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Evaluation of FASTT Math

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Running Head: EVALUATION OF FASTT MATH

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Abstract

FASTT Math is an online, computer-based program that helps students develop fluency with basic math facts. FASTT Math can be used by students in second grade and up. Monroe Public Schools implemented this program in 2008 as a way to help improve fact fluency in the elementary grades. An evaluation of the effectiveness of the program was conducted and recommendations for future use are provided.

Evaluation of FASTT Math

Monroe Public Schools first offered FASTT Math in 2008. FASTT Math is an online, computer-based program that helps students develop fluency with basic math facts. FASTT Math can be used by students second grade and up. Prior to student use, teachers may differentiate lessons as they set individual parameters for student use. Students take an initial placement assessment for the math operation (+, -, x, ÷) the teacher has assigned. This assessment should take 15 to 20 minutes to complete. As part of this initial assessment, students will complete a typing test which allows FASTT Math to distinguish typing time in relation to their fast fact time.

Upon completing the placement assessment, students will view the fact grid for the first time. This will display their assigned "focus facts, "fast facts," and "study facts." A fast fact is identified as a fact that a student can answer correctly and fluently in at least 0.8 seconds, focus facts are facts that a student is receiving instruction on and usually take 1.25 seconds or less to answer, and study facts are facts that students continually respond slowly or incorrectly to or have not encountered for instruction (Goins & Hasselbring, 2007). This visual reminder is a valuable tool that allows students to monitor their progress, success, and areas of difficulty. The fact grid (Figure 1) will appear to students each time that they log in to begin a lesson, and prior to signing out. As student's master facts, their progress is displayed on the Fact Grid. After focus facts and fast facts are assigned, students complete lessons at least three times a week. Each of these lessons will take approximately ten to twelve minutes to complete.

Figure 1. Fact Grid

Subsequent to completing the lesson on the operation and facts that the student is concentrating on, the student will have the opportunity for independent practice. FASTT Math incorporates this independent practice time to motivate the student and increase fact fluency in an interactive game format. There are nine games (Figure 2) that the student can choose from, regardless of the facts or operation they are working on. The software adjusts the games to include a set of 70 problems that consist of a combination of focus and fast facts that are most current to what the student has learned so it reinforces the skill set being developed through the lessons. For example, a student may choose to play the *Bubble Buster* game where a series of fact questions must be answered in order to pop the bubbles. It is required that the student complete the daily lesson prior to playing one required independent practice game. However, the student can play additional practice games as permitted by the teacher. If a

Figure 2. Students can choose a game that is appealing to them as independent practice with their focus facts and fast facts.

student logs out after completing the lesson and independent practice they can log back in on the same day to play additional practice games if needed (Goin & Hasselbring, 2007).

The creators of FASTT MATH believe the program differs from traditional "drill and practice" software in many ways. FASTT MATH is individualized. Students do not waste precious time on facts they already know. Instead, the creators believe the software instructs students only on facts they are not fluent with by "presenting small, manageable amounts of new information" (Goin & Hasselbring, 2007). It also provides immediate feedback for students and has an option for custom worksheets to support transfer to paper and pencil.

FASTT Math was introduced to Monroe Public Schools during the 2008-2009 school year. Stakeholders in the implementation of this program include district administrators, teachers, and parents/community members. The goals behind implementation include:

1. To help students work towards fluency with basic math facts while participating in the FASTT MATH program.

2. To eliminate the responsibility of teaching rote memorization of math facts so teachers can focus more on the other aspects of math (application, problems solving, etc.).

3. To satisfy parents' desire for more student practice with basic math facts.

The FASTT MATH program was funded mostly by the Monroe County Intermediate School District (MCISD). Monroe Public Schools is only responsible for a small portion of the license fee. It is also interesting to note that while Monroe Public Schools has a Math Committee made up of consultants, coaches, and teachers, they are not necessarily considered stakeholders in the project. Many opposed the use of FASTT MATH because they felt it did not support current research in mathematical development in children.

