (A)</td>
<td></td>
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<tr>
<td></td>
<td>One Less in Sequence: From 9 (I)</td>
<td>One Less in Sequence: From 22 (A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One More One Less out of Sequence: From 18 (P)</td>
<td>One More One Less out of Sequence: Past 100 (P)</td>
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</tbody>
</table>
Targets to be Reached as Defined by Kathy Richardson and *Math Trailblazers*

- Can students use numbers to describe and order sets of objects?
- Do students have a developmentally appropriate strategy for problem solving?
- Can students identify, describe, create, copy, extend, and compare patterns?
- Can students develop meaning for the part-part-whole relationships of the benchmark number 5 and 10?
- Can students count backward from the number 5 and 10?
- Can students use comparison language to describe number relationships?
- Can students estimate a quantity of objects when given a referent amount of the same object?
- Do students show understanding of addition and subtraction operations?
- Do students understand the meaning of “equal”?
- Can students count a given quantity?
- Can students count out a given quantity?
- Can students identify one more or one less than a given number

Organization of Counting

Both the Richardson and the *Math Trailblazers*’ assessments have students count a particular quantity. The Richardson assessment elaborates on this by having the student count out a specific pile of counters given to them by the teacher. Later in the assessment students create a specific number of counters. Depending on students’ ability level the Richardson *Counting Objects* assessment has students count 32, 21, 12, or 7 counters, then depending on the amount a student gets correct they are asked to count out a pile of 18, 9, or 5. The *Math Trailblazers*’ assessment asks that students count a pile of 30. *Counting Objects* has a particular option that allows the assessor to mark the way the child organizes their counting (Lines up, Looks, Points, or Moves). Out of the 7 students who are focused on in this study 3 were able to count to 20 or higher at the beginning of the year. Each of the three moved the objects they were counting. These students were marked as ready to apply (A) or practice plus (P+), meaning they had either total mastery or sufficiently mastery of numbers 20 and higher. The 3 students who looked or pointed to organize their counting were unable to successfully count out piles past 10. These students were marked as in need of instruction (I, I+, I-) or practice (P, P-), meaning they had little to no understanding for numbers up to ten. The students who used moving or lining up as a counting strategy were at target or higher at the beginning of the year, and those who pointed or looked were below target at the beginning of the year.

Students who did not organize their counting by moving or lining up received instruction on how to organize their counting. The following is a recorded event of an interaction with instruction of how to organize counting.

*A student was given a group of 12 objects to count. Ashley was performing below target and was working on counting to the number 20. However, she was unable to organize her*
Valentine 10
counting so the teacher candidate decided to work on her organization skills before counting to the number 20. Ashley was usually correct in her counting to the number ten, but without organizing her counting she skipped counters or counted a counter more than once, which was weakness in her “one-to-one” counting skills (realizes that one counter represents one number only).

Teacher: Can you count how many we have here?
Ashley: (without moving the counters, points) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10...Ten
Teacher: Do you want to recount to make sure
Ashley: (without moving the counters, points) 1, 2, 3, 4, 5, 6, 7, 8...Eight
Teacher: O.K. this time when you count I want you to take one from this pile and put it in this box until you’ve moved each one.
Ashley: (picking up one counter at a time and placing it in a box as she says each number) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12...twelve

The mini-lessons that followed had Ashley counting higher and higher piles all while placing objects in a new area. Eventually moving counters became second nature to her and she steadily gained proficiency in counting ability. All the students that received counting instruction were able to count a larger group of objects quickly after instruction was given. At the end of the year assessment 7 out of the 7 students used moving or lining up as a counting strategy, and of these 7, 5 of them were ready to apply past 32, and the other 2 were ready to apply past 10. By the end of the year 71% were at or above target level, as opposed to the 41% at the beginning of the year. However, organization of counting cannot be directly linked to increasing ability, as all students will naturally progress throughout the year. This suggests that counting strategies play a role in increasing child’s counting ability. As shown with Ashley’s steady improvement counting strategies can influence student achievement levels.

