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Effective Strategies for Increasing Basic Math Fact Fluency

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An Action Research Report

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Abstract

The action research study was conducted to focus on improving math fact fluency through the teaching of strategies. It was done in a small group setting with second and third grade students at a suburban school in Minnesota. These particular students receive Title I math intervention 30 minutes a day because they are considered high risk for not meeting the grade level targets in math. Pre-assessment data were collected using student feedback forms to determine their feelings toward math fact practice and baseline assessments to determine their math fact fluency ability. After the pretests, they completed activities to practice each addition strategy for 10 minutes a day for one to two weeks before being introduced to a new strategy. At the completion of the study, the students again completed the feedback form and took the math fact post-test to determine if their fact fluency improved. The results from the feedback forms indicated that the students felt they were able to use addition strategies effectively after the intervention period. The addition fact post-test also indicated that many students improved their addition fact fluency; however, a possible next step would be to lengthen the duration of the study to see if it could have a greater impact with more students.

Keywords: math fact fluency, addition strategies, repeated practice

Throughout my teaching career I have personally observed that when students do not know their basic math facts, it can be a major hindrance for them to learn more advanced or multi-step skills in math. I have taught middle school math, fifth grade general education, and Title I math, and in all three of these settings I have witnessed that students with poor mathematical fluency struggle to develop the skills necessary for more complex math tasks. For example, it is quite challenging for students to understand multi-digit subtraction with regrouping and compute accurately if they do not already have automaticity with their basic subtraction facts. Furthermore, when students do begin to grasp the concept of regrouping but do not know their facts, they often get the answer incorrect because they make a basic calculation error somewhere in the problem even if they understand the process of regrouping. I have chosen to implement specific math strategies to improve mathematical fact fluency for my second and third grade students.

Codding, Chan-Ianenetta, Palmere, and Lukito argue, "Fluency in basic mathematical skills is essential for the success of students in primary education because it serves as a foundation for mathematical applications…" (as cited in Smith et al., 2011, p. 248). In addition, "Without the ability to retrieve facts directly or automatically, students are likely to experience a high cognitive load as they perform a range of complex tasks" (Woodward, 2006, p. 269). Furthermore, the National Council of Teachers of Mathematics (NCTM) states that fluency in computation and knowledge of math facts are critical components of national math standards (Smith, Marhcand-Martella, & Martella, 2011).Therefore, it is crucial that students should be able to automatically retrieve their math facts in order to be more successful with complex math skills.

The fact fluency study was done in a small group setting with second and third grade students. There was one group of five second-grade students, four girls and one boy; one group of four third-grade students, two girls and two boys, and one group of three third-grade students, two girls and one boy. These particular students receive Title I math services because they are considered high risk for not meeting the grade level targets in math. They come to me for math intervention instruction 30 minutes a day for four days per week. My classroom is in a suburban school in Minnesota. None of the students in these groups are currently on a math Individual Education Plan (IEP). Although my school qualifies for Title I federal funding based on the percentage of our school that receives free or reduced lunch, the students are only selected for this program based on their academic need regardless of their socioeconomic status.

Through this study, the students participated in math fact fluency interventions. The students began with a basic math fact pretest to see which of the following fact strategies they already used accurately: Counting On, Doubles, Doubles +1, Ten Facts, and "Magic Nines." After the pretest, they completed activities to practice each strategy for 10 minutes a day for one to two weeks before being introduced to a new strategy. After all of the strategies had been taught and practiced repeatedly, the students took a basic math fact posttest to see if their fact fluency improved.

In recent years there have been far too many students that do not master their basic math facts. In order to increase math fact fluency skills, a study was done in the previously stated setting to focus on this question: What impact does strategy instruction and timed practice have on math fact fluency among primary students? It is my desire that through focused strategies and repeated practice, students will increase their math fact fluency through this study.

Review of Literature

Many students in America are struggling to meet grade level standards. According to the 2005 National Assessment of Educational Progress (NAEP), 64% of 4th-grade students and 70% of 8th-grade students did not demonstrate grade-level competency in mathematics skills (as cited in Poncy, Skinner, & Jaspers, 2007). In studying the current literature on strategies for teaching basic math fact fluency, two main approaches to basic facts come to light: memorization (Smith et al., 2011), and teaching math fact strategies (Woodward, 2006). Research demonstrates that the most effective approach actually integrates strategy instruction with frequent timed practice drills (Woodward, 2006).

Mathematical fluency is a critical skill for overall math achievement because improving fluency with basic math facts frees up cognitive resources that can be applied to learning tasks that are more complex (Poncy et al., 2007). For example, a student who can respond automatically to basic multiplication facts will have more resources to use toward gaining new skills necessary to complete more advanced computation problems such as multiplication of two digit numbers(Skinner, as cited in Poncy et al. 2007). There are multiple effective strategies available to help students master their basic math facts that will in turn increase mathematical competency, but research indicates that the most effective approach integrates strategy instruction with frequent timed practice drills (Woodward, 2006). Throughout this literature review the definition of mathematical fluency will be clarified, the importance of mastering basic facts will be presented, and multiple math fluency interventions including traditional and strategy-based methods will be examined.

