Math Fact Strategies Research Project

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Abstract

An action research project was conducted in order to determine effective math fact strategies for first graders. The traditional way of teaching math facts included using timed tests and flashcards, with most students counting on their fingers or a number line. Six new research-based strategies were taught and analyzed to decide which methods work best. The project took place at Calcutta Elementary School in Calcutta, Ohio with nineteen students. Research, including data collection and analysis, occurred between January and July, 2011. Data sources included previous math grades, student journals, teacher observations with anecdotal notes, math fact pre and post tests, a parent survey, teacher interview, focus groups, and Ohio Achievement Test scores compared to third and fourth grade math averages. Overall, the action research results showed the effectiveness of the new math fact strategies discussed, especially in comparison with the former way of teaching math facts.

Introduction

This action research project will occur in a first grade class at Calcutta Elementary, a small school of less than four hundred students in rural Ohio. The school district is in a low-income area in Appalachia; however, most of the students are from middle-class homes. I have taught first grade at Calcutta for almost two years. Prior to this position I was a substitute teacher for one year, and I taught preschool for one year before that. There will be nineteen students involved, all Caucasian, divided into ten girls and nine boys. I have a mixture of academically high achieving students, as well as a few students who struggle in every subject, with many students falling somewhere in between those two extremes. I typically have strong parental support, which will be important in this study as I ask parents to complete a survey. The

support of my colleagues will also be needed when I conduct a teacher interview, ask for math grades, and seek their advice.

One of the common struggles among elementary teachers is how to teach math facts in a way students will remember them. There is a debate between whether it is better to have students memorize math facts or develop an overall understanding of how to solve math problems through math fact strategies. I currently use traditional methods of flashcard games and timed tests to encourage memorization of facts. However, after taking a professional development math course, I have been taught it is better to teach a more holistic approach. Furthermore, students have displayed feelings of dislike and even stress when presented with the more traditional methods of learning math facts. For this reason, it is my goal to conduct a study of mathematics in hopes of discovering how to best develop automaticity of math facts in my first graders in a meaningful way.

Data collection will begin with a pretest to determine how students currently solve math problems, as well as their speed and accuracy. Various strategies will then be taught over the course of several weeks with students being tested over each strategy and journaling their thoughts about each one. Other data sources will include teacher interviews, parent surveys, observation notes, math test scores, student focus groups, and a post-test. After the data has been collected, I will analyze and interpret it in order to determine how the strategies impacted student learning. My underlying assumptions about this project include:

1. Certain math strategies such as doubles and adding nine are more effective than doing drill and timed tests alone.
2. First graders can implement these strategies when taught correctly.

3. Teaching math fact strategies will help students develop automaticity of math facts.
4. Automaticity of math facts is important.
5. Students who have developed automaticity of math facts perform better on higher level math problems.

Area-of-focus Statement

The purpose of this study is to investigate the effects of various strategies on student mastery of first grade mathematics. This statement "identifies the purpose of study" as I am seeking different strategies to improve my students' understanding and automaticity of basic math facts in new ways (Mills, 2007, p. 44).

Research Questions

1. What math fact strategies work best?
2. How do math fact strategies impact student learning?
3. Why is automaticity of math facts important for students?

Mayner states, "Developing the research questions triggers everything" (Video, Strategies in Action: Advice for ways to avoid common mistakes). For this reason, I developed questions to guide my research throughout the project.

Variables

There will be several variables, or "anything that will not be the same," throughout the research project (Video, Expert Commentary: How should I consider variables in my research?). Firstly, the math strategies taught will vary from my current way of teaching math facts. There will be other daily changes to consider, such as my enthusiasm or students' attitudes towards the

subject. The time of day the topic is studied will most likely change slightly from day to day. Other variables possibly affecting my class on any given day include snow days, holidays, being absent, and interruptions from parents, administrators, or programs.

It is necessary here to also define a few key phrases in the area-of-focus statement and research questions. "Math facts" refers to addition and subtraction facts zero through ten. "Math fact strategies" means methods such as "counting on" or "doubles," which will be discussed in the project. The phrase "automaticity of math facts" means being able to have a rapid recall of facts without having to count or use other strategies to figure out the given problem.

Review of Literature

To help answer my research questions, I examined current literature on the topic of teaching math facts, including journal articles, books, research papers, and websites. I discovered the debate among educators arguing math fact strategies, which is the new trend, versus the more traditional approach of memorization of math facts. Many of the strategies I read about were familiar to me; however, I did learn about some new strategies or programs claiming to increase student mathematic skills. After reviewing the literature, I noticed a theme declaring students develop automaticity of math facts best when taught strategies. I chose six reoccurring strategies, or promising practices, from the literature I studied to implement with my first graders. The following are the resources I will use in my research project:

Brennan, Julie. (March 2006). What about memorizing math facts? Aren't they important? *Living Math!* Retrieved from http://www.livingmath.net/MemorizingMathFacts/tabid/306/Default.aspx

This webpage differs slightly in that it is written by a mother who has a child who struggled with learning math facts. The author asks why it is important to have math facts memorized (or have automaticity of math facts). She also discusses several ways to develop declarative knowledge through card and board games. In the end, the author agrees automaticity of facts is vital for students to develop a higher level of understanding of math throughout life.

Burns, Matthew. (2005). Using incremental rehearsal to increase fluency of single-digit multiplication facts with children identified as learning disabled in mathematics computation. *Education and Treatment of Children, 28(3),* 237-249.

This research article describes the effects of Incremental Rehearsal (IR) on students with math disabilities level to develop fluency of math facts. While this paper does focus on multiplication facts, it has valuable information regarding automaticity of math facts. The paper explains a study done in detail, and is therefore, deeper than other articles. It is interesting as it describes how students' math scores increased due to repetitious drill and practice of facts. This article allows me to "see" my problem "through someone else's lens" as it discusses ways to increase automaticity for students who struggle with learning disabilities (Adapted from Mills, 2011, pp. 44-45).

Caron, Thomas. (July/August 2007). Learning multiplication. *The Clearing House, 80(6),* 278-282.

The author makes the point that to develop automaticity students must have meaningful experiences with the facts, as stated, "A recent summary of the relationships between brain

research and educational practice emphasizes the vast importance of understanding developed from rich and meaningful connections as opposed to the relative uselessness of superficial rote memory (Caine et al. 2004).” He provides these experiences by doing daily worksheets where students see how many facts can be solved in one minute, and the answers are given at the top of the page. A good quote about automaticity is, “Robert Gagne (1983) emphasized that the processes of computation that underlie all problem solving must be ‘not just learned, not just mastered, but automatized.’ Developing automaticity frees up cognitive capacity for problem solving.”

Crawford, Donald. (n.d.) The third stage of learning math facts: developing automaticity. *R and D Instructional Solutions.* Retrieved from http://rocketmath.net/uploads/Math_Facts_research.pdf

This research article is about how students develop automaticity of math facts through various stages. The paper points out several unique ideas as it discusses each stage individually, but still focuses on the third stage which is automaticity. A great quote from the abstract is, “Learning math facts proceeds through three stages: 1) procedural knowledge of figuring out facts; 2) strategies for remembering facts based on relationships; 3) automaticity in math facts” (Crawford, n.d., p. 1). This quote shows the breakdown of how to teach math facts. Like other articles, it is stated that the most effective math facts are learned in sets of two to four. Furthermore, I think part of my current problem of teaching students math facts lies in this statement, “teaching strategies that address earlier stages of learning math facts may be counterproductive when attempting to develop automaticity” (Crawford, n.d., p. 3). The author

explains how learning the various strategies is an important step for students to understand between having the procedural knowledge of counting up and the final rapid recall stage. A quote for my project is, "Thorton's (1978) research showed that using relationships such as doubles and doubles plus 1, and other "tricks" to remember facts as part of the teaching process resulted in more facts being learned after eight weeks than in classes where such aids to memory were not taught" (Crawford, n.d., p. 7). Page 15 begins a section directly answering my third research question, "Why is automaticity of math facts important for students?"