Number Combinations

As students progress through the Math Trailblazers curriculum, they encounter different math tasks they need to complete to help solidify their early numeracy skills. One area that Math Trailblazers focuses on is number combinations, which is simple addition and subtraction, specifically with ways to make ten and one more/one less than a given quantity. Trailblazers’ proposed activities to help students increase knowledge in this area. When encountering these different problems students have different strategies they use when executing the problem. While in higher level math automatic recall is beneficial for addition problems, students in lower level grades are encouraged to use back-up strategies, ways of double checking their answers, in other words another way of arriving at a solution, to solidify the basic number combinations. In the Kindergarten classroom I observed a different level of competency in two different types of back- up strategies: finger counting and use of previous knowledge of math facts. Different ability level types also had different preferences of strategy to use. Teacher prompted questions and modeling can greatly help a student become competent in a strategy that is in their ability level.

The video described below shows how a student performing below target student struggled with using finger counting and the teacher provided instruction on how to guide the student to use finger counting correctly. In this video Ashley is using her fingers to figure out one more of a certain number.
Ashley is sitting trying to figure out what one more than 5 is using her fingers as the teacher suggested. She keeps coming up with the number 5 as the final answer. The teacher repeats the question as, “What is 5 and one more?” Ashley again attempts to use her fingers by holding up 5 fingers in one hand and counting out fingers with the other. However, she is unable to count the one more since she is using one hand for counting. The teacher candidate offers her hand with 5 fingers held up and 1 finger in the other hand. Ashley proceeds to count all the fingers and come up with 6. The teacher continues to use her fingers as manipulatives instead of the child using her own fingers.

The teacher’s use of fingers was beneficial in that it helped increased Ashley’s accuracy with the answers. However, it did not help clarify the understanding of more, or auto recall of one more facts for Ashley.

The previous event can be contrasted to an above target student using finger counting. When working with Will, a teacher was assessing his simple number combination knowledge. Most of the time Will was able to auto-recall, but when he was unable to remember the answer he frequently used his fingers, but in a different manner than Ashley.

Will was working on reviewing his doubles number combination (two of the same number addition, 2+2, 3+3 etc...) ways to make ten, and discovering ways to make 11 in this particular lesson. He was able to automatically recall almost all of the problems asked of him, but when asked what 5+4 was he was unable to auto-recall. Without teacher prompting he began to use his fingers. He held up five fingers and then proceeded to put up 4 fingers and counted on “6, 7, 8, 9” reaching the correct answer of 9.

Will had counted on using his fingers instead of trying to combine his fingers, which allowed him to keep better track of his fingers, and reach the correct answer since he didn’t have to use one hand for counting. This method of finger counting was used by most of the above target and target students in their videos as well.

These two videos provide evidence suggesting that above target and target learners use back-up strategies more efficiently and correctly than their peers, who are below target. However, this also provides documentation of how to correct incorrect back-up strategies in below target learners. Will’s organization of finger counting, counting on, helped him correctly answer a question and with much more ease. The counting on strategy could help establish a better one-to-one ratio for counting, as well as a more organized counting method. One way I used to teach this idea was through the use of dominos. When instructing children with number combinations, I would have them count out one side of the domino, and then pause, then continue counting on the other side of the domino. This allows them to practice their counting on skills, and with teacher encouragement, a student could transfer this over to their finger counting. Encouraging students to count on and use fingers as a backup strategy could be beneficial to accuracy with simple number combinations, according to the data collected.

Students that are performing above target can also be challenged to use their background knowledge to help answer simple arithmetic combinations; this can be done by the teacher asking appropriate questions. Other times students are able to use their background knowledge without teacher prompting and this should be encouraged as it helps build abstract math concepts for later grades.
When working with Michelle, an above target student, who had already mastered number combinations to make 10, a teacher is working on ways to make ten and number combinations with answers greater than ten. The first question Michelle approaches is 10+10 to which she answers 20 automatically. The teacher asks, “How did you know that?” Michelle replies, “1+1 is 2 so 10+10 is 20, the 0 doesn’t do anything.” When Michelle gets stuck on a particular problem (9+3) the teacher asks if Michelle knows what 9+1 is, Michelle answers correctly, and the teacher asks what is left over, Michelle responds with 2, and the teacher asks what is 10+2, Michelle answers 12. The teacher then repeats the original question and Michelle correctly answers that 9+3=12.