FASTT Math has been used in a variety of ways across Monroe Public Schools since its implementation. Teachers may choose to implement it during Math Workshop, Intervention/Enrichment time, or Technology. Teachers create the student accounts through Scholastic Achievement Manager. Students use their individual student number as their username, and the universal password for the district is "mps" in order to have access to the software. Teachers participating in one-to-one pilots also can assign FASTT Math as homework in place of implementation in the classroom or for additional instruction for particular students who are struggling in math. Teachers who are not participating in the one-to-one pilot do not assign FASTT Math as homework because not all students have equal access to the internet. If students have internet access, they can log in at home if they choose to. There is also an option that allows the teacher to create customizable worksheets based on the operation that the student is working on that could be used as homework or for additional practice.

Teachers can track student progress using the Scholastic Achievement Manager. They can run reports for each child or for the entire class. These reports show frequency of student use, number of focus facts, number of lessons students completed, the average time it takes for the student to complete a lesson, etc. (Figure 3). At this time, there is no parent portal for FASTT Math. If parents are curious about student progress they need to contact their child's teacher.

PROGRESS MONITORING

Progress Report

TEACHER: AMANDA IOCOANGELI

SCHOLASTIC FASTT Math

School: Waterloo Elementary
Grade: K, 1, 2, 3, 4, 5, 6

Time Period: 05/16/11 – 05/20/11

				PERFORMANCE (CURRENT)			USAGE			
STUDENT	OPERATION	DATE STARTED OPERATION	PLACEMENT ASSESSMENT FAST FACTS	FAST FACTS	FOCUS FACTS	STUDY FACTS	AVG. INSTRUCTIONAL TIME PER LESSON (MIN.)	AVG. LOGIN TIME (MIN.)	AVG. LESSONS PER WEEK	LAST LOGIN
Bloniarz, Lukas	Division (0-12)	02/16/11	40	84	7	65	8.6	8.6	4	05/19/11
▸Carroll, Joshua	Multiplication (0-12)	11/20/09	46	108	8	53	15.4	15.4	▸0	05/18/11
Dehner, Keiara	Division (0-12)	03/04/11	81	142	8	6	7.7	7.7	4	05/19/11
Johnson, Dominic	Multiplication (0-12)	11/20/09	76	124	8	37	14.4	14.4	3	05/19/11
▸Miranda, Gustavo	Multiplication (0-12)	12/18/09	52	102	2	65	8.5	8.5	▸1	05/17/11
▸Oliver, Ryekal	Multiplication (0-12)	12/18/09	27	▸69	24	76	15.8	15.8	3	05/19/11
Punches, Britney	Division (0-12)	03/25/11	87	133	2	21	10.8	11.5	4	05/19/11
▸Shopshire, Adam	Division (0-12)	04/20/11	32	▸50	6	100	7	7	4	05/19/11
Stepp, Hunter	Division (0-12)	03/14/11	31	82	9	65	10.4	10.4	4	05/19/11
Tyler, Amy	Multiplication (0-12)	12/18/09	42	110	0	59	10.7	10.7	4	05/20/11

Figure 1. Progress Report

Our team of three evaluators will be completing a summative evaluation of FASTT Math. Our evaluation will include two parts: teacher attitude/implementation and student achievement. We will begin by evaluating how teachers' attitudes affect implementation through an online survey. Results will be analyzed to determine whether teachers are using the program as it was intended by the district. The second part of the project will evaluate the effectiveness of FASTT Math as an instructional tool for supporting math fact fluency by comparing student progress for a month. Results will also be compared with students who do not use FASTT Math as an instructional tool. This will allow us to better determine the effectiveness of the program and give recommendations for future use. As evaluators, we have a vested interest in the outcome of this project because we are Monroe Public Schools teachers and want the best for our students. However, we will be objective with data analysis. The

purpose of this evaluation is to determine the effectiveness of FASTT Math versus traditional interventions in our school district.

To learn more about FASTT Math, go to http://www.tomsnyder.com/FASTT Math/index.html.