Hanlon, Bill. (2004). Facts practice – add by strategy. *Hanlon Math.* Retrieved from

http://hanlonmath.com/pdfFiles/340AddfactsR.pdf

While this is not an article, it is a very useful page for my project. This file created by Bill Hanlon goes through the main strategies I will be studying during my research. For example, there are several pages dedicated to doubles facts, others that focus on sums to ten, and so on. This source will be useful in my project as I will be able to refer to it when creating assessments for my students to study the effectiveness of various strategies.

Hanlon, Bill. (2004). Strategies for learning the math facts. *Hanlon Math.* Retrieved from

http://hanlonmath.com/pdfFiles/244StrategiesforFactsBH.pdf

This article starts with a quote that will provide answers to one of my research questions, "The more sophisticated mental operations in mathematics of analysis, synthesis, and evaluation are impossible without rapid and accurate recall of specific knowledge" (Hanlon, 2004, p. 2). While this paper simply goes through the various strategies of Hanlon Math, it does argue young children have difficulties starting with the memorization of math facts, but rather should begin

by learning these methods. This article will be beneficial to me as it explains several of the strategies I will implement in my project. It also explains strategies for subtracting, multiplying and dividing.

Kaechele, Michael. (2009, July 26). Is rote memorization a 21st century skill? [Web log post]. Retrieved from http://concretekax.blogspot.com/2009/07/is-rote-memorization-20th-century-skill.html

This website is a blog that contemplates the need for students to memorize information, such as math facts. The author points out that when he began teaching a middle school math class his students struggled to remember their basic multiplication facts. To remedy this issue, he began having his students review and recite facts. The rest of the site is a discussion, primarily between teachers, on whether or not memorization is the best way to teach math facts. This blog would be useful to compare varying teachers' feelings in my research. I like this source because it offers a variety to the other journal articles I already have, which Korzym states, "you still need to make sure you've reviewed various articles from different sources" (Video, Expert Commentary: How do I conduct a Literature Review?).

Lehner, Patty. (2008). *What is the relationship between fluency and automaticity through systematic teaching with technology (FASTT Math) and improved student computational skills?* Retrieved from http://www.vbschools.com/accountability/action_research/PatriciaLehner.pdf

This article discusses the importance of automaticity so students can build upon their basic facts with higher computation skills. It points out the struggle teachers face to help students develop automaticity, and how students think they know their math facts when they really only know strategies to solve them. Research is shared showing the correlation between knowing basic math facts and success in the workplace. The article then studies the effects of computer software, FASTT Math, in relation to developing automaticity. This study found that lacking automaticity of math facts not only impedes higher level mathematical understandings, but even "the development of everyday life skills" (Lehner, 2008, p. 4).

Math Facts Automaticity. (2009). *Renaissance Learning.* Retrieved from

http://doc.renlearn.com/KMNet/R004344828GJF314.pdf

This is another article that discusses the importance of automaticity of math facts. It begins by explaining the problem with math and what can be done about it. According to this paper, the issue is a lack of foundations in math facts. The article discusses how if math facts are not automatic it uses more working memory, making it more difficult to solve complex problems. There are interesting graphs shared showing how few students practice math facts multiple times a week and how students who have math facts mastered rank higher in mathematics. The author states the importance of timed practices when developing automaticity of facts. The rest of the paper is then dedicated to a description of how a certain program increases automaticity among students.

Math Fluency. (2011). *Scholastic*. Retrieved from

http://www2.scholastic.com/browse/article.jsp?id=324

This article is an excerpt from a research paper that discusses the need for fluency of math facts in order to "attain higher order math skills" (Math Fluency, 2011). It is "up-to-date" as suggested by Mills (2007, p. 37) since it has a copyright date of 2011. This article contains amazingly in-depth explanations of how having math facts memorized uses less working memory in one's brain. This article, like many others, compares learning math facts to learning how to read. Students need to know how to solve addition problems, just as they need to know how to sound out letters to make words. To be successful, however, students must develop a declarative knowledge of automatically knowing their math facts, the same as students need to automatically recognize sight words.

Mental Math Strategies. (2005). *Saskatoon Public Schools Online Learning Centre*.

Retrieved from http://olc.spsd.sk.ca/de/math1-3/p-mentalmath.html#master

This website shares many of the common math fact strategies including, "Doubles, near doubles, commutative property, adding ten" and more. It is a quick and easy source to find some of the most recommended strategies. A good quote from this website is, "It is recommended that students learn patterns and strategies for as many facts as possible so that they strengthen their understanding of the relationships between numbers and the patterns in mathematics. Then they begin to memorize" (Mental Math Strategies, 2005).

R & D Instructional Solutions. (2009). Teacher Directions. *Rocket Math.* Retrieved from

http://www.rocketmath.net/uploads/Rocket_Math_Teacher_Directions.pdf

Rocket Math is a program that focuses on teaching math facts for automaticity. While this product does more or less encourage memorization, it has countless reports of being a fast

effective way to help students learn their math facts. The program teaches four math facts a day, which students practice through a drill with a partner, then take a test. If the student passes, they get to move on to the next four facts the next day. If the student does not pass, they practice those facts for homework and try again the next day, moving on once they pass.

Woodward, John. (2006). Developing automaticity in multiplication facts: integrating strategy instruction with timed practice drills. *Learning Disability Quarterly, 29*, 269-289. Retrieved from http://www2.ups.edu/faculty/woodward/LDQfall06.pdf

Woodward's paper describes how automaticity of math facts can be developed among students through the combination of various strategies and timed drills. The author states even the recent research that places an emphasis on problem solving still acknowledges the importance of automaticity of math facts. This information supports my original ideas for my project. The paper then explains the process used to collect data regarding the main topic, including trying various strategies and timed practice drills. The final conclusions of Woodward's research showed an increase in students' mastery of math facts with only timed tests or only strategies, but even more so when combining the two.

Woodward, John. (n.d.). Fact mastery and more! *Overview for Teaching Facts.* Retrieved from http://www2.ups.edu/faculty/woodward/facts%20overview.pdf

This article explains why students need to know math facts, and then it provides worksheets of various strategies to help students reach this goal. The author states how, without rapid knowledge of math facts, it is difficult to solve math of higher-level thinking. He further states how learning the math strategies themselves enforce mental computation skills which

students lack. It is suggested that math facts are often taught too quickly, and it would be better if facts were taught a few at a time. The strategies are the common "Plus Zero/One, Doubles, Sums to ten" and so on; however, they are presented in a fashion similar to Rocket Math where students must perfect each section before moving on to the next.

Yermish, Aimee. (2003). Why memorize math facts? *Hoagies' Gifted Education Page.*

Retrieved from http://www.hoagiesgifted.org/why_memorize.htm

This article is primarily about how even students who are gifted need to be fluent in knowing their math facts. The author explains the importance of automaticity by saying, "When it takes you too long and uses too much working memory to do the basic skills, you can't keep track of the higher skills you're supposed to be learning in your current grade." Furthermore, in a more casual tone, she states, "It's going to be very difficult to get to graduate-level mathematics if you can't hack calculus because you couldn't hack algebra because you couldn't hack middle-school math because you couldn't hack arithmetic" (Yermish, 2003).

Proposed Intervention or Innovation

In hopes of improving students' retention of basic math facts, six various strategies will be implemented. Instead of using current methods of teaching math facts (flashcard games and timed tests), strategies shown to be effective through research will be used. The strategies utilized in this project will be adding zero and one, adding two, doubles, doubles plus one, sums to ten, and adding nine. These strategies will be applied in order to "address the teaching/learning issue identified" (Mills, 2007, p. 45).

Data Collection Matrix (Appendix A)

Research Questions	1	2	3
1.What math fact strategies work best?	Previous math grades	Student Journal	Teacher observation with anecdotal notes
2. How do math fact strategies impact student learning?	Math fact pre-test	Parent survey	Math fact post-test
3. Why is automaticity of math facts important for students?	Teacher Interview	Focus Groups (Group that knows math facts & Group that does not) – Solving higher level math	3rd and 4th grade teachers' math assessment grades/OAT scores in math

Previous Math Grades

Data will be collected from students' previous math fact grades in timed and untimed assessments. Throughout the year, students have taken daily timed tests as well as once a week untimed tests on whichever math fact we are working. For example, one week students are being tested over +7 facts and the next week -7. I will analyze this data by looking at students' averages and comparing their previous grades with new ones from similar assessments from this study. Grades will be interpreted by how they change due to the different teaching strategies. Currently, students typically solve math facts by counting up or down on fingers, a number line or by rote memorization. After the math fact strategies are taught, however, students grades will, hopefully, improve. Analyzing and interpreting the quantitative data of previous math grades

will allow me to determine which math strategies are more effective, counting on combined with drill and practice or the new research based strategies.