Defining math fluency and effect on achievement

The definition of mathematical fluency can be explained in slightly different terms. Poncy et al. states, "In addition to responding accurately, mastering basic math facts requires the ability to recall the facts quickly and with little effort. Haring and Eaton (1978) refer to this as fluency, while others (e.g. Hasslebring, Goin, & Bransfored, 1987) refer to this as automaticity" (as cited in Poncy et al., 2007, p. 28). However, Smith et al. (2011) describes the term in a slightly different way and define fact fluency by stating that by the spring of second grade, students should know the basic combinations of addition and subtraction. Furthermore, they argue that at the conclusion of second grade, students should be fluent in adding two-digit numbers. In addition, Common Core standards for second grade state that second graders need to "Fluently add and subtract within 20 using mental strategies. By end of grade 2, know from memory all sums of two one-digit numbers" (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2015). For students to be fluent in mathematics, they should be able to recall basic math facts with speed and little effort, as well as add two-digit numbers in an efficient manner by the spring of second grade.

The National Council of Teachers of Mathematics (NCTM) states that fluency in computation and knowledge of math facts are critical components of national math standards (as cited in Smith, Marhcand-Martella, & Martella, 2011). Furthermore, Codding, Chan-Ianenetta, Palmere, and Lukito argue, "Fluency in basic mathematical skills is essential for the success of students in primary education because it serves as a foundation for mathematical applications…" (as cited in Smith et al., 2011, p. 248). These authors agree that increasing math fluency can increase the motivation and effort of students. Finally, Wong and Evans declare that students

cannot complete higher-level math skills if there is not an automatic recall of basic facts (as cited in Smith et al., 2011). All of these claims from various authors agree that math fact fluency is indeed an essential element to overall math success.

Drill & Practice Strategies for Improving Fact Fluency

One approach effective for improving math fact fluency is the drill and practice technique. Poncy et al. states, "Students who are responding automatically typically have less anxiety in math due to the lack of effort required and the increased level of success" (as cited in Smith et al., 2011). Mong and Mong (2010) declare that an effective drill and practice method is Cover-Copy-Compare (CCC). CCC is a valuable intervention intended to address skill deficits in mathematics, and it is specifically designed to improve both accurate and fluent responses (Mong & Mong, 2010). The students first look at a model of the math problem with the answer, then cover the problem and answer, next they record the problem with the answer, and finally, they uncover the problem and answer to compare the answer (Burns et al., 2010). "Overall, CCC has been cited as a pragmatic intervention that has been effective in addressing mathematics skill deficits…" (Saeker et al., as cited in Mong & Mong, 2010, p. 274). Furthermore, CCC has been found to be effective for students with low *digits correct per minute* (dcpm) but less effective than traditional timed practice for students already nearing the fluency level with their computation skills (Codding Eckert et al., as cited in Burns et al. 2010). The CCC intervention is another effective strategy that should be considered when working with students to improve fluency in mathematics, especially for students that have low dcpm scores.

Another useful method for achieving mathematical fluency is Detect, Practice, and Repair (DPR). Poncy et al. (2013) declare that this technique is an effective group-oriented drill

and practice method. This particular strategy involves a set of procedures designed to individualize math fact practice while in a classroom setting, and it targets a specific basic fact operation. “DPR consists of three activities: (1) the detect phase, (2) the practice phase using Cover, Copy, and Compare (CCC), and (3) the repair phase consisting of a 1-min math sprint (i.e., explicit timing procedure) with self graphing” (Poncy, Fontenelle, & Skinner, 2013, p. 218). The detect phase involves a timed pre-test to identify items that the students will need to practice. After the detect phase is completed, each student identifies the first five uncompleted problems on the pretest and uses those targeted facts in the next step, practice. In the practice phase, CCC procedures (Skinner et al. 1989) are used to repeatedly practice the five identified facts until they complete all 25 items. Finally, students complete the repair phase, which consists of a timed procedure on an alternative form of the assessment. Student results on this math sprint are totaled and graphed by every student. This DPR procedure shows promise for use in classroom settings, as this study indicates that the procedure is an effective method to differentiate math fact instruction for a large group of students at varied achievement levels.

A third strategy for improving math fact fluency is the taped-problems (TP) intervention. McCallum, Skinner, Turner, and Saecker (2006) state that with the TP intervention the student listens to a recording of a person reading a series of math facts and is told to try to write the correct answer before the recording gives the answer. If they answer incorrectly, they need to cross out the incorrect response and write the correct answer. “The TP intervention is an easily implemented, low-tech intervention for increasing math fact fluency” (McCallum & Schmitt, 2011, p. 280). The TP intervention is created so that it can be adjusted to the particular needs of a student or group of students, and little teacher involvement is necessary beyond providing

materials. Furthermore, Poncy et al. (2007) declare that although CCC and TP procedures both improved the student's math fact accuracy and fluency, TP was more effective because it took less time to implement with students.

An Integrated Approach for Improving Fact Fluency

A second successful approach for improving mathematical fact fluency involves integrating specific mathematical strategies with the timed practice. Codding et al. (2011) declare that strategy instruction or nontraditional delivery resulted in larger effect sizes on fluency than not involving these factors. Another study notes that students who receive strategy instruction became significantly more accurate when asked to complete a transfer task (Tournaki, 2003). Furthermore, Cumming and Elkins also suggest a middle ground position for teaching facts that involves integrating strategy instruction with frequent timed practice drills (as cited in Woodward, 2006). Results in recent studies show that instruction in strategies alone does not necessarily lead to automaticity, and frequent timed practice is crucial. However, the strategies are necessary to help increase a student's flexible use of numbers (as cited in Woodward, 2006). It is evident that an integrated approach to fluency that involves strategy instruction and timed practice is effective for increasing math fact fluency.

When using strategy based instruction for math fact fluency, it is important to follow a sequence of relationships.