Literature Review

Developing automaticity with math facts has been a concern among researchers for many years. Automaticity refers to a student's ability to respond to a certain fact quickly, accurately, and without much thought (Poncy, Skinner, & Jaspers, 2007; Parkhurst et al., 2010). Research has shown that automaticity has been linked to a student's ability to "learn, develop and/or apply advanced math skills" such as estimating or mental math skills (Shapiro, 2004; Woodward, 2006). In addition, automaticity frees up cognitive resources or space so that students are able to become better problem solvers. "Without automatization of these basic computations, their solution uses cognitive capacity for problem solving," (Gagne, 1983).

A 2008 study conducted by the National Mathematics Advisory Panel (NMAP) showed that students in the United States are lacking in important math skills when compared to students in other countries (Poncy, Skinner, & Axtell, 2010). In addition, the National Center for Education Statistics (2009) found that our nation's fourth graders did not show overall improvement on the math portion of the national assessment in 2009. This is the first time since 1990 that improvement was not made. Attention must be paid to basic math fact fluency in order for students to continue to grow as mathematicians.

According to the National Council of Teachers of Mathematics (NCTM), understanding is essential in learning mathematics (2009). Students must use prior knowledge and experience

to build on in order to make understanding. Additionally, conceptual knowledge, skills, and problem solving should be developed simultaneously. In order to create a rich, connected learning experience, students must be able to apply basic fact knowledge to real world context (NCTM, 2009). Models for mathematical thinking have become a popular way to encourage students to develop appropriate strategies for working through problems and communicating their thinking. Fostnot (2007) advocates for children to experience a hierarchy of models. First, they experience models in a realistic situation. Then, students are exposed to models to represent computational strategies. Finally, students use of models evolves to represent tools for mathematical thinking. These developmental practices become very complicated when students are not able to fluently recall basic math facts.

Approaches to Drill and Practice

According to NCTM there have been many different phases of math instruction throughout the years (Lambdin and Walcott, 2010). Beginning in the early twentieth century, drill and practice was the primary means of math instruction. As part of drill and practice, students' main goal was to build mental math skills through the memorization of math facts and algorithms (Lambdin and Walcott, 2010). In a study completed by Knowles (2010), students who completed daily time test did significantly better than students who either had no intervention or who completed timed test on a weekly basis. In addition, Knowles concluded that "written, timed practice drills" did improve automaticity of multiplication facts in sixth graders (Knowles, 2010). In his research, Burns supports Knowles findings when he states that in order to retain information, information must be rehearsed and success with retention is connected with the number of practice tests (2005).

Although Knowles and Burns found drill and practice to be an effective approach to learning basic math facts, research also supports Detect, Practice, and Repair (DPR) as an effective approach to learning basic math facts. Under this approach, as students detect facts they do not know, they practice those specific facts, and then show they have repaired the misconception through a fluency test (Poncy et al., 2010). By focusing on facts that are unlearned, students do not waste time and cognitive resources on previously mastered facts (Axtell, McCallum, Bee, & Poncy, 2009). In addition, because of limited response time, students move from an inefficient strategy of counting to an efficient strategy (Axtell et al., 2009). In their 2010 study, Poncy et al. found DPR to be effective at increasing math fact fluency by 63% over the two weeks the study was conducted.

Another method that is gaining popularity in schools is the use of quick images and ten frames. Both of these activities can be used as early as preschool to help students think about numbers in flexible ways (Kling, 2011). The basis of a quick image is to quickly show a representation of a number to students. Students then retain a mental picture of the image and use it in some way. For example, the teacher could show a series of 8 dots that are grouped in two's or four's. Students try to identify the total number quickly, without the opportunity for counting each dot. Ten frames can also be shown quickly. They consist of a 5 x 2 grid. The teacher puts a dot in the boxes to represent a number. Again, students are expected to create a mental picture and identify the total number of dots by grouping in their own way. These two strategies for basic addition fact fluency help move students away from counting each individual object, and towards recognizing different representations of a number (Kling, 2011).