It is important to challenge above target learners so they are engaged. By having Michelle think outside the box, not only was she advancing, she was also engaged while doing it. Since she was struggling with a problem, she was involved in her learning and was able to learn a number combination. If approached using the theories of Dewey and Kohler, having students call on their previous knowledge allows them to solidify basic facts and extends their thinking; it also allows them to approach a problem in different ways which aids in problem solving. Dewey argued that unless a student personally struggled with the problem they are not learning, rather committing something to memory. Kohler stated that the learner had to have all pieces of the puzzle and use them to figure out the problem at hand (Phillips and Soltis, 2004). These two theories support the claim that having students use background knowledge, to solve a new problem enhances learning. The videos show progress and accuracy when students are questioned with higher level thinking questions, which suggests that above target students should be challenged with abstract thinking questions. My work in the classroom exposed that higher level questioning will engage, challenge and enhance above target level students’ learning.

Peer Assisted Learning

The research Baker et al. (2002) conducted suggests that students benefit from peer-assisted learning and my data supports that to some extent. According to my data certain ability group pairings are not beneficial in the sense they do not enhance student understanding or help student progress. When constructing peer groups a teacher has to be incredibly careful, as putting two students of the same ability may not always work to the advantage of either student. My data suggests that when pairing students, two below target students should not work together, but any other combination of students seems to be beneficial and can foster growth. The following are three examples of different pairings of students. The first is two students Jamie and Ashley, who are performing below target in number recognition and counting out quantities. The second one on target student, Mike and one above target student, Marie, and the third is two above target students, Will and Michelle.

Jamie and Ashley are working on a penny jars and estimation game taken from the Trailblazer’s text. The jars have the number of pennies on one side and a blank on the other. After a child guesses the jar is turned so they can see the number. The child is then asked what that number is, and to count the pennies in the jar, so their number recognition skills are used as well. During the activity Jamie would attempt to help Ashley but her instructions led Ashley more astray, and Ashley’s direction misled Jamie as well. Jamie would begin by telling Ashley to move more pennies into the jar. They
were working on the number 12, and as per instruction there were 12 pennies in the jar. Each student was taking turns counting out the number of pennies; however, the two did not take turns. Jamie would often interrupt Ashley’s counting and place another penny in the jar. Ashley would accept this as correct, and count that as part of the total. Leading her to believe the number 13 was represented numerically by the number 12. When it was Jamie’s turn to count Ashley would let her count to 12 but would add one more after due to the previous misunderstanding. When sorting out piles of a set number Ashley would model Jamie’s counting, this was done incorrectly. At the last part of the activity the two were asked to guess how many were in a jar. Jamie would repeat Ashley’s guess and Ashley would repeat Jamie’s guess, depending on who went first. The two would model their guesses off of each other and not spend time analyzing the pennies before guessing.

Mike and Marie were working on the computer with another Number Sense team member, and were working on some word problems. Using the Word Problem software Marie was focused and read the question while looking at the computer and used the manipulative on the program to get an answer when stuck. Marie was answering all the questions quickly and accurately, using the various manipulatives the software provides, but Mike was losing focus, playing with objects around him, and often more concerned with making shapes with the manipulatives then getting the correct answer. However, after Marie announced she was beating Mike, he became more alert and concentrated on the problem. His accuracy increased and his concentration improved, as he stopped making pictures with the. Marie was also encouraging him and helping him pay attention and correcting his wrong answers and overall accuracy with the game.

Will and Michelle were working on their different shapes, and Michelle was struggling making a diamond on the geoboard. Instead of telling her how to do it Will was encouraging his classmate and giving some very detailed pointers to help her succeed. Suggestions like, “move that down a little” or, “how about putting that here?” Will took on the role of a teacher and guided Michelle to the correct shape. Later, Michelle was counting the sides of an octagon and Will also came up to help her count the sides. Michelle also corrected Will when he was using his shapes as he misspoke and said trapezoid instead of triangle. Michelle laughed and said, “Are you sure that’s a trapezoid?” Will quickly realized his mistake and self corrected and correctly identified the shape as a triangle.

These three events highlight some of the positives such as meeting the learning target for the day, and making new connections, as well as negatives such as confusion for their partner. The vignettes also provide suggestions of good grouping strategies based on ability. Firstly, the interaction between Ashley and Jamie was not successful since they did not accomplish the learning target of the lesson as outlined by Math Trailblazers because neither one had the skills to help the other understand the problem. Their guidance did not help their partner and confused both of them. According to this, placing two below target students in a group appears to hinder students rather than help.

Marie and Mike worked well as a pair since their word problem ability was solidified. Marie’s successes pushed Mike to try and succeed to be the best he could be. Because of Marie’s achievement and motivation Mike was able to stay on task and get more answers correct. This
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grouping works well and could be beneficial to students who are easily distracted or above target learners, as it allows them to take on a new role in their learning.