Student Journals

My matrix consists of quantitative and qualitative data collection tools to bring balance to the research. Using a student journal as a data source will provide qualitative data when much of my other data collection techniques are quantitative. It will also allow me to discover which math fact strategies students use and prefer. After learning a new strategy, students will write a description of how to use the strategy to solve math facts as well as their own thoughts and feelings towards the strategy. For example, after learning and implementing the adding nines strategy I would expect students to be able to write in their journal how the math problem 6+9 can be solved by thinking what is one less than six (five) and make it a teen giving the sum of fifteen. Beyond explaining the strategy, however, I want to know whether or not students find this strategy effective, useful or easy to use. For this reason, they will be asked to share their thoughts on the strategy. These ideas will help answer research questions, "What math fact strategies work best?" and "How do math fact strategies impact student learning?" as they will identify how students use the strategies and which ones they feel work best. Student journals are an important aspect of my research because they will allow me to collect data, not only of teachers or parents' points of view, but the students as well. Having students' views in my research will cause the data to be more accurate and complete.

I will analyze student journals by identifying themes among students' writings. Mills (2007) suggests developing a coding system to determine "…patterns that emerge, such as events that keep repeating themselves, or key phrases that participants use to describe their feelings" (p.

123). As I read students' journals, I will make notes on index cards to analyze common themes among students' thoughts.

One way I could interpret the data from student journals is by extending the analysis (Mills, 2007). After reviewing students' thoughts, I will ask questions about the study of math facts "…noting implications that might be drawn without actually drawing them" (Mills, 2007, p. 135). For example, once I interpret the data more questions may arise such as, "Why do students prefer learning math fact strategies or memorizing math facts?"

Teacher Observations with Anecdotal Notes

Observations will be made throughout the data collection process by taking anecdotal notes. The attached form will be used to keep track of how students are doing with learning the math fact strategies individually and as a group. By observing students while they learn the new ideas, I will be able to determine which strategies work best. These notes will then be analyzed by recording any common themes among students' reactions, understandings, and applications of the material. This qualitative data collection source will balance out the other more numeric sources. The data will be interpreted as it may lead to more questions for the students about why they solved a problem a certain way, made a positive or negative comment, or displayed a specific attitude.

Math Fact Pretest

Data collection for this research project will begin with a math fact pretest. Teacher made tests are "…one of the most common quantitative data collection techniques" (Mills, 2007, p. 73). This pretest will assess students' current understanding of various math strategies, which

will help answer the research question regarding the way strategies impact student learning of math facts. The sets of math problems on the test are grouped according to strategies that will be researched throughout the project, including adding zero and counting on by one, counting on by two, doubles, doubles plus one, sums to ten, and adding nine. In my research, these strategies will be compared with students' current addition methods.

This assessment will be given in small groups for various reasons. First, students will time themselves so after learning the various strategies I can analyze their time to see if there is improvement from the pretest to the similar post-test. Since I do not have access to twenty timers, I will only be able to work with a few students at one time. Furthermore, students will be observed as they complete the test, noting whether or not they use certain strategies, and using small groups will allow me to carefully monitor each student. Students will do a few practice rounds of timing themselves and completing math problems before beginning the test to prepare. Using a pretest will give me clear results of whether or not students know how to use various math fact strategies effectively, and as Munafo states, qualitative data was "helpful, but the quantitative is probably the most beneficial" (Video, Strategies in Action: Data collection tools).

Parent Survey

A parent survey will be conducted during the research process in order to gain a different perspective on how math fact strategies impact student learning. In the past two years, several parents have commented on their dislike for the way math facts are currently assessed in my classroom. This complaint stems from their child feeling anxious about timed tests and moving on to a new set of facts before the student has mastered the previous set. After sending home a note informing parents of the new strategies being taught and giving students time to learn the

strategies, I will ask parents to complete a survey. Their answers will show me how parents view the methods as well as any changes they have noted in their child's skill or attitude towards math facts. The surveys will be analyzed by tallying answers of yes and no questions and identifying common themes of any written comments. The data will then be interpreted by consulting critical colleagues, and it will be taken into consideration when planning how to teach math facts in following years.

Math Fact Parent Survey (Appendix B)

Please complete the survey. Your name and your child's name will not be included in the sharing of the results. Thank you!

Do you feel the previous way of using flashcards and timed tests to teach math facts was effective?	**YES**	**NO**
Does your child practice math facts at home?	**YES**	**NO**
Do you feel the new math fact strategies are effective?	**YES**	**NO**
Did your child like learning math facts by using flashcards and timed tests?	**YES**	**NO**
Does your child like learning math facts by using the new math fact strategies?	**YES**	**NO**
Would you recommend using the old or new methods for teaching math facts?	**OLD**	**NEW**

Have you seen a change in your child's attitude towards learning math facts since starting the new strategies? **YES** **NO**

(If yes, positive or negative?) **POSITIVE** **NEGATIVE**

Have you seen a change in your child's grade in math facts since starting the new strategies? **YES** **NO**

(If yes, positive or negative?) **POSITIVE** **NEGATIVE**

Other comments? _____

_____

_____

_____

Math Fact Post-test

Students will complete a math fact post-test at the conclusion of the unit in order to provide quantitative data for my research. The assessment is the same as the pre-test and will show if students have improved their time solving math facts and whether or not they implement the taught strategies. While the post-test primarily answers the research question, "How do math fact strategies impact student learning?" it also addresses, "What math fact strategies work best?" as it will show how students' speed and accuracy has changed since the math fact pre-test. The pre and post tests will work together to give an overall view of student understanding.

I will analyze the post-test in a variety of ways. First, I will record the times each student posted in order to determine an average speed for each student to complete ten math facts. I will

compare this data with the times from the pre-test to see how they have improved. Percentage of math facts correct will also be averaged for each strategy to show whether or not students have increased understanding of math facts strategies.

I will interpret post-test results by turning to theory (Mills, 2007). The results of students' post-tests will be influenced by theories about effective math fact strategies. By studying, teaching and implementing these strategies, I will be able to compare students post-test scores to the results found in my theory resources. Once I interpret the post-test data, I will be able to change the way I teach math facts to accommodate those strategies that work best, which Korzym says is, "…the most empowering part of research" (Video, Expert Commentary, How do I analyze and interpret my data?).

Math Pre/Post Test (Appendix C)

Directions: Time yourself as you solve these problems. Stop the timer when you have solved them all, then answer the questions about them.

Start the timer and begin.

2+1=	**1+3=**	**0+1=**	**7+1=**	**5+0=**
0+3=	**1+4=**	**7+0=**	**9+1=**	**1+8=**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. ***Did you count on your fingers?*** **Yes** **No**
2. ***Did you use a number line?*** **Yes** **No**
3. ***Did you use a different strategy?*** **Yes** **No**

Start the timer and begin.

2 + 5 =	**3 + 2 =**	**6 + 2 =**	**2 + 4 =**	**1 + 2 =**
10 + 2 =	**3 + 3 =**	**2 + 8 =**	**7 + 2 =**	**9 + 2 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. Did you count on your fingers?	**Yes**	**No**
2. Did you use a number line?	**Yes**	**No**
3. Did you use a different strategy?	**Yes**	**No**

Start the timer and begin.

5 + 5 =	**2 + 2 =**	**1 + 1 =**	**4 + 4 =**	**0 + 0 =**
10 + 10 =	**3 + 3 =**	**8 + 8 =**	**7 + 7 =**	**6 + 6 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. Did you count on your fingers?	**Yes**	**No**
2. Did you use a number line?	**Yes**	**No**
3. Did you use a different strategy?	**Yes**	**No**

Start the timer and begin.

2 + 3 =	**4 + 5 =**	**5 + 6 =**	**7 + 8 =**	**6 + 7 =**
4 + 3 =	**8 + 9 =**	**1 + 2 =**	**3 + 2 =**	**10 + 9 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. ***Did you count on your fingers?*** **Yes** **No**
2. ***Did you use a number line?*** **Yes** **No**
3. ***Did you use a different strategy?*** **Yes** **No**

Start the timer and begin.