Since the implementation of traditional drill and practice, DPR, and quick images, technology is beginning to play a more important role in the automaticity of math facts. In Williams' research she compared traditional paper and pencil drill and practice to technology based drill and practice. When doing so, Williams found that students who completed drill and practice using software had better results than students who use the traditional paper and pencil drill and practice (2010). In addition, a study completed by Reynolds (2010) found that a computerized flashcard program was effective in teaching basic math facts. Mendicino, Razzaq, and Heffernan (2009) also back up the Williams and Reynolds findings when they compared traditional paper and pencil homework to computer-assisted homework. The results of this study concluded that students who participated in the computer-assisted homework showed the most gain. Mendicino et al. (2009) believed that the growth with the computer-assisted treatment was due to the differentiation of questions and immediate feedback. Although this wasn't directly related to mathematics, the relationship can be made that computer-assisted support in mathematics may provide the interventions needed for success and ultimately lead to increased fluency and proficiency. Immediate feedback is crucial for the development of basic facts given that once a student responds incorrectly and is unaware they may commit that incorrect understanding to memory. This positive effect on learning through technology has been closely linked to motivation.

Technology Increases Motivation

Research supports that technology has reformed education. The need to prepare our students for the 21st century continues to become increasingly important. Given the trends and shifts of curriculum moving to be technology driven, it makes sense that teaching

mathematical content and simple processes such as teaching multiplication facts are crossing over as well. The National Council of Teachers of Mathematics (2011) supports the need for technology in the mathematics classroom in effort to amplify success and incite motivation as long as it is implemented correctly.

Additionally, technology plays a central role in regards to student success by motivating students in content areas that they may have otherwise been disinterested or thought to be incapable of academic achievement. Chang, Chen, and Huang (2008) conducted a study that compared computer assisted learning with traditional learning in consideration of basic math facts. In reflection of the study, student responses indicated that computer-assisted instruction generated the most significant growth in the area of motivation. Furthermore students who are struggling tend to have less motivation to attempt mathematics and in return have higher levels of math related anxiety that will ultimately affect their long term mathematical success (Ashcraft, 2002). In her previously mentioned study, Williams found that students who did not use technology, became "disinterested in trying to improve their math skills and just went through the process of doing the problems without trying to improve." Williams also stated that this lack of motivation could have contributed to her "treatment group" doing better than the control group (2000).

With the latest statistics in mathematics education, there is a need for increased fluency in students' basic fact fluency. There are various methods for meeting this goal, including traditional drill and practice, Detect, Practice, and Repeat, and quick images. The use of technology has become more frequent in the classroom as we move farther into the 21st

century. Students need practice with different applications for their future schooling and careers. In addition, technology has become a motivating factor in education.

Measuring Effectiveness

To evaluate the effectiveness of FASTT Math, we will begin our study by conducting a pre-test of basic math facts, using a paper and pencil test. Students will then be randomly placed in one of two groups. The first group will receive intervention using FASTT Math software three times a week. The second group will receive regular classroom instruction only. At the end of four weeks, students will complete a post-test to evaluate growth. In addition, teachers will participate in a survey to evaluate teacher attitude on FASTT Math. We will also be looking for trends across the district by analyzing usage reports from FASTT Math.

The teacher survey was piloted with the district math team. The team consisted of four teachers who were either in the role of math coach or math consultant. Positive feedback was received regarding the original survey. It was suggested by one individual that a question be modified to provide teachers with more choices (How do you teach basic math facts (+,-,x,÷)? Choose the option that best reflects your teaching: a) direct instruction b) flash cards c) timed tests d) FASTT Math). The options were changed to include “using games to practice” and “teaching students to use patterns and facts they know to solve problems.” (See Appendix A).

Context for Evaluation and Data Collection

The summative FASTT Math evaluation was given to show the efficacy of the software FASTT Math. A pre-test (Appendix B) containing one-hundred basic multiplication facts were

given in classes that acted as the control as well as the intervention classes across two schools in the same school district that are similar in demographics, beliefs, and teaching style. At school “A” a fourth grade class acted as the intervention group, while a fifth and sixth grade class acted as a control group. At school “B”, a fourth grade class acted as the control, while two fifth grade classes and one sixth grade class acted as the intervention group. Students were given three minutes to answer as many basic multiplication facts correctly as possible. Students turned these tests in following the initial evaluation, and they didn’t test again until four weeks later after the intervention had been implemented. At that time students received the same test they took as a pre-test. Again, they were given three minutes to answer as many facts correctly as possible.