Isaacs and Carroll (1999) suggested the following steps for addition and subtraction facts:

1. Basic concepts of addition; direct modeling and 'counting all' for addition

2. The 0 and 1 addition facts; 'counting on'; adding 2

3. Doubles (6 + 6, 8 + 8, etc.)

4. Complements of 10 (9 + 1, 8 + 2, etc.)

5. Basic concepts of subtraction; direct modeling for subtraction

6. Easy subtraction facts (-0, -1, and -2 facts); 'counting back' to subtract

7. Harder addition facts; derived-fact strategies for addition (near doubles, over-10 facts)

8. 'Counting up' to subtract

9. Harder subtraction facts; derived-fact strategies for subtraction (using addition facts, over-10 facts) (as cited in Crawford, n.d., p. 8).

Crawford (n.d.) also states that if you teach students the facts in a logical order and stress the relationships, it will be easier for them to remember.

The Common Core Standards also emphasize the importance of students learning strategies first and then later knowing the facts from memory.

The grade 1 Standards for Mathematical Practice require students to do the following:

Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. Use strategies such as counting on; making ten (e.g., 8 + 6 = 8 + (2 + 4) = (8 + 2) + 4= 10 + 4 = 14); decomposing a number leading to a ten (e.g., 13 - 4 = 13 - (3 - 1) = (13 - 3) - 1 = 10 - 1 = 9); using the relationship between addition and subtraction (e.g., knowing that 8 + 4 = 12, one knows 12 - 8 = 4); and creating equivalent but easier or known sums (e.g., adding 6 + 7 by creating the known equivalent 6 + 6 + 1 = 12 + 1 = 13) (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2015).

The grade 2 Standards for Mathematical Practice require students to "Fluently add and subtract within 20 using mental strategies. By end of grade 2, know from memory all sums of two one-digit numbers" (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2015). In the Common Core standards, there is a progression from conceptual understanding with strategies to becoming fluent and knowing the facts from memory. Therefore, it is necessary to first build a basic understanding of the addition and subtraction concepts before moving onto timed practice.

Somewhat relatedly, the Siegler study (Tournaki, 2003) states that the addition strategy that is used most often and is most efficient is minimum addend counting, where students determine which is the larger addend and count on from that cardinal value the number of units named by the smaller addend. The mastering of this strategy is a critical predictor of success in beginning mathematics. Students who are not successful with this approach seem to be those with LD and those that are at risk for school failure.

Conclusion

When reviewing the varied research articles focused on mathematical fluency, it is evident that fact fluency needs to be achieved in order to build the necessary foundation for further learning in math. It is also clear that the most effective intervention strategy for math fact fluency is a blended approach of strategy-based instruction to increase conceptual understanding along with repeated timed practice to develop automatic recall of basic facts.

Description of Research Process

Throughout the 12-week intervention period, data was collected through student feedback forms, timed tests as baselines, and a school-wide assessment as a benchmark test. At the

beginning of the study, the students were given a feedback form (Appendix A) to share how well they feel they know their math facts and identify any strategies they use with confidence. Each baseline timed test included 40 addition questions, and the students were given two-minutes to complete as many questions as they could. The first timed test was easier addition problems (Appendix B) and included the doubles facts, and counting on by 0, 1, or 2. The second timed test involved addition problems that were a bit more challenging (Appendix C) and used strategies such as doubles +1, ten facts, counting on by 3 or 4, and "Magic Nines." If students completed a test before the 2-minutes were over, I recorded the time it took them to complete the test at the top of their paper. Since none of the students scored 90% or higher on the addition pretests, I started my intervention with basic addition strategy instruction. These baseline addition timed tests came from University of Puget Sound (Woodward (n.d.)). In addition, the students took the schoolwide aMath assessment by Fastbridge Learning (FAST) to evaluate their overall math ability, and those results were compared with the spring results to determine if math fact fluency had an impact on overall math achievement.

Each day during the 12-week intervention period, we would spend about 10 minutes practicing one of the addition strategies: Counting on, making ten, doubles, doubles +1, and "Magic Nines." The strategy activities that were implemented came from *K-2 Addition and Subtraction Strategies (*K-5 Math Teaching Resources LLC, 2016). We started with an explicit demonstration of the strategy and students completed an activity to practice the new strategy. If students finished the daily activity, they would practice that strategy in a different way such as rolling dice or using focused flashcards while they waited for the other students to finish. We typically spent one to two weeks repeatedly practicing each strategy. After that time period, I

gave every student a sheet of problems that required the use of the strategy we had just been working on. We initially started reciting the problems and answers aloud as a group, and then I gradually released them to answer all of the problems individually. Through this procedure I was able to observe that each student could answer those problems efficiently, and it became evident to me that the students were confident in that strategy. Once all students demonstrated confidence using the strategy, we would introduce the next strategy.

For counting on, we started with an activity where students were given a handout with a concrete way to practice the count-on strategy. Each problem contained a box with a single-digit number and next to the box there were either 1, 2, or 3 circles for the student to point to as they counted on to find the answer. The next day the students were a given a handout of basic addition problems, and the students had to identify the larger number, underline it, and then draw their own counters to represent the smaller number. Finally, they were to count on from the larger number to find the sum. The next day a similar activity was used, but instead of drawing counters to find the answer, the students used a number line to count-on.

In order to practice the making ten strategy, students used number cards and made pairs of cards that equaled 10. The next day, students turned over just one number card at a time and they had to determine what number went with that card to make 10. Then they wrote that 10 fact equation on their paper. Finally, students completed a fact sort where they cut out facts and separated them into two groups, 10 facts and not 10 facts.