2 + 8 =	**3 + 7 =**	**1 + 9 =**	**6 + 4 =**	**0 + 10 =**
5 + 5 =	**10 + 0 =**	**7 + 3 =**	**8 + 2 =**	**4 + 6 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. ***Did you count on your fingers?*** **Yes** **No**
2. ***Did you use a number line?*** **Yes** **No**
3. ***Did you use a different strategy?*** **Yes** **No**

Start the timer and begin.

4 + 9 =	**9 + 2 =**	**1 + 9 =**	**9 + 9 =**	**9 + 5 =**
10 + 9 =	**9 + 3 =**	**9 + 8 =**	**7 + 9 =**	**6 + 9 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. ***Did you count on your fingers?*** **Yes** **No**
2. ***Did you use a number line?*** **Yes** **No**

3. Did you use a different strategy? **Yes** **No**

Teacher Interview

Another qualitative data collection instrument I will utilize is a teacher interview. Including an interview will balance qualitative items with quantitative in my research. Questioning other teachers will help me answer the research question, "Why is automaticity of math facts important for students?" The interview will focus on how math facts are taught, why they are taught in that fashion and their importance. The answers to these questions will give me insight to commonly taught strategies, which also will address my first research question, as well as the reasons behind using them. Since my interview will answer multiple research questions, it will help complete the data. I will interview the eight first grade teachers in my district since my research focuses on first grade mathematics, but I also want to interview all the teachers in my building to gain a broader aspect of how my school teaches math facts across the grade levels.

I will analyze the teacher interview by coding the transcripts. After reading through the data several times, I will be able to identify reoccurring themes throughout my interviews. Once I have determined common themes, I will go back through the transcripts again and make note of those ideas, similar to the example in Mills (2007) on pages 127-129. For example, I may find many teachers use memorization strategies through drill and timed tests. In that scenario, drill, memorization and timed tests could be common themes to look for in the interview transcripts.

I will interpret the teacher interviews by, "seeking the advice of 'critical' friends" (Mills, 2007, p. 136). Once I have identified the themes of common strategies and purposes from the interviews, I can then seek the advice of other colleagues to help me interpret what this information means. It will be important for me, at this point, to seek the advice of colleagues who

did not complete the interview to limit any bias. On the other hand, it would be beneficial to report back to those teachers, who did complete the interview, to share with them the results of my study. Interpreting the teacher interviews will help me determine which math fact strategies work best and why learning them to the point of automatic recall is important, which I will then be able to implement in my own classroom.

Focus Groups

In order to help answer the question, "Why is automaticity of math facts important for students?" I will use focus groups. This activity will provide me with both qualitative and quantitative data for my research. Groups will be based on students who have mastered their math facts and students who still rely on counting on their fingers or a number line to solve math facts. Results from the math fact pretest will determine which students will be in which groups. Each group will then be asked to solve higher level math problems that involve math facts; for example, questions that involve algebra concepts or word problems. The results of the focus groups will be analyzed by how each group performed overall on the problems. Completing this activity will provide data that shows whether or not students perform better on higher level mathematics if they have first developed automaticity of math facts. The data will be interpreted as students in both groups will continue to be encouraged to develop automaticity of math facts and use those skills to solve higher level math problems.

Problems for Focus Groups (Appendix D)

1. What number should go in the blank? 6+5 = _____+2 _____+4 = 2+2

   3+_____ = 11+1 2+8 = 4+_____ 7+_____ = 5+2

2. Read and solve each word problem.

Two birds sat in a nest.
Eight more birds joined them.
How many birds were there in all?

Ben ate five apples.
Justin ate five apples too.
How many apples did the boys eat all together?

One cat had seven stripes.
Another cat had nine stripes.
How many stripes did the cats have in all?

Olivia had one doll.
Alania had six dolls.
How many dolls did the girls have all together?

There were zero cookies on a plate.
I put four cookies on it.
How many cookies are on the plate in all?

Third and Fourth Grade Math Grades/OAT Scores

The other data collection source used to answer my third research question will be a combination of third and fourth grade math grades and math scores on the Ohio Achievement Test. This quantitative data will show if there is a correspondence between lacking automaticity of math facts and struggling with higher level math problems. I will ask the third and fourth grade teachers in my building for a copy of their math grades and test scores to collect this data. The grades will be analyzed by looking at math fact grades in comparison to overall math grades. Similarly, test scores will be analyzed by reviewing results from test questions which involve math facts and higher level thinking. I will interpret the data by relating it to theory stating a correlation between students who correctly complete higher level math problems and those who have automaticity of math facts.

Data Analysis

Question One

To answer the question, "What math fact strategies work best?" I collected and analyzed quantitative and qualitative data from three sources: students' previous math grades, student journals, and teacher observations with anecdotal notes. These sources show me the new research based strategies are more effective and overall preferred by students than my previous way of teaching math facts. There were a total of nineteen students who participated in this study.

Previous Math Grades

By comparing students' previous grades in math facts to their math fact grades when using the research based strategies, I am able to decide which methods work best. The following chart contrasts students' average math fact grades over six weeks when using the previous methods of strictly flashcards and timed tests and six weeks when using the new strategies.

Student Math Grades Chart

Students	Previous Average (Former methods)	New Average (New methods)
1	88	96
2	53	72
3	100	100
4	68	86
5	100	100
6	64	68
7	98	100
8	72	83
9	100	100
10	92	91
11	98	98
12	93	94
13	53	74
14	88	93

15	98	99
16	87	81
17	73	83
18	79	83
19	52	79

This source contributes to the research because it illustrates student growth from the previous way of teaching math facts to using the new strategies. Seventeen out of nineteen students either stayed the same or improved in their average math grade. The green shows the highest percentages of growth with Student Four's average going from 68% to 86%, and Student Nineteen's average grade going from 52% to 79%. The two yellow rows, Students Ten and Sixteen, are the only students who decreased in their average math grades. The results of all but two students improving in their math grades show the new research based strategies are more effective than the former methods of using only flashcards and timed tests.

Student Journals

Student journals provide interesting qualitative data when determining which math fact strategies work best. Students kept weekly journals over the new math strategies filling in three main areas for each strategy including, how to use the strategy, how they felt about it and why, and any other comments about it. For the Adding Zero and One strategy students demonstrated their understanding of the strategy by explaining, "When it is plus zero you just look at the other number. When it is plus one you just count up one." All nineteen students agreed, this strategy was easy with thoughts similar to, "It's super easy cause I can think it in my head super fast" or "I just look at it and know it in my head." Other comments included more explanations of why they liked it, how easy it was, examples, and even one remark of it being too easy. The Adding Two strategy also proved well liked and easy to use by students when their thoughts were, "It's

easy because you just count up two" and "I love it! It's cool." Students explained this strategy by reverberating a poem they learned, "If you see a plus two that's what you do, go to the other number and count up two!" or they simply stated, "You count up two in your head." Students shared a variety of ways to do the Doubles strategy including, "Memorize the doubles," "Sing the Doubles Rap," and "Just count up the same number." With this strategy, students disagreed saying, "It is easy because you just know it" or "It is hard because some are hard to remember." Other comments, however, were, "I really do like it," "Memorize," and "It's easy as pie." At the Doubles Plus One strategy, all nineteen students, except one, said "This strategy is hard." The one student who disagreed explained, "It is easy because you just do the double and count up one." Although the other students admittedly found this strategy more challenging, they were still able to describe how to do it saying, "First, go to the lower number, do the double, and then count up one more." One student in the section for other comments gave the example, "Because if I have 7+8 you just say ok 7+7=14 so if I just count up one it will be 15." When asked how to do the Sums to Ten strategy students wrote, "Memorize" and "Learn which ones equal ten." They said they liked them because "They are easy" and "All you have to do is remember which ones are ten." For the final strategy, Adding Nine, students correctly explained the process writing, "Go to the other number, count down one and make it a teen." Students were split in their reactions to this strategy saying, "It was hard and easy" and "It was kind of in the middle." In other comments one student stated, "People think it is easy, but it is not." Student journal entries contribute to the research as they show students struggled most with the Doubles Plus One and Adding Nine strategies, while finding the other strategies enjoyable and easy to use. Strategies which work best are the ones students prefer to use and can apply rather than strategies which prove to be challenging, confusing and disliked.