This was a summative evaluation because the assessments were used to gauge the growth of students who received FASTT Math as an instruction tool after the four weeks of implementation in comparison to the students who did not receive the intervention. The goal was to determine, based on the program’s effectiveness, if this software is worth the price that the district pays for the license and if it is worthwhile for implementation in classrooms district wide.

To collect the data from this summative evaluation, each class received an identification code to be sure all data is confidential. In addition, each student received a code to provide for the same confidentiality. Tests were administered by each teacher and the documents were immediately given to the researcher for keeping and scoring. The protocol was the same for both the pre-test and the post-test. Once all tests were scored, the researcher created an excel

spreadsheet to view each classes growth on average as well as individual student growth based on grade level. The classes' average growth was compared to the intervention growth for each grade level to determine if the intervention increased fact fluency.

Findings

Student Results

The fourth grade control group showed more growth than the intervention group by almost eight facts on average (Figure 4). Nine students in the intervention group had a decrease in their scores from the pre-test to the post-test. Sixteen students had an increase (Figure 4). Of the sixteen students who showed improvement, twelve scored above the class average of 2.48.

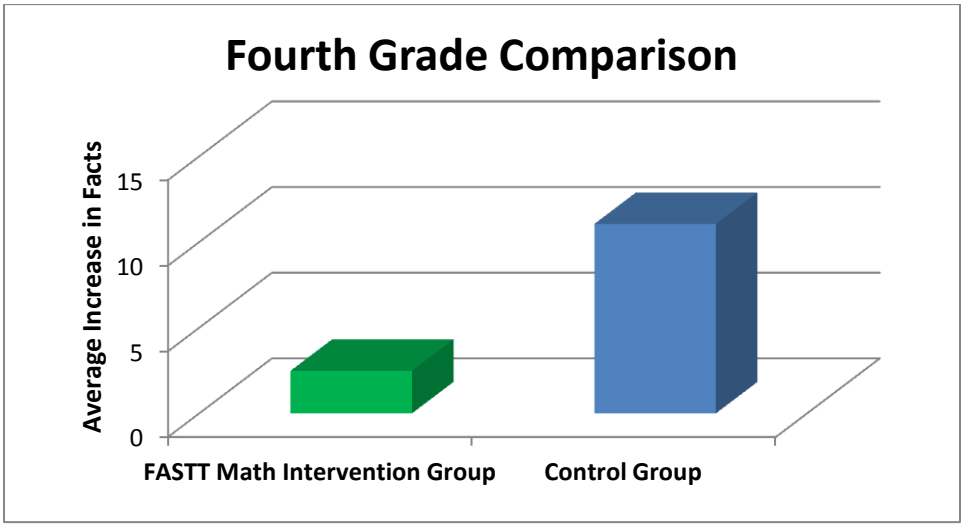

Figure 2. Fourth Grade Comparison

The control group showed an average improvement of 11.06 facts during the data collection phase. Only three students showed a decrease in scores out of the total students. Ten students showed improvement above the class average (Appendix C).

Four classrooms were used for comparison in the fifth grade, two intervention groups and two control groups. Intervention Group 1 showed the most improvement on average—16.69 facts. Intervention Group 2 did not show as much improvement with only an average of 7.53 more facts from the pre-test to the post-test (Figure 5). Control Group 1 showed an average improvement of 11.78 facts and Control Group 2 showed an improvement of 9.08 facts. Twenty-five students in the control group showed improvement beyond the class averages, whereas only eighteen students in the intervention groups scored above the class averages.