For the doubles strategy, the students again used numeral cards. They started with cards 0-5, and they turned over a card, doubled the number, and recorded the addition fact. Once they were confident with doubles to 5+5, they repeated the procedure with cards 5-10 to practice

doubles up to 10 + 10.Once all of the doubles facts had been practiced repeatedly, they moved onto the doubles +1 strategy. To practice doubles + 1, the students were given a variety of addition problems, and the students that to circle all of the problems that could be solved using the double +1 strategy. Then they worked to solve those problems by writing the doubles fact that could be used to solve that problem. Then they would show adding one to the answer of that fact. For example if the problem was 5+6, they would write 5 + 5 = 10; 10 + 1 = 11. Finally, they would go back to the original addition problem of 5 + 6 and record the answer of 11.

Finally, I taught students the "Magic Nines" strategy to use whenever 9 is one of the addends in the addition problem. For this strategy, the students are taught to add 10 to the other addend, and then take one away from that number to get their answer. For example, to solve 6 + 9, students would think in their head that 6 + 10 = 16, so 6 + 9 = 15 (16-1). To practice this strategy, the students were given a 5x5 grid of the most challenging “Magic Nine” facts. The top line of the grid contained the problems 9 + 5; 9 + 8; 9 + 6; 9 + 7; and 9 + 4. The remaining four lines of the grid had those same problems mixed up in a different order. With these 5 x 5 grids, the students would practice the "Magic Nine" facts by saying the problem and the answer aloud. At first, I would start by saying all five problems (with their answers), and then the small group of students would repeat that line back to me. We repeated that method a couple of times and then gradually released the students to practicing entirely on their own. Later, I had individual students do one line at a time so we could check for accuracy. After repeating this activity multiple times, I was able to observe each student doing the entire 5 x 5 grid accurately on their own; it became evident to me that the students were confident in the "Magic Nines" strategy.

At the conclusion of the intervention period, all of the students again took the two assessments that each contained the same 40 addition problems as the pretests. The students were given two minutes to complete each test, and if they finished early their time was recorded at the top of their paper. In addition, the students completed the same feedback form that they took prior to the study to see if their feelings toward fact fluency and strategies had changed at all. Finally, the students took the schoolwide FAST benchmark assessment at the end of the school year to see how their overall math ability changed from winter to spring. The results from these three assessments were analyzed to determine whether or not the students' math fact fluency improved as a result of the study.

Analysis of Data

Data was collected from multiple sources during my action research project. First, I used the results from the schoolwide winter benchmark assessment, aMath, as a baseline to identify the student's current overall math ability; I later compared those results with the spring scores to determine student growth. My second source of data included the basic fact timed tests. Each timed pretest included 40 addition questions, and the students were given two-minutes to answer as many questions as they could. The first timed test was easier addition problems, and the second timed test involved addition problems that were slightly more challenging. These same two tests were given at the end of the intervention period and the results were compared to the pretests to determine growth. The third data source consisted of student feedback forms. The students answered questions to show their level of confidence with math fact fluency and identify which strategies they use to answer math facts. These same surveys were completed at

the end of the intervention to determine how the students felt their math fact fluency changed through the study.

The majority of the students showed growth on the schoolwide benchmark assessment, aMath, from the winter testing period to the spring, as shown in Figure 1. One student had substantial growth, and his/her score improved by 16 points. Students #1, 5, and 6 showed little or no growth on this assessment. These three students have been tested for Special Education services previously, but they did not qualify for services in math. When looking at all of the students in the study group, the average score change for this general math assessment was 4.82 points per student. The data indicates that most students in this fact fluency study improved their overall math ability.