Will and Michelle also worked well since they were modeling the teacher. They used the same guiding questions I would use, and never provided the direct answer. Will’s questions challenged and clarified ideas for Michelle, and Michelle’s questions prompted Will to look at his work again, and double check himself. Both of the students received a sense of accomplishment for helping their classmate. They also were challenged to think in a different way to create the guiding questions for their classmate. This enriches and enhances their learning, and gives them multiple perspectives on one concept.

Technology

My videos indicated that technology can be beneficial to all learners and if designed correctly many computer programs can be altered to meet student needs. One game that was beneficial to students struggling with number order and counting to 20, and as such were performing below target, was Line ‘Em Up. In this game students were given a line with spots for the numbers 1-20 with certain numbers on their appropriate place on the line. Students then had to click loose tiles and place them in the appropriate spot on the line. This proved beneficial to students who were struggling with number order, one more/one less, and students learning to count on from particular numbers. I frequently played this game with Ashley, and other students below target level. The following demonstrates how Ashley began to understand the concept of one more due to the game.

*Working with Ashley using Line ‘Em Up she has come to the number 16 and cannot figure out where it belongs on the number line. She begins to count from the very beginning in order to try and figure out where 16 belongs. I prompt her by asking what is one more than 15, which has already been placed on the line. She doesn’t react right away, due to not understanding the word more (Ashley has a language delay, and struggles with expressing words, or comprehending abstract ideas as they are presented). I rephrase the question and ask what is after 15 and she places the 16 after 15. So I reiterate by repeating 16 is one more than 15.*

While Ashley still wasn’t performing above target at the skill of recognizing what value is more or less than a given value the end of the year, her end of the year assessment showed improvement in the skill of identifying a value which is one more than a given values. She was labeled as an “I-“in the one more category and by the end of the year she was a “P+“ in the one more category. While student growth can be attributed to a variety of factors, it is reasonable to conclude that the experience with technology contributed to growth as well. This is due to natural development, but also technological enhancement as well. Since she was able to make a tangible connection and see how a number could be one more, she was able to more easily understand the concept of “more.” Computers provide a high level of engagement, and tangible representations of more abstract math ideas. This helps create strong connections between

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3 As noted in page 6 of this paper, ready to apply (A) or practice plus (P+) , meaning they had either total mastery or sufficiently mastery for the particular skill. In need of instruction (I, I+, I-) or practice (P, P-), meaning they were unable to complete the task or struggled greatly while completing the task.
abstract and concrete which benefits low achieving learners who cannot visualize abstract
concepts such as more.

For above target learners the computer software gives educators the option to change the
level of difficulty for their students. Since it can help individualize instruction for the student,
this helps all students progress at the rate they need to without excluding any. My research
suggests that technology, due to its ability to be individualized, is a promising pathway for
exceptional learners. Students can pace themselves at a rate that is comfortable to them, and if
they are competent with the program they can even discover concepts on their own, leaving the
teacher with more time to address other students. Technology can be targeted for all learners to
help their achievement, and as observed in the Kindergarten classroom, shows a promising way
for enhancing all students’ learning.

Conclusion

In the beginning of the school year, all students were assessed using the Richardson C1:
Counting Objects assessment. Of the students focused on in this study only 3 of them were on
target or above target level. Will was above target when starting kindergarten, and progressed as
such throughout the year. At the beginning of the year, he was ready to apply one more/one less
past a hundred. At the end of the year, in his assessment video, he demonstrated knowledge of
the tens and ones place, by using digiblocks to show the number 55. He also corrected
all questions in the one more one less past a hundred. He mentally calculates 1 less than 300
correctly in the end of the year video.

Michelle started out at target level, but progressed to above target very quickly. By the
end of the year she was able to complete the Hundred and beyond section of the Richardson C1:
Counting Objects assessment, and only made the mistake of 300 and one less as 209. She also
demonstrated her knowledge of place value by making 33 with digiblocks, and then proceeded to
double check by counting each block in the video.