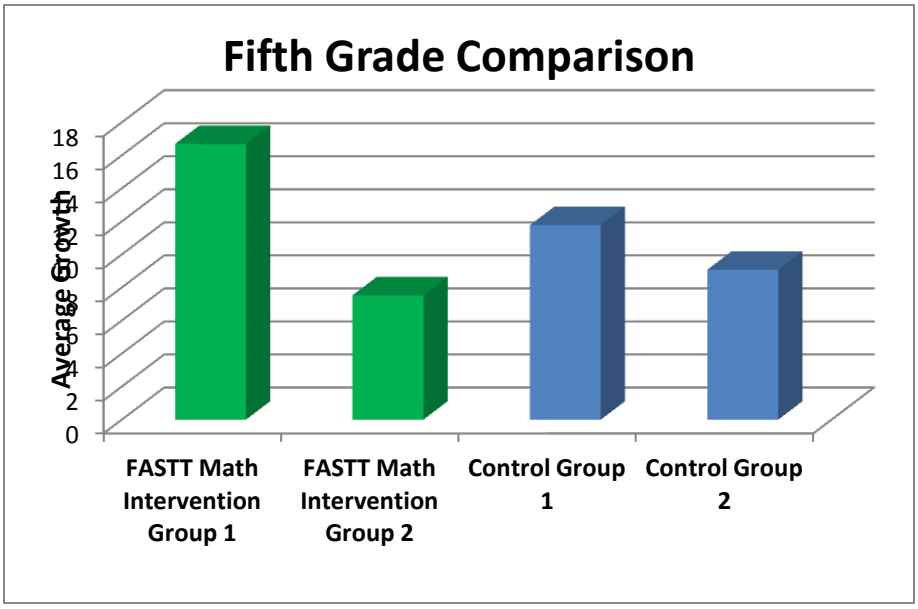

Figure 3. Fifth Grade Comparison

Sixth graders showed the most drastic improvement using FASTT Math. The class average for improvement in the intervention group was 24.35 facts, compared to the control group who showed an average improvement of only 7.46 facts (Figure 6). All but one of the twenty-six students showed improvement on the post-test in the intervention group. Three students showed an improvement of fifty or more facts after using FASTT Math for one month.

The 6th grade control group showed improvement as well, but not as drastically as the intervention group. Twenty-one out of twenty-six students showed improvement in the control group, with the highest improvement being a gain of twenty-seven facts.

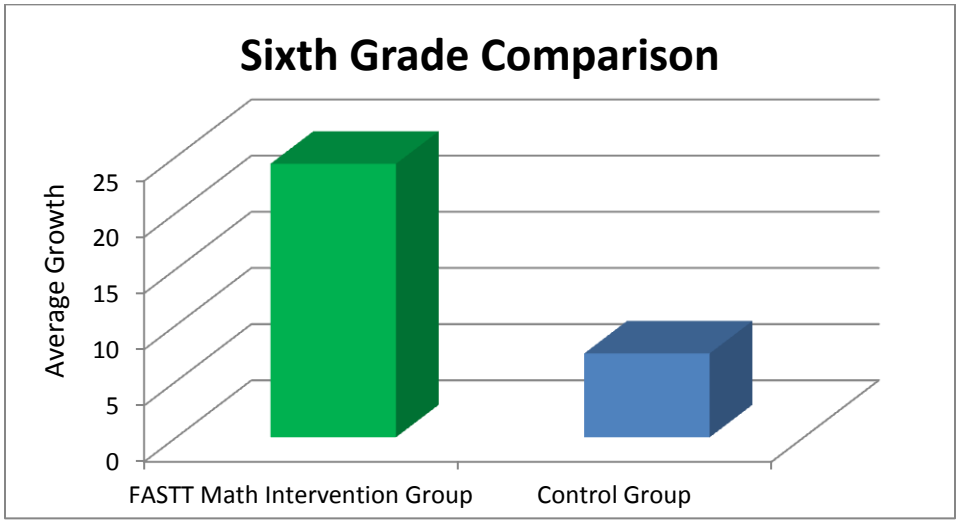

Figure 4. Sixth Grade Comparison

Teacher Survey Results

Fourth through sixth grade teachers from the two elementary school which participated in the study were asked to participate in a multiple choice survey on teacher attitude and implementation of FASTT Math. Nine teachers total participated in the teacher survey: two- fourth grade teachers, two- fourth/fifth grade teachers, one- fifth/sixth grade teacher, and four- sixth grade teachers. After specifying grade level, teachers were asked how many years they had been teaching. Of the teachers who participated in this study, 33.3% had less than five years of teaching experience, 33.3% had six to ten years of teaching experience, 11.1% had sixteen to twenty years of teaching experience, and 22.2% had twenty-one to twenty-five years of teaching experience. In response to the question how individual teachers reinforce basic math facts (+,-,x,÷), 77.8% responded with direction instruction, 66.7% responded with flash