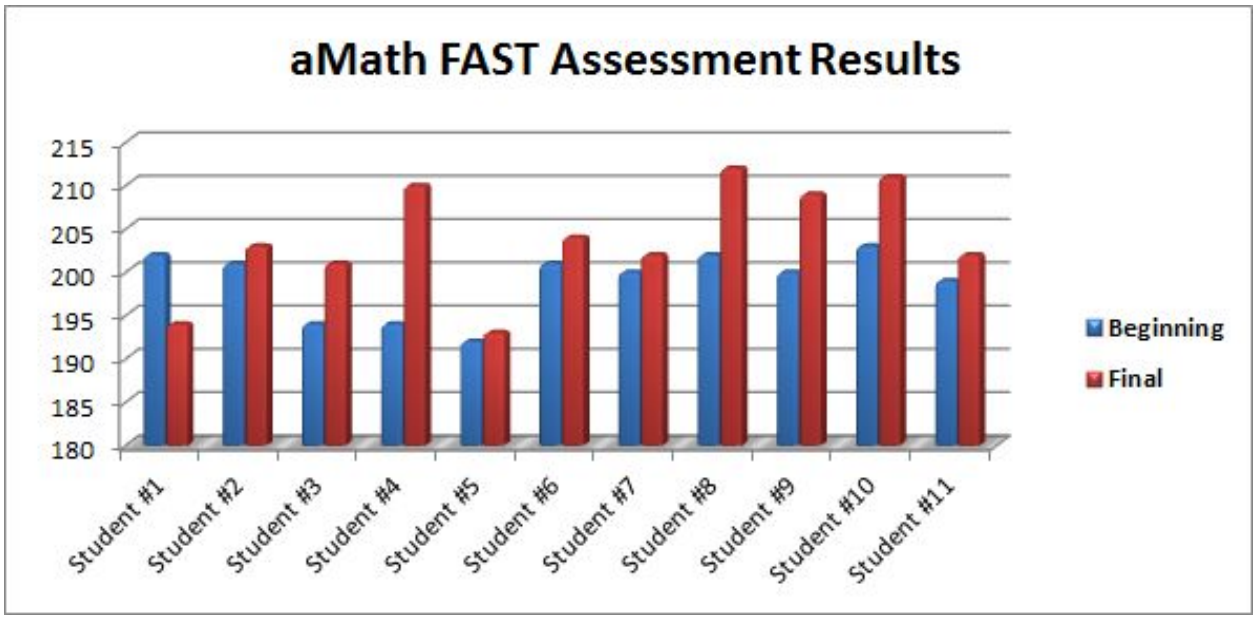

Figure 1. aMath FAST assessment winter to spring scores.

After the intervention period, all of the students again took the two assessments that each contained the same 40 addition problems as the pretests. The students were given two minutes to

complete each test. The easier addition test contained the doubles facts, and counting on by 0, 1, or 2. This test had an average improvement of 2.36 points per student. As shown in Figure 2, seven of the eleven students in this study scored very high on the pre-assessment for this easier addition test, so there was very little room for improvement for those students on this particular assessment. Student #1 had the largest gain on this test, and his score improved by 14 points.

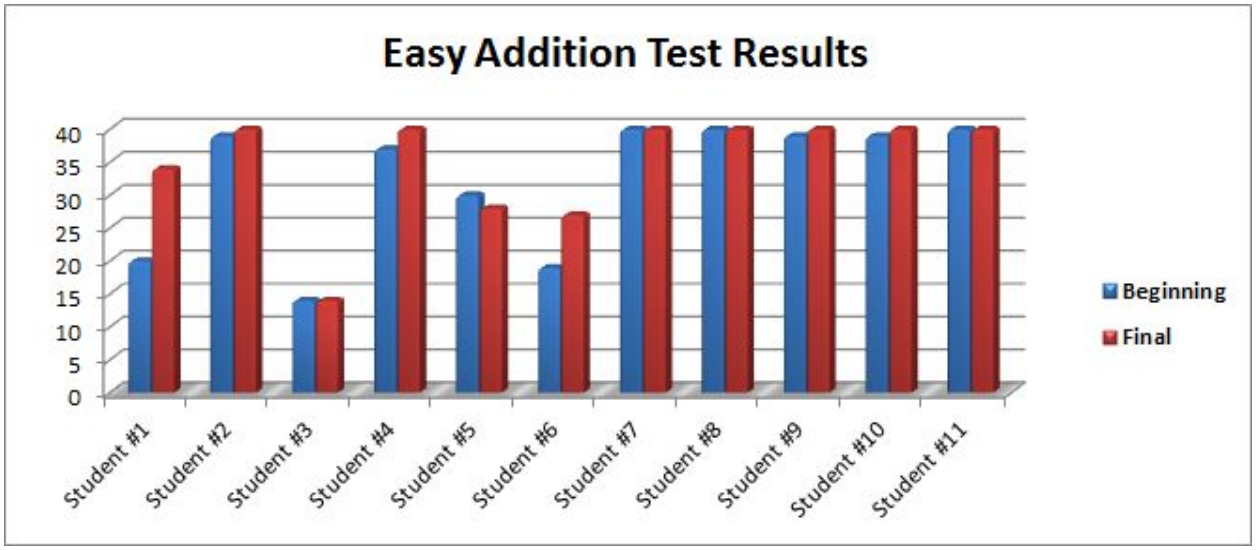

Figure 2. Easier addition timed test pretest-posttest growth.

For the more challenging addition timed test, the students answered problems that were a bit more challenging and used strategies such as doubles +1, ten facts, counting on by 3 or 4, and "Magic Nines." On this particular test, it was surprising to see that four students actually scored lower on the final test than on the beginning test, as shown in Figure 3. Through observations during the final test it appeared that students were applying the strategies they learned in the study, but some of them were not yet able to apply the strategies in an efficient manner. For these particular students, at this point in time, the new strategies may take them longer to calculate the answer than using their former count-on method. If the students had more time to practice the

challenging strategies, it is likely they would have demonstrated improvement on the final test because they would have been able to use the strategies more efficiently. The average score change overall was 3.09 points, but the average change for students that had positive results was 7.0. One student's score improved by 20 points. For one second-grade student, it was observed that on the pre-test, she was drawing sticks to find the answer. For example, to solve the problem 3 + 9, she drew 3 sticks next to the number 3 on the test, and she drew 9 sticks next to the number nine, yet she still answered that particular problem inaccurately. On the final test, she was able to use mental math to solve the addition problems and none of the problems had drawings to help her solve the problem. This student's score improved by four points likely because the addition strategies were a more efficient method than her previous method of drawing sticks.