Teacher Observations with Anecdotal Notes

The final source used to determine which math fact strategies work best are teacher observations with anecdotal notes. Throughout the six weeks of teaching the new strategies I wrote down notes of students' reactions, understandings and applications of the strategies. These detailed observations contribute to the research because they identify students' thoughts on the strategies on a daily basis. They also show how students did on timed tests throughout the week and on a non-timed test at the end of the week. In the first week, when learning the Adding Zero and One strategy, students made comments such as, "This is too easy," "This is kindergarten stuff," and "I can do it without thinking about it!" Students then proved their understanding by being able to apply their knowledge on timed tests where, by the third day of taking the test, all nineteen students earned 100% at least once. On the non-timed test, sixteen out of nineteen students received 100%, with the three who did not missing one or two problems. Adding Two was another strategy students were comfortable with, still commenting on its ease, though not as often as the first strategy. On the timed tests only four students out of nineteen did not reach 100%, but their tests showed they understood the concept, but did not finish in time. On both the timed tests and the non-timed test, every student made improvements in Adding Two using the new methods from when we did it at the beginning of the year using the old strategies. The Doubles strategy was liked by students more when I introduced "The Doubles Rap" a song to help remember the math facts. Twelve out of nineteen students had 100% on the timed tests, and the seven who did not struggled on any facts above 5+5. On the non-timed test, eleven students had 100%, four earned 97%, two had 91% and one student received 75%. Students' reactions were more negative with the Doubles Plus One strategy. Since it is a more complex strategy, I had to explain and give examples several times before they understood how to use it. By the end

of the week, students said they were still confused; however, most of them were applying it correctly. The timed test results were considerably lower on this week with only five students earning 100%. The non-timed test was similar with five 100%'s, five A's either 94% or 97%, three B's at 88% or 91%, two 81%'s, one 63%, and one 13%. The student who had only 13% added up one, skipping the do the double step, showing a complete lack of understanding. These lower results show the difficulty of this strategy. The Sums to Ten strategy was easier for the students, who seemed comfortable using the strategy by the end of the week, but frequently forgot 3+7 and 4+6. Sixteen out of nineteen students received 100% on their timed tests, demonstrating their understanding. On the non-timed test thirteen students earned 100%, four others had A's with 94% or 97%, one student had 91%, and the same student who earned 13% on Doubles Plus One had 41% on this test. Although the other students did well, this particular student showed a lack of understanding by writing random numbers for the answers. Students thought the final strategy, Adding Nine, was difficult at first, but showed some improvements by the end of the week. The timed tests for this week had overall lower grades than any other strategy with two students earning 95%, one 90%, one 75%, four 70%'s, one 55%, one 50%, and one 45%. Students did somewhat better on the non-timed test, which indicates an understanding of the strategy, but a lack of speed when using it. Eleven students out of nineteen had 100%, two had 97%, one earned 94%, one received 91%, two had 84%, one had 78%, and one had 75%. Overall these observations of student reactions, understandings and applications show students enjoy and understand the new strategies, but struggle with Doubles Plus One and Adding Nine.

Each of these three sources, previous math grades, journals and teacher observations, help me understand what math fact strategies work best. Both the qualitative and quantitative data contribute by revealing an improvement in student knowledge of math facts when using the

new methods. When examining which strategies work best, one is also considering the impact strategies have upon student understanding.

Question Two

I was able to answer the question, "How do math fact strategies impact student learning?" by collecting data from and analyzing math fact pre-tests, parent surveys, and math fact post-tests. These three sources show me how the research based strategies can positively impact student understanding of math facts.

Pre-test

The first source used to answer this question was a math fact pre-test. The pre-test contributes data by showing how students solved math facts before being taught the new research based strategies. For each section students could have counted on their fingers, used a number line, or used a different strategy, meaning they knew a strategy of how to solve the problem other than counting on fingers and using a number line, or they had it memorized. Students could use any combination of these methods. For example, they might have counted on their fingers for a few facts in a section while having the others memorized. It also tells how long students took to answer each strategy section, which will be compared to their times on the post-test.

Students' best results were with the strategy Plus Zero and One. It indicates eighteen out of nineteen students used a strategy other than counting on their fingers or a number line, three out of nineteen counted on their fingers, and three out of nineteen counted up using a number line. Students averaged one minute and eleven seconds on this section. Next, sixteen out of nineteen students used a different strategy to solve Plus Two math facts, eleven out of nineteen students counted on fingers, and eight out of nineteen used number lines to solve the math problems, averaging two minutes and six seconds for the ten problems. Students demonstrated

previous knowledge of Doubles as nineteen of nineteen students used a different strategy on at least one of the Doubles facts, eight of nineteen students counted on their fingers, and six of nineteen used a number line, while averaging one minute and forty-two seconds. On the Doubles Plus One section, students started relying more on their fingers and number lines as only thirteen out of nineteen used a different strategy, fourteen of nineteen counted on their fingers and seven of nineteen used number lines. In this section, students' struggles also show in their times by averaging two minutes and fifty seconds. When students reached the Sums to Ten section, while they did comment, "A lot of these are ten!" they still relied heavily on their fingers and number lines to help solve the problems with fifteen of nineteen using a different strategy, fifteen of nineteen counting on fingers, and six of nineteen using a number line completing it in an average of one minute and forty-three seconds. The last section, Plus Nine, proved to be the most challenging for students. Even though twelve of nineteen students used a different strategy, none of them used the Plus Nine strategy; rather they used strategies they knew, such as Plus One for 9+1. Fifteen of nineteen students counted on their fingers, and seven of nineteen students used number lines averaging the slowest time, two minutes and fifty-six seconds to answer ten math facts. Because of this data, I know which strategies students knew the best, Plus Zero and One as well as Doubles, and which they knew the least, Doubles Plus One and Plus Nine.

Parent Survey

Another source I used to determine how math fact strategies impact student learning were parent surveys. Of nineteen parent surveys sent home, ten were returned, although the numbers do not always add up to ten because sometimes parents circled both responses or left it blank. The parent surveys contributed because they gave insight into which math fact strategies were

preferred by students and parents at home, if parents saw a change in their child's math grades or attitude, and it allowed me to see any miscommunications between home and school with regards to the strategies. When asked, "Do you feel the previous way of using flashcards and timed tests to teach math facts was effective?" six parents said yes, and two parents said no. To the question, "Does your child practice math facts at home?" nine parents answered yes and one said no. Seven parents said they feel the new math fact strategies are effective, while two said they are not. Parents responded to the question, "Did your child like learning math facts by using flashcards and timed tests?" with six saying yes and four replying no. An encouraging seven out of ten parents said yes to the question "Does your child like learning math facts by using the new math fact strategies?" while only one said no. Two parents said they would recommend using the old methods for teaching math facts, while seven parents preferred the new strategies. When asked if they have seen a change in their child's attitude towards learning math facts since starting the new strategies, one parent responded no, while seven parents said yes with five indicating a positive change and one saying the change was negative. The next question was, "Have you seen a change in your child's grade in math facts since starting the new strategies?" to which three parents said no, and six said yes with four marking it was a positive change, and two saying it was negative.