By the time the Number Sense Project was in its 4th month Michelle was performing at
the same level as Will, so the two of them were paired together. Knowing that Will was above
target when he started the year, and that Michelle had progressed, most of my lessons with them
were on the computer, or based on 1st grade level material. Technology proved to be the best
method to give Michelle and Will the instruction they needed, as it allowed me to challenge
them. I frequently used Balance Math with them to work on simple addition or subtraction, and
later on in the year I also used number line math. Those two computer activities also were used
with students below target, but when using them with Will and Michelle, I would make one side
equal a particular number and have them take turns figuring out different number combinations
to make the number on the other side. The idea of having students use the materials in front of
them to solve a problem is an educational philosophy that works well for above target learners.
Technology provided an excellent way to do this, and also provided a way of making the
students grapple with a challenge, thanks to custom settings. Another method that seemed to
benefit Michelle and Will, was working together. When one of them wasn’t there for “Math
Time” the other seemed disengaged, and was less willing to do work. I asked Will why he was
sad, and he said because he didn’t have anyone to help, or play with that day. In my opinion, the
two provided feedback for each other, and liked correcting the other, or competing.

Another pair of above target learners was Marie and Mike. Marie started out as an on
target learner, and was ready to apply to number past 20 in all areas. By the end of the year she
was able to complete both the Richardson C1: *Counting Objects* and C2: *Changing Numbers* and was ready to apply in all areas. Mike, however, started off as an in need of instruction in all categories. He was unable to organize his counting, and based on his constant movement in the first video of the year, he found it difficult to sit still for most activities. By the end of the year, however, he was ready to apply in all areas of Richardson C1: *Changing Numbers* and practice plus for the Richardson C2: *Changing Number* assessment.

Mike was instructed on how to organize his counting, and once he had mastered that, he was performing at the same level as Marie, in terms of counting out piles. However, he progressed with one more and one less very quickly, and the two were working on the same concepts for a majority of the year. Due to Mike’s restlessness, he would often shout out answers before thinking them through, and Marie often second guessed herself. The pair mainly worked on number combinations, and back-up strategies. The major back-up strategy used was a number line. This was provided to them via number line math and a number line tape measure. When they were presented with an addition question, they were encouraged to use the number line to make sure they were correct. They used the number line more and more habitually, and it greatly helped solidify their one more/one less, ways to make ten, and doubles number combinations. At the end of the year assessments, both of them were able to change numbers easily and could give all the ways to make ten. They also could easily answer doubles addition questions, and one more/ one less from memory. These were all ideas solidified by checking with the number line, and later became automatic recall.

At the beginning of the year, Ashley, Jamie, and Brian were all students that were in need of instruction on various sections of the assessment. When they counted they either looked at the counters, or pointed at them without moving. They lacked one-to-one, and counted past or miscounted, when counting out a given quantity or asked to make a certain quantity. In the assessment video of Brian, he is unable to figure out which objects he has already counted and counts some chips multiple times. They had rote counting skills but did not associate that each number said related to one object, so they could not differentiate between big or large quantities so estimation was impaired. In the assessment of Jamie, when given a smaller pile of counters, she guesses a higher number.

Ashley, Jamie, and Brian were all not achieving target level with counting out piles of a particular quantity, and would frequently miscount or count past. Each one of them was instructed in organization of counting. Most of their activities consisted of moving chips from one pile to another, to begin to understand one-to-one and how to organize counters. When Ashley would hit the correct number she needed to count out, I would put my hand down and say stop so she understood asking for 10 counters meant to count out 10, and not count all of them. After they were instructed in how to count, the highest number they could count to increased. They also were able to estimate better, and understand quantities differentiation, which pile was bigger, smaller etc… Organization of counting improves a students’ knowledge of one-to-one and that has an effect on other areas of childhood numeracy. Having students that are below target practice how they organize their counting can be a quick remediation in some areas of difficulty. This should be one of the first efforts taken to help students with MD.

These four categories provide some insight into supplemental instruction ideas to help students be challenged, and get the supports needed to achieve in mathematics. Technology supports should be encouraged for all learners. Back-up strategies should be used by students, and then gradually lessened. Organization of counting can help correct errors in one-to-one thinking, and other areas of math. Peer learning should be supported with the proper group
composition. There are other areas to be illuminated on as well, such as time (how much should a teacher give to each student)? How to increase depth of knowledge, but not overwhelm students with new subject matter too soon? Lastly, is there an ideal pairing of students that will help foster the most learning? All of these practices and questions, when examined in greater detail, have the potential to provide individualized learning experiences for each child. The research and previous literature suggests there is a way to eliminate the “Matthew Effect,” and provide meaningful, challenging instruction. If implemented properly, these ideas can help each student progress at their ideal rate, while still giving the supports each learner needs.
References