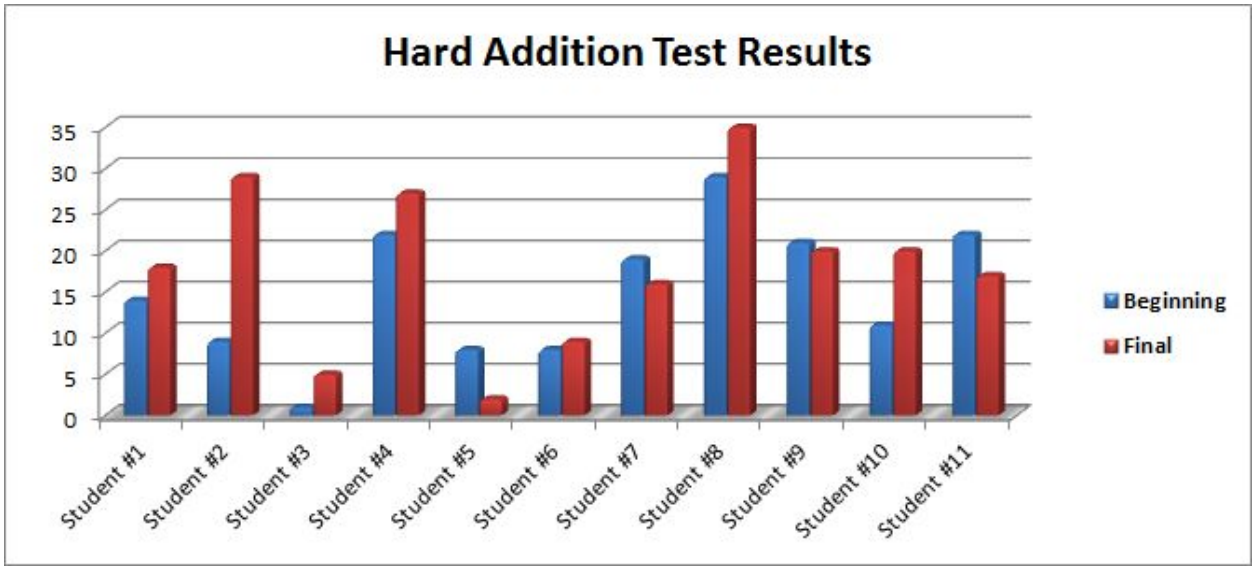

Figure 3. More challenging addition timed test pretest-posttest growth.

The third data source was the student feedback form. These forms were used to indicate the students' level of confidence in their math fact fluency as well as to identify which strategies

they could use confidently to solve addition problems. There were five questions that students answered to demonstrate their personal feelings on their ability to answer basic math facts. For each question, the students responded by saying “No” (1 point), “Sometimes” (2 points), or “Yes” (3 points). The feedback forms were completed at the beginning of the study and again at the end to indicate how the students’ feeling toward basic math facts changed throughout the study. The overall average change for these five questions was 1.55 points. The results from these feedback forms were inconclusive. One of the students that had a lower score on both of the addition pretests answered “Yes” for all of the questions regarding his ability to answer math facts. He even said, “Yes” I can answer addition facts quickly, but his pretest scores did not indicate that he had this ability. For this student, his responses are not able to indicate any growth in confidence or ability because he indicated that he felt he had these abilities even before the study began. Some students even had a negative change in their responses from the beginning to end of the study, as shown in Figure 4. It appears evident that at this time many students do not have an accurate picture of their own abilities when it comes to math fact fluency.