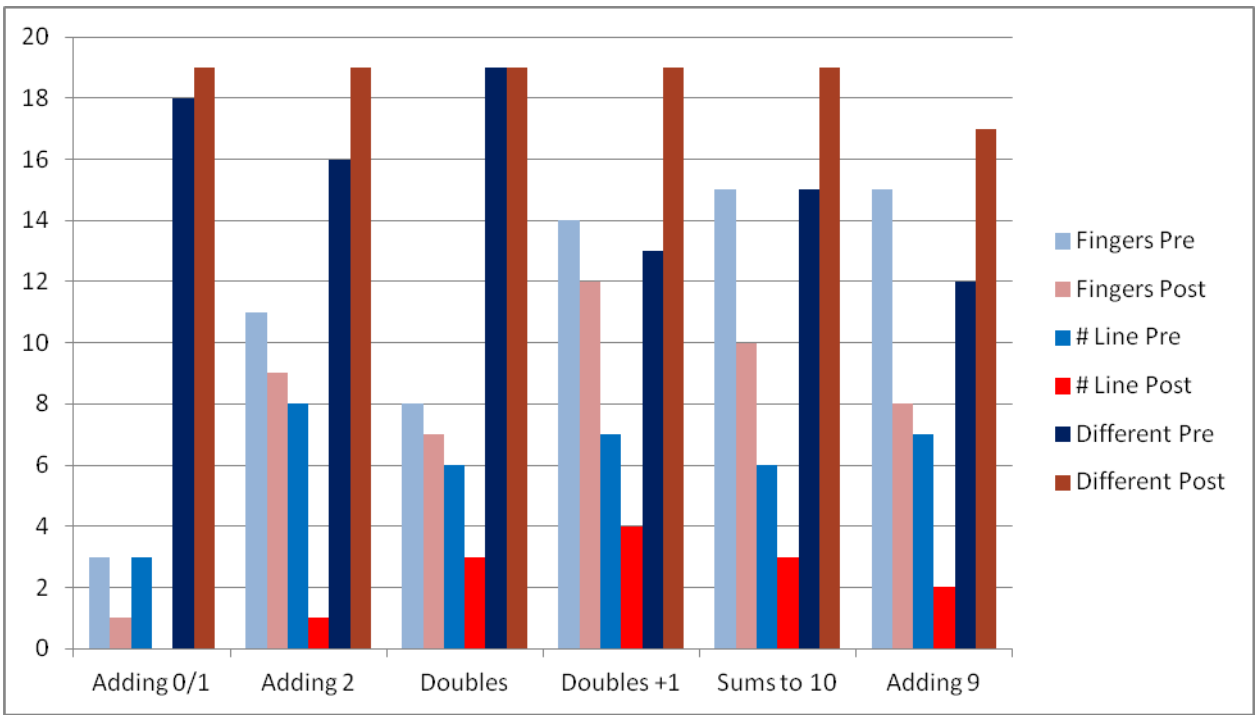
Besides the circle your response section of the survey, there was also an area for other comments, which four out of the ten surveys included. One parent remarked, "I think the new strategies will stick with them throughout life. I can still remember strategies like that from being in school. I feel that the same thing can happen from your new strategies." Another parent wanted to clarify some of their responses saying, "The only reason I said no about the old ways being effective is because my child has anxiety about the timed tests. He worries about it so

much that I think he gets so caught up in how much time is left that he hurries through and doesn't do as well as he could." Then I had two parents with negative comments, although they both were misinformed in some way. These comments were results of miscommunication, and both students discussed actually showed improvement at school when using the new strategies. The first parent said, "Negative change in child's grade because he dropped a letter grade on recent report card in math." When I looked at his math grades, however, his drop was in other areas in math, not in math facts. In math facts, he went from 88% with the old methods to 93% using the new strategies. The other parent commented, "The new strategies seem to confuse him. I believe he is misunderstanding how the new strategies work, and I can't figure out how he's trying to explain them to me." This student's grade in math facts actually went from 73% with the old methods of timed tests and flashcards to 83% with the new strategies. In class he seemed to do very well using the strategies with the exception of Doubles Plus One and Adding Nine, which are the two most challenging strategies to learn. These results showed that parents found a combination of the old methods and new strategies to be the most effective and preferred, while leaning more towards using the new ways.

Post Test

The final source used in this section, a math fact post test, correlates with the pre-test. The post test contributes data because it shows the methods students used to solve math facts after learning the new research based strategies, and how long students took to answer each strategy section, in comparison with the pre-test. The following is a chart which shows the pre and post test data of how students solved the math facts in each strategy section.

Pre/Post Test Graph



Overall, the results show students used their fingers or a number line less to solve each section on the post test than they did on the pre-test. Furthermore, all nineteen students used a different strategy on every section, except in Adding Nine, where two students used only their fingers or a number line to solve all ten equations. These results inform me of students' better understanding of math facts when using the new strategies, rather than the former way. On Adding Zero and One, only one student used their fingers, zero students used a number line and all nineteen used a different strategy. Students lowered their average speed in this section from one minute and eleven seconds to thirty-seven seconds. Next, nineteen out of nineteen students used a different strategy to solve Plus Two math facts, nine out of nineteen students counted on fingers, and only one out of nineteen used a number line to solve the math problems. Students lowered their average speed from two minutes and six seconds to one minute and five seconds.

Again, nineteen of nineteen students used a different strategy to solve Doubles, seven of nineteen students counted on their fingers, and three of nineteen used a number line, while averaging twenty-nine seconds less than their previous time with one minute and thirteen seconds. Although the numbers did decrease, Doubles Plus One proved to remain the most challenging section for students as twelve of nineteen students still counted on their fingers and four of nineteen used number lines. However, all nineteen students were able to use a different strategy for at least one of the ten problems, and students improved their time by going from two minutes and fifty seconds down to one minute and forty-four seconds. Students seemed to forget about the Sums to Ten strategy because ten of nineteen still counted on fingers and three used a number line, although nineteen of nineteen were able to use a different strategy too. Students completed this section in an average of one minute and eleven seconds, down from their previous one minute and forty-three seconds. The last section, Adding Nine, ended up being the most improved area for students. The number of students using their fingers dropped from fifteen of nineteen to only eight of nineteen. Likewise, students using a number line decreased from seven of nineteen students to two of nineteen. In the pre-test students averaged the slowest time in this section at two minutes and fifty-six seconds to answer ten math facts; however, they were able to lower that time down to one minute and thirty-two seconds on the post test. When comparing the pre and post tests, I am able to determine students best understand the Adding Zero and One strategy, still struggle some with the Doubles Plus One strategy, and improve greatly when learning the Adding Nine strategy. The data showing the reduction in how long it took students to solve the ten problems in each section contributes because it shows the more students understand math facts, the faster they can solve them.

By collecting the qualitative and quantitative data from math fact pre and post tests and parent surveys, I understand the positive influences math fact strategies have on student learning. After considering the impact math fact strategies have on student understanding, a new question emerges inquiring why students need to know math facts with rapid recall.

Question Three

The research question, "Why is automaticity of math facts important for students?" was answered through teacher interviews, student focus groups, and math grades of third and fourth graders along with their Ohio Achievement Test (OAT) scores. While these three sources were the most difficult to collect and analyze, the results clearly show why it is beneficial for students to know their math facts automatically.

Teacher Interviews

Four teachers were interviewed to determine how various teachers teach math facts and why it is important for students to develop automaticity of math facts. When asked, "How do you teach math facts to your students?" three of four teachers mentioned using timed tests and flashcards, although they also added these tools are only used as reinforcements, not formal assessments. Three teachers also said they use computer programs or games to teach math facts. Three of four teachers identified math strategies, such as Adding Nine, Doubles and Sums to Ten as other teaching methods. These responses show me most teachers use a combination of strategies to teach math facts. The second question was related to the first, asking why they teach math facts the ways they stated. Three of four teachers discussed using a variety of strategies in order to reach all types of learners, while one educator said, "Strategies seem to help my students learn and understand their facts more than rote memorization." Question three deals directly with automaticity of math facts by asking why rapid recall of math facts is important for

students. Two teachers discussed the value of having automaticity because quickly adding math facts is a skill needed in everyday life. Another teacher talked about how the basic skills must be solid for students to be successful at higher level math, even in two and three digit addition. This teacher added, "Students seem to understand the regrouping process, but make mistakes on basic addition and/or subtraction facts." The surprising response came from the third grade veteran teacher who said, "I don't necessarily think it's important to have rapid recall, but it is a means for them to learn their facts." This answer shocked me because I thought this teacher would be more insistent about automaticity as she teaches even higher level math than I do. When asked how their students typically solve math facts, teachers had a variety of responses. Three of four said students count on their fingers, two teachers mentioned number lines and two teachers said students use Touch Math. Other answers included using the math fact strategies, manipulatives and memory. The next question was to discuss whether they encourage rote memorization of math facts or understanding of the math fact strategies and why. Two teachers said they focus on students learning the strategies because students need to learn how to apply math concepts. One teacher said she uses both by teaching the strategies, but when the class has a hard time remembering a certain math fact, they work on memorizing it. The other teacher said he does not focus on any one strategy, but introduces them all then encourages memorization. When asked whether or not their students struggle with rapid recall of math facts, two teachers said no, the majority of their students do well with them, while the other two teachers said yes, they struggle. I was not surprised when one of the teachers who said yes, her students struggle, was the same teacher who said she did not consider rapid recall of facts important. If a teacher does not encourage students to develop automaticity of math facts, they will most likely struggle in being able to recall their facts rapidly. The final question was whether or not their students

enjoyed learning and solving math facts to which all four teachers answered yes, all discussing the ways they make them fun for students. One teacher added if students are good at their math facts they enjoy them, but the ones who struggle with remembering them become frustrated with trying to solve them. The responses to my interview questions contribute because they demonstrate the emphasis teachers place on learning math facts, how they teach them, and how students respond to those teaching methods. Overall, teachers discussed the benefits of students developing automaticity of math facts by using a combination of teaching strategies.