cards, 22.2% responded with timed tests, 55.6% responded with FASTT Math, 66.7% responded with using games to practice, and 88.9% responded with teaching students to use patterns and facts they know. When asked why they chose to implement FASTT Math, 22.2% of teachers said it was because the district provided it, 11.1% said it was because nothing else was working and they were looking to try something new, 33.3% said they wanted to incorporate technology into math, and 33.3% said they do not use FASTT Math. Teachers who do not use FASTT Math were asked why. One teacher stated it was because they had not been trained and were not familiar with the program, one teacher responded they did not use FASTT Math due to lack of time, and a third teacher responded their lack of use was due to lack of time and access to the computers. Half of the teachers who use FASTT Math use it three to five times a week. The other fifty percent of teachers only use FASTT Math one to two times a week. Lastly, when asked if they think FASTT Math is an effective program for increasing math fact fluency, 33.3% strongly agrees, 33.3% agreed, 22.2% were neutral, and 11.1% disagreed.

Discussion

The trend for the fourth grade groups is opposite of the sixth grade groups. There are a few possible reasons for this discrepancy. Firstly, the intervention group was at a different school than the fifth and sixth grade intervention groups. The original class that was slated for intervention received a new teacher right before implementation. The evaluators felt it was unnecessary to ask the new teacher to incorporate this project into the school day for four weeks. In addition, the fourth grade intervention group did not use FASTT Math the recommended number of times per week. The teacher reported an interruption in the availability of the technology in the building throughout data collection. The building laptop

carts were taken for updating by the technology department. These two factors could have contributed to the difference in trends between fourth grade and the fifth and sixth grades.

In addition to the fourth grade data, the fifth grade data was also somewhat inconsistent. Intervention Group 1 made much more improvement than Intervention Group 2. A possible reason for this is Intervention Group 1 had twenty-six students participate, whereas Intervention Group 2 only had nineteen students participate. The difference in class size may account for some of the difference in average improvement.

The sixth grade intervention group showed the most drastic improvement. The teacher implemented FASTT Math three to five times a week, which may account for the level of growth. In addition, sixth graders have been using this program since fourth grade. They are used to the way the program is run and can quickly move through the steps because of their familiarity. In addition, sixth graders have been working on and using their multiplication facts for several years.

The evaluators recognize the improvement that is possible when students use FASTT Math the recommended three times a week. Based on the significant growth that was reported from the use of FASTT Math appropriately, we recommend that the district continue the use of FASTT Math three to five times a week as a way to increase math fact fluency. In addition, we recommend additional training be made available for teachers so that all teachers within the district feel comfortable and understand how to use this intervention. Further study is needed to determine whether this growth would continue over the course of an entire school year, and in what grades it would be most beneficial.

EMU Master's Student Concepts/Skills

Throughout our journey in the EDMT Master's program, we were assured that technology integration was the key to student motivation, success, and academic achievement as long as the technology was implemented correctly. In an effort to use technology correctly we were informed of the importance of analyzing software or any technology based learning tool for effectiveness, quality, and validity. As evaluators we will seek to evaluate the effectiveness of computer-assisted instruction, specifically the software FASTT Math as a tool for teaching basic math facts and developing fact fluency.

Timeline

October 4, 2011: Proposal Due

October 11, 2011: Human Subjects Due

November 7, 2011: Pre-Test Conducted- Begin Collecting Data

November 7-December 2, 2011: Collect Data- Students Complete FASTT Math

December 5, 2011: Post-Test to Evaluate Student Growth

December 8, 2011: Have Data Analyzed

December 12, 2011: Final Project Due

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Appendix A: Survey Instrument

1. Consent to Participate:

I have read or had read to me all of the above information about this research study, including the research procedures, possible risks, side effects, and the likelihood of any benefit to me. The content and meaning of this information has been explained and I understand. All my questions, at this time, have been answered. I hereby consent and do voluntarily offer to follow the study requirements and take part in the study.

- ◯ Yes, I consent to voluntarily participate.
- ◯ No, I decline at this time.