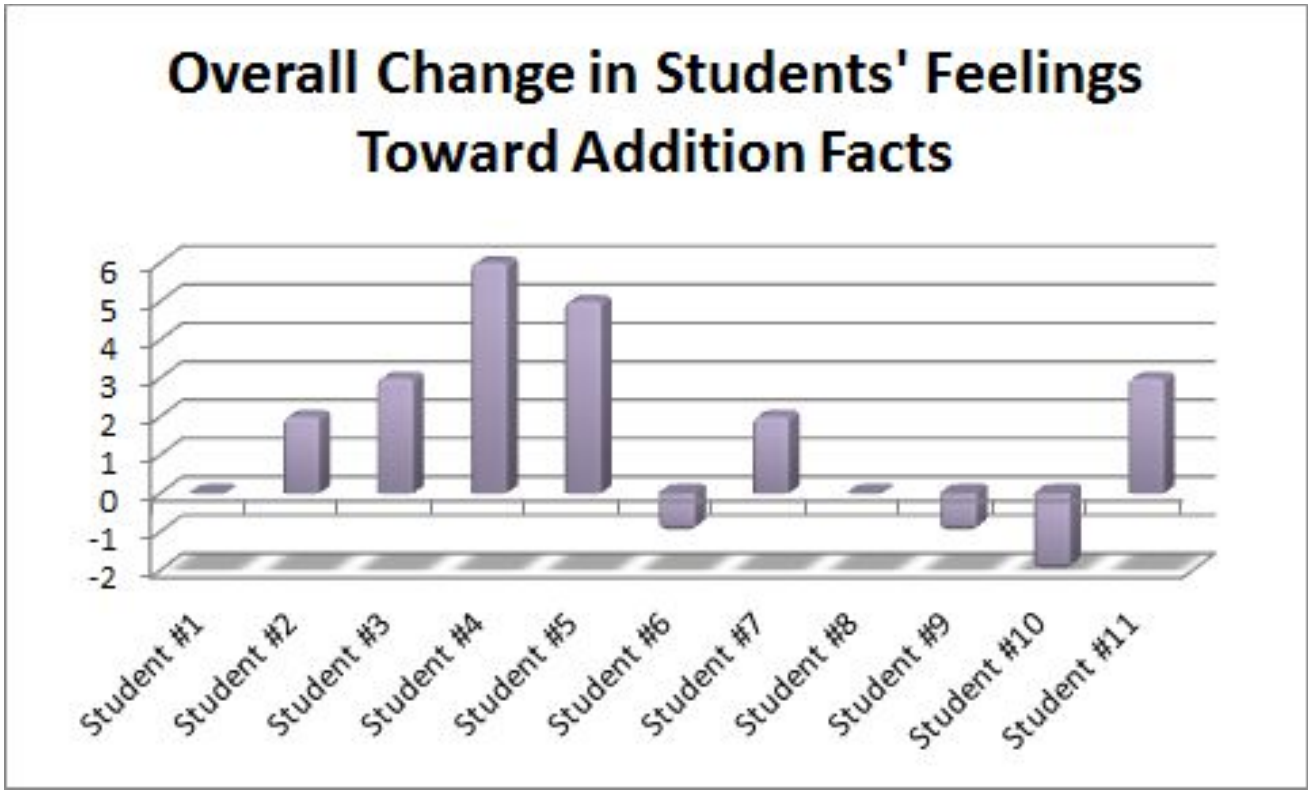

Figure 4. Overall change on feedback form from beginning to end of study.

The final question on the student feedback form specifically asked which of the addition strategies the students were able to use on their own to solve addition problems quickly. At the beginning of the study, the average number of strategies that students used was 1.82. The individual student results are represented below in Figure 5. It should be noted that the one student that indicated she knew all five strategies at the beginning of the study scored poorly on the addition fact timed pretests. At the end of the study, the average number of strategies used by the students increased to 4.55. Therefore, the average number of strategies used to solve addition problems increased on average by 2.73 or nearly three strategies. While the addition timed tests showed a small improvement in the number of problems correct from the pre- to post-tests, this feedback form question indicates that the students believe they are now proficient at using more addition strategies to answer the problems.

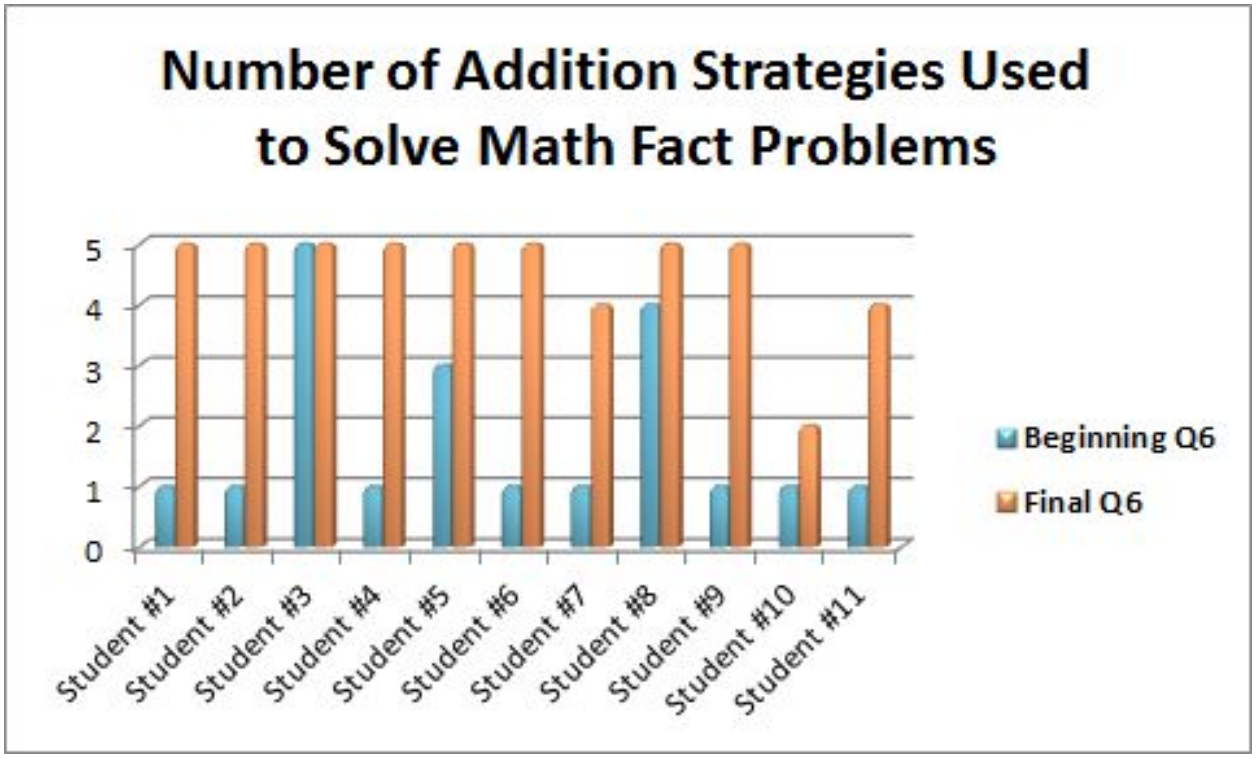

Figure 5. Feedback form overall change in addition strategies used from beginning to end of study.

All of the students in this study struggle with math and number sense skills, and they qualify for Title I math instruction because they are identified through the aMath FAST assessment as "high risk" for not meeting the grade level target. Therefore, these particular students may have had more favorable results with a longer study since they would have had more time to master these addition strategies and be able to apply them more efficiently. Math fact fluency is a crucial skill for students to master in order to be more successful in higher-level math skills. Therefore, I have continued working with my Title I math students and am trying different methods to improve their math fact fluency and work toward automaticity. I have used the data from my study to develop an action plan in order to continue building math fact fluency with my students.