Focus Groups

To also answer the question about the importance of automaticity of math facts, students solved higher level math problems which included basic math facts in focus groups. Based on students' math fact strategy pre-test scores, five students were placed in a low group, and seven students were placed in a high group. The students were given the same problems, but their responses differed greatly. On the first section of problems, which had algebra concepts, only one student of five in the low group understood and could solve the problems. The other students were confused, not wanting to try. They used number lines, counted on their fingers, or guessed a number to fit in the blank. Students said, "They are hard because there were a whole bunch of numbers" and "There were a lot I didn't know." The high group, however, had six of seven students understand the problems and solve them correctly. This set of students solved the problems much faster than the lower group, with less confusion overall. Only two students in this group relied on their fingers to help them answer the problems, the rest used the new math strategies to help them, or already had the facts memorized. Students in the high group said, "Some were easy, but some where a little harder because I had to think in my head" and "They were easy, you just use all the strategies." These results show when it comes to higher level

math, the students who already have automaticity of math facts are quicker to understand new concepts. This data also indicates students who lack automaticity struggle, not only because the concept is new, but because they do not have a strong foundation of math facts to help them.

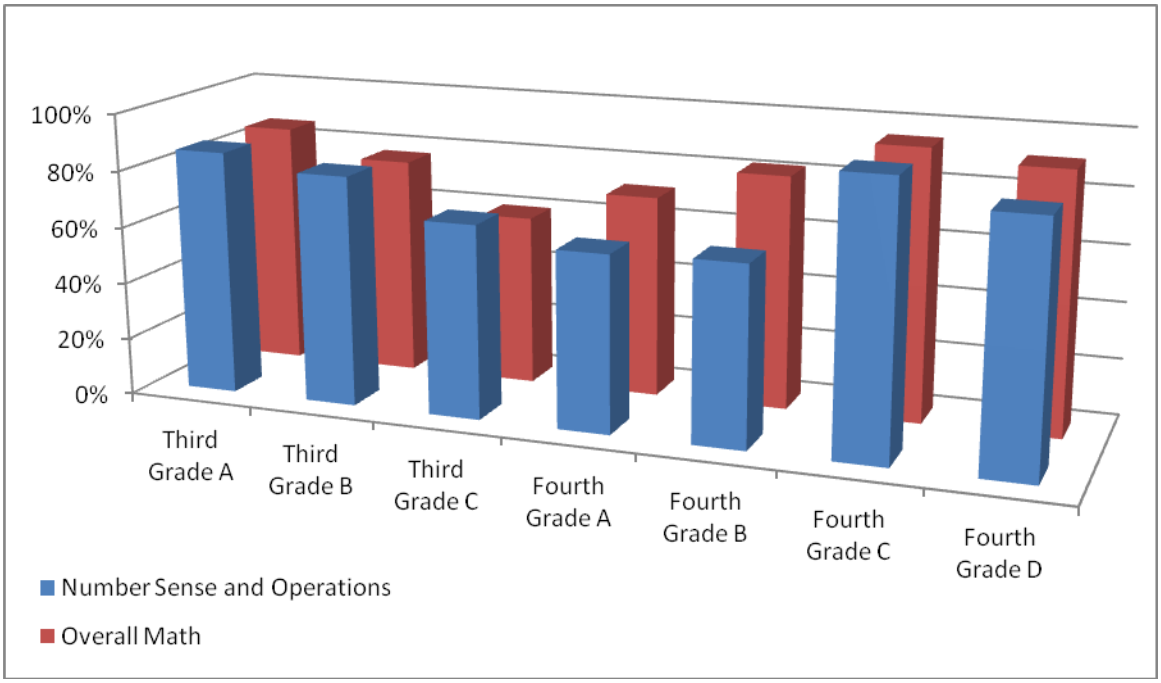
The other section of math problems the focus groups did were word problems with basic math facts. Because a word problem was a concept we already covered, students knew how to solve these problems with five of five students in the low group and seven of seven in the high group all understanding the problems. Of them students said, "They are easier to figure out," "They are easier because you just write the numbers they tell you," and "They are easy because you get to read the stories and then try to use the strategies." When making observations however, I did notice slight differences in the groups. While the low group solved the problems quickly and correctly, they all still counted on their fingers or a number line for at least one of the problems, whereas the high group had the math facts memorized or used the strategies. Since the low group was relying more on the older strategies, they took longer to solve the problems. The high group, having automaticity of most of the math problems, completed the problems faster. This data contributes because it shows when students have automaticity of math facts, they can solve higher level problems involving math facts faster than those who rely on other tools to help them count.

Third and Fourth Grade Math Grades and Test Scores

The final data used to determine the importance of automaticity of math facts are third and fourth graders' average math grades and test scores on the Ohio Achievement Test (OAT). When looking at third and fourth grade OAT results in mathematics, there is a definite correlation between doing well in Number Sense and Operations (math facts) and doing well

overall. The data in the following graph contributes because it indicates students who did better on the Number Sense and Operations portion had higher overall percentages in mathematics.

OAT Results Comparison Graph



As shown in the graph, students who did well on the Number Sense and Operations section of the test did better overall as well, while students who struggled with math facts were less proficient on the test as a whole. It should be added, this was not the case in every section of the test. For example, in the Geometry and Spatial Sense portion, Third Grade C had the highest percentage with 96%, Third Grade B had 93%, and Third Grade A had 90%. This data shows how math facts in particular affect one's overall success in mathematics.

To determine if this relationship is also true in the classroom on a daily basis, I examined third and fourth graders' math grades. Nineteen of forty-six students earned A's in their math facts while eighteen of forty-six earned A's in their overall math grades. Only three students of forty-six received A's in their math facts but not their math grades overall. Similarly, two

students of forty-six earned A's in their overall math, but not in their math facts. This data contributes because it indicates students who do well in math facts, or have developed automaticity, typically do well in math overall.

Furthermore, when I asked teachers for their grades, I also asked them if they saw a correlation between students' grades and test scores based on whether or not students knew their math facts automatically. Teachers agreed, students who have automaticity of math facts typically have higher math grades and test scores than students who struggle with math facts or count on their fingers or a number line. These results contribute by indicating students with automaticity of math facts are more likely to have higher math grades and test scores.

The data from all three sources directed at question three share the idea of automaticity of math facts being important in order for students to be able to do higher-level math problems without the added complications of having to count up using their fingers or a number line. The qualitative and quantitative data collected and analyzed from these nine sources answers the three posed research questions; however, the data is of no use if it is left in this stage. The questions must be asked, "Now what? What is to be done with this information concerning the effects of various math fact strategies on student mastery?"

Action Plan

This action research project has taught me many things about teaching math facts which I will not only use to improve my instruction, but will share with other educators as well. Overall, I have learned the best way to teach math facts is a combination of the research based strategies with timed tests and flashcards as reinforcement. While it is important for students to learn how to count up using their fingers, manipulatives or a number line, this research shows students who develop automaticity of math facts through other strategies benefit more long term. For this

reason, when teaching math facts I will focus on teaching the strategies while using timed tests and flashcards as supporting activities. From this data, I have learned when teaching the math strategies it would be beneficial to spread out the more challenging strategies, such as Doubles Plus One and Adding Nine, over the course of at least two weeks, instead of one; although, every classroom will be different and may need more or less time on a certain strategy. Out of the nine data sources, I felt students' math grades and the pre and post tests were the most useful quantitative data, while teacher observations and teacher interviews were the most beneficial qualitative data. I also found the parent survey to be a valuable resource and a tool I should use more often even in other content areas. I will share this project with other educators by submitting it to educational journals and explaining the data to my colleagues so they too can understand the effects of various strategies on student mastery of first grade mathematics. In the end, the goal of this project, determining the effectiveness of various math fact strategies, was accomplished.