Action Plan

After analyzing the data collected from the second and third grade students that participated in this study, it is evident that improvements were made in their addition fact fluency. Overall, the majority of the students in the study made gains to increase the number of addition fact problems that they could complete in two minutes. The emphasis of this math fact fluency study was on strategy instruction with repeated practice. Although the student improvements did not increase as much as I had anticipated, I was pleased to see that so many students improved their addition fact fluency through this short intervention study.

Through the literature review on math fact fluency and my personal teaching experiences, it was clear to me just how crucial it is for students to know their basic math facts in order to be more successful with higher level math skills. In addition, I have realized that if I were to conduct a similar study in the future, I would make a few changes. First, I would conduct the study over a longer period of time because it was clear to me that students did in fact need additional practice time in order to become efficient with all of the addition strategies. Second, I would add an element of at-home practice to the study to determine if that additional time practicing would have a greater impact on the fact fluency improvement. Finally, I would have students track their own growth every one to two weeks and set personal goals for themselves to help increase motivation. If students could see their gradual improvement and had a goal in mind, they would likely have greater improvement in their math fact fluency. With these changes to the initial study, I believe I would have seen greater growth in the final results of this study,

While this study appeared to be beneficial to the students, I also feel it is necessary to evaluate other methods for increasing fact fluency. While it is likely that any math fact practice

will increase fluency, there may be a more effective method than strategy practice that would yield even greater results. The students in this study have all been identified as struggling with math, and it appeared that some students had a difficult time grasping all of the different strategies and were unable to apply them efficiently after this short study. While strategy instruction is a researched-based intervention, it may not be the best fit for students that already find math to be challenging.

The first method I would like to investigate and test out with my future students is "TouchMath." Innovative Learning Concepts, Inc. (2016) states that in their program, each numeral from 1 through 9 has "TouchPoints" that correspond to each digit's value. As students are counting the "TouchPoints," they connect numerals with real values. They begin to realize that each numeral, such as the numeral 3, represents a quantity such as three apples, three bugs, three marbles or three "TouchPoints." With the "TouchMath" model, I believe it would have been more likely for my students to have a more significant increase in their fluency if we had done this method, given the short duration of this study. In my teaching position, I only see the students for 20-30 minutes of intervention a day, so it was challenging to implement the fluency intervention in addition to our school district's adopted math intervention curriculum. The other benefit of "TouchMath" is that students can apply the same concepts they learned to complete subtraction problems. Once the students have become proficient with the "TouchPoints," they would be able to complete subtraction problems more easily as well without having to learn additional strategies. It is my hope that with struggling math learners, this method would be more effective at increasing basic math fact fluency.

Another area of consideration for further research would be to again use the focused strategy approach, but I would conduct the study in a general education setting. It would be interesting to see how the results would differ in a setting that included students of diverse mathematical abilities. In a general education classroom, I would analyze the data differently and compare the results from students of varied math abilities. For example, I would use the baseline general math assessment to identify students as high risk, some risk, and low risk for meeting the grade level target in math. Then I would conduct a similar study to the one I have conducted with my Title I math students, but I would compare the results from each group to determine which group of learners had the most significant gains.

After reviewing the results of my study, I feel that the time and energy spent on math fact fluency was time well spent for my students as well as myself. Even though the results were not as significant as I had hoped, many students did demonstrate improvement in their addition fact fluency. Also, after analyzing the results, I know my future students will benefit from this study because of my knowledge of the importance of basic fact fluency, as well as the fact that I have new ideas for how to increase their fluency in methods that will hopefully yield even greater results. Through further fluency practice, I will continue to evaluate the effectiveness of the different methods and determine the best approach to increasing the fact fluency of my Title I math intervention students.

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Abstract A

Student Feedback Form

Math Inventory - Student Feedback Form

1. I can answer math facts without using my fingers or other objects.

Yes ☐ No ☐ Sometimes

2. It is easy for me to show what I know on timed math fact tests.

Yes ☐ No ☐ Sometimes

3. I think that using flashcards helps me learn my math facts.

Yes ☐ No ☐ Sometimes

4. I think I am good at math and feel confident in math class.

Yes ☐ No ☐ Sometimes

5. I can answer addition facts quickly.

Yes ☐ No ☐ Sometimes

6. Which strategies are you able to use on your own to solve addition problems quickly? Please check all that apply.

- ☐ **Counting On**
- ☐ **Doubles**
- ☐ **Doubles +1**
- ☐ **Ten Facts**
- ☐ **"Magic Nines" (Add 10 and take 1 away)**
- ☐ **Other _____**

Appendix B

Easy Addition Fact Timed Test

1 +6	4 +4	0 +3	8 +2	7 +2
4 +2	8 +8	2 +5	1 +4	7 +1
2 +8	8 +1	2 +3	6 +1	3 +3
1 +3	0 +7	4 +1	6 +6	6 +2
9 +1	5 +5	2 +1	1 +8	8 +0
1 +2	1 +5	2 +2	9 +9	5 +2
7 +7	2 +7	1 +1	6 +0	3 +1
5 +1	3 +2	2 +6	7 +1	2 +4

Appendix C

Hard Addition Fact Timed Test

3 +7	4 +8	7 +9	6 +5	5 +8
9 +6	4 +7	3 +9	5 +7	6 +3
8 +5	3 +5	7 +3	9 +2	8 +7
6 +4	8 +3	9 +5	6 +7	7 +5
4 +3	6 +8	5 +9	4 +6	8 +4
2 +9	5 +3	8 +9	3 +6	7 +4
9 +4	3 +8	9 +3	7 +8	6 +9
9 +8	7 +6	9 +7	3 +4	8 +6