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Appendices

Data Collection Matrix (Appendix A)

Research Questions	1	2	3
1.What math fact strategies work best?	Previous math grades	Student Journal	Teacher observation with anecdotal notes
2. How do math fact strategies impact student learning?	Math fact pre-test	Parent survey	Math fact post-test
3. Why is automaticity of math facts important for students?	Teacher Interview	Focus Groups (Group that knows math facts & Group that does not) – Solving higher level math	3rd and 4th grade teachers' math assessment grades/OAT scores in math

Math Fact Parent Survey (Appendix B)

Please complete the survey. Your name and your child's name will not be included in the sharing of the results. Thank you!

Do you feel the previous way of using flashcards and timed tests to teach math facts was effective?	**YES**	**NO**
Does your child practice math facts at home?	**YES**	**NO**
Do you feel the new math fact strategies are effective?	**YES**	**NO**
Did your child like learning math facts by using	**YES**	**NO**

flashcards and timed tests?

Does your child like learning math facts by using the new math fact strategies? **YES** **NO**

Would you recommend using the old or new methods for teaching math facts? **OLD** **NEW**

Have you seen a change in your child's attitude towards learning math facts since starting the new strategies? **YES** **NO**

(If yes, positive or negative?) **POSITIVE** **NEGATIVE**

Have you seen a change in your child's grade in math facts since starting the new strategies? **YES** **NO**

(If yes, positive or negative?) **POSITIVE** **NEGATIVE**

Other comments? _____

_____

_____

_____

Math Pre/Post Test (Appendix C)

Directions: Time yourself as you solve these problems. Stop the timer when you have solved them all, then answer the questions about them.

Start the timer and begin.

2+1=	**1+3=**	**0+1=**	**7+1=**	**5+0=**
0+3=	**1+4=**	**7+0=**	**9+1=**	**1+8=**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. Did you count on your fingers?	**Yes**	**No**
2. Did you use a number line?	**Yes**	**No**
3. Did you use a different strategy?	**Yes**	**No**

Start the timer and begin.

2 + 5 =	**3 + 2 =**	**6 + 2 =**	**2 + 4 =**	**1 + 2 =**
10 + 2 =	**3 + 3 =**	**2 + 8 =**	**7 + 2 =**	**9 + 2 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. Did you count on your fingers?	**Yes**	**No**
2. Did you use a number line?	**Yes**	**No**
3. Did you use a different strategy?	**Yes**	**No**

Start the timer and begin.

5 + 5 =	**2 + 2 =**	**1 + 1 =**	**4 + 4 =**	**0 + 0 =**
10 + 10 =	**3 + 3 =**	**8 + 8 =**	**7 + 7 =**	**6 + 6 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. *Did you count on your fingers?* **Yes** **No**
2. *Did you use a number line?* **Yes** **No**
3. *Did you use a different strategy?* **Yes** **No**

Start the timer and begin.

2 + 3 =	**4 + 5 =**	**5 + 6 =**	**7 + 8 =**	**6 + 7 =**
4 + 3 =	**8 + 9 =**	**1 + 2 =**	**3 + 2 =**	**10 + 9 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. *Did you count on your fingers?* **Yes** **No**
2. *Did you use a number line?* **Yes** **No**
3. *Did you use a different strategy?* **Yes** **No**

Start the timer and begin.

2 + 8 =	**3 + 7 =**	**1 + 9 =**	**6 + 4 =**	**0 + 10 =**
5 + 5 =	**10 + 0 =**	**7 + 3 =**	**8 + 2 =**	**4 + 6 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. *Did you count on your fingers?* **Yes** **No**
2. *Did you use a number line?* **Yes** **No**
3. *Did you use a different strategy?* **Yes** **No**

Start the timer and begin.

4 + 9 =	**9 + 2 =**	**1 + 9 =**	**9 + 9 =**	**9 + 5 =**
10 + 9 =	**9 + 3 =**	**9 + 8 =**	**7 + 9 =**	**6 + 9 =**

Stop the timer.

Time it took to solve the problems: _____

How did you solve these problems? *(Circle)*

1. Did you count on your fingers?	**Yes**	**No**
2. Did you use a number line?	**Yes**	**No**
3. Did you use a different strategy?	**Yes**	**No**

Problems for Focus Groups (Appendix D)

1. What number should go in the blank? 6+5 = _____+2 _____+4 = 2+2

   3+_____ = 11+1 2+8 = 4+_____ 7+_____ = 5+2

2. Read and solve each word problem.

   Two birds sat in a nest.
   Eight more birds joined them.
   How many birds were there in all?

   Ben ate five apples.
   Justin ate five apples too.
   How many apples did the boys eat all together?

   One cat had seven stripes.
   Another cat had nine stripes.
   How many stripes did the cats have in all?

   Olivia had one doll.
   Alania had six dolls.
   How many dolls did the girls have all together?

   There were zero cookies on a plate.
   I put four cookies on it.
   How many cookies are on the plate in all?

Student Math Fact Strategy Journal (Appendix E)

This week we learned the _____ math fact strategy.

You use this strategy by _____

_____

_____

_____.

This strategy is _____ because _____

_____

_____

_____.

Other thoughts about the strategy: _____

_____

_____

_____.

Teacher Observation Form (Appendix F)

Section 1 – *Plus 0/1*

Student reactions:_____

_____

_____

Student understandings:_____

_____

_____

Student applications: _____

_____

_____

Section 2 – *Plus 2*

Student reactions:_____

_____

_____

Student understandings:_____

_____

_____

Student applications: _____

_____

_____

Section 3 – *Doubles*

Student reactions:_____

_____

_____

Student understandings:_____

_____

_____

Student applications: _____

_____

_____

Section 4 – *Doubles Plus 1*

Student reactions:_____

_____

_____

Student understandings:_____

_____

_____

Student applications: _____

_____

_____

Section 5 – *Sums to 10*

Student reactions:_____

_____

_____

Student understandings:_____

_____

_____

Student applications: _____

_____

_____

Section 6 – *Adding 9*

Student reactions:_____

_____

_____

Student understandings:_____

_____

_____

Student applications: _____

_____

_____

Teacher Pre/Post-test Observations (Appendix G)

Section 1 – *Plus 0/1* – **Did the student:**

Count on fingers? **Use a number line?** **Use a different strategy?**

Comments:_____

_____

_____

Section 2 – *Plus 2* – **Did the student:**

Count on fingers? **Use a number line?** **Use a different strategy?**

Comments:_____

_____

_____

Section 3 – *Doubles* **- Did the student:**

Count on fingers? **Use a number line?** **Use a different strategy?**

Comments:_____

_____

_____

Section 4 – *Doubles Plus 1* **- Did the student:**

Count on fingers? **Use a number line?** **Use a different strategy?**

Comments:_____

_____

_____

Section 5 – *Sums to 10* **- Did the student:**

Count on fingers? **Use a number line?** **Use a different strategy?**

Comments:_____

_____

_____

Section 6 – *Adding 9* **- Did the student:**

Count on fingers? **Use a number line?** **Use a different strategy?**

Comments:_____

_____

_____

Teacher Interview (Appendix H)

1. How do you teach math facts to your students? (i.e. Timed tests, flashcards, strategies: doubles, nines trick, etc., computer games)

2. Why do you teach math facts that way?

3. Why is it important for students to be able to rapidly recall math facts?

4. What strategies do your students use to solve math facts? (i.e. Count on fingers, use a number line, etc.)

5. Do you encourage rote memorization through drills or do you focus on math strategies? (i.e. Doubles, sums to ten) Why?

6. Overall, do your students struggle with rapid recall of math facts?

7. Overall, do your students enjoy learning/solving math facts?