***2. What grade level do you teach?**

- ◯ 1st/2nd
- ◯ 2nd
- ◯ 2nd/3rd
- ◯ 3rd
- ◯ 3rd/4th
- ◯ 4th
- ◯ 4th/5th
- ◯ 5th
- ◯ 5th/6th
- ◯ 6th

***3. How many years have you been teaching?**

- ◯ less than 5
- ◯ 6-10
- ◯ 11-15
- ◯ 16-20
- ◯ 21-25
- ◯ 26 or more

***4. How do you reinforce basic math facts (+, -, x, ÷)? Select all that apply.**

- ☐ direct instruction
- ☐ flash cards
- ☐ timed tests
- ☐ FASTTMath

***5. If you use FASTTMATH, why did you choose to implement it?**

- ◯ suggested by colleague
- ◯ it was provided by the district
- ◯ nothing else was working/looking for a new intervention
- ◯ wanted to incorporate technology into math
- ◯ administrative mandate
- ◯ do not use FASTT Math

Other (please specify)

***6. How often do your students use FASTT Math?**

- ◯ daily
- ◯ 3 or more times a week
- ◯ 1-2 times a week

*7. If you do not use FASTT Math, what is your reasoning?

***8. I believe FASTT Math is an effective program for increasing math fact fluency?**

- ◯ Strongly agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly disagree

Appendix B: Pre- and Post-Test

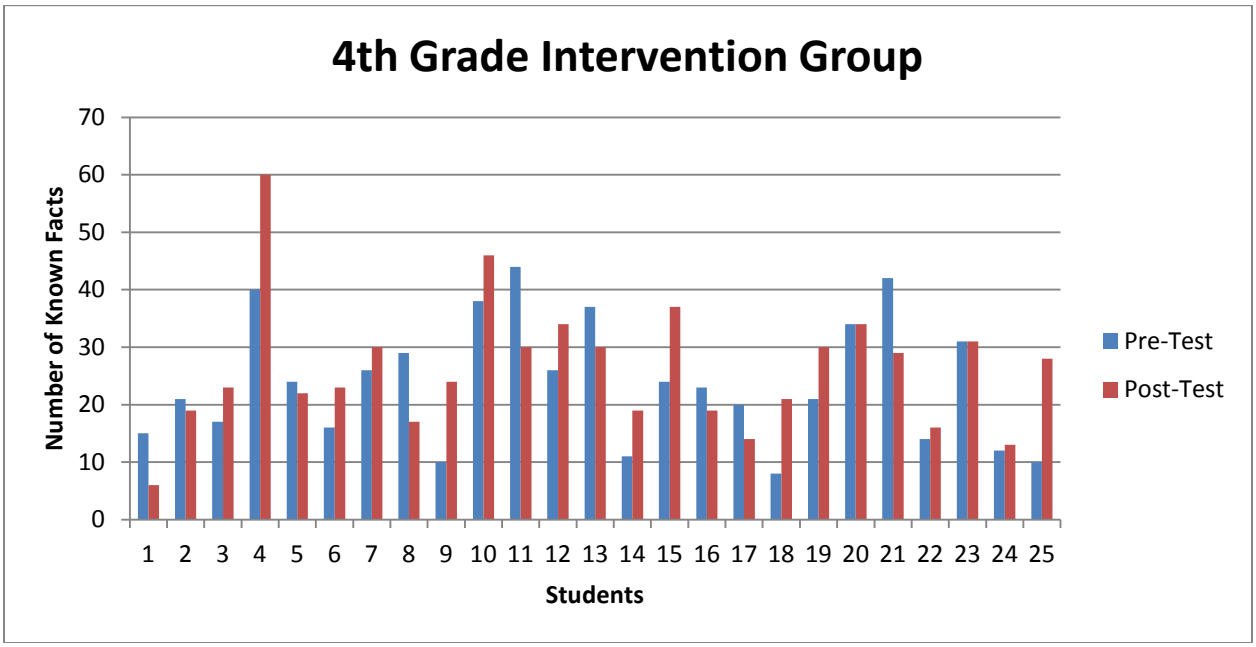
Name _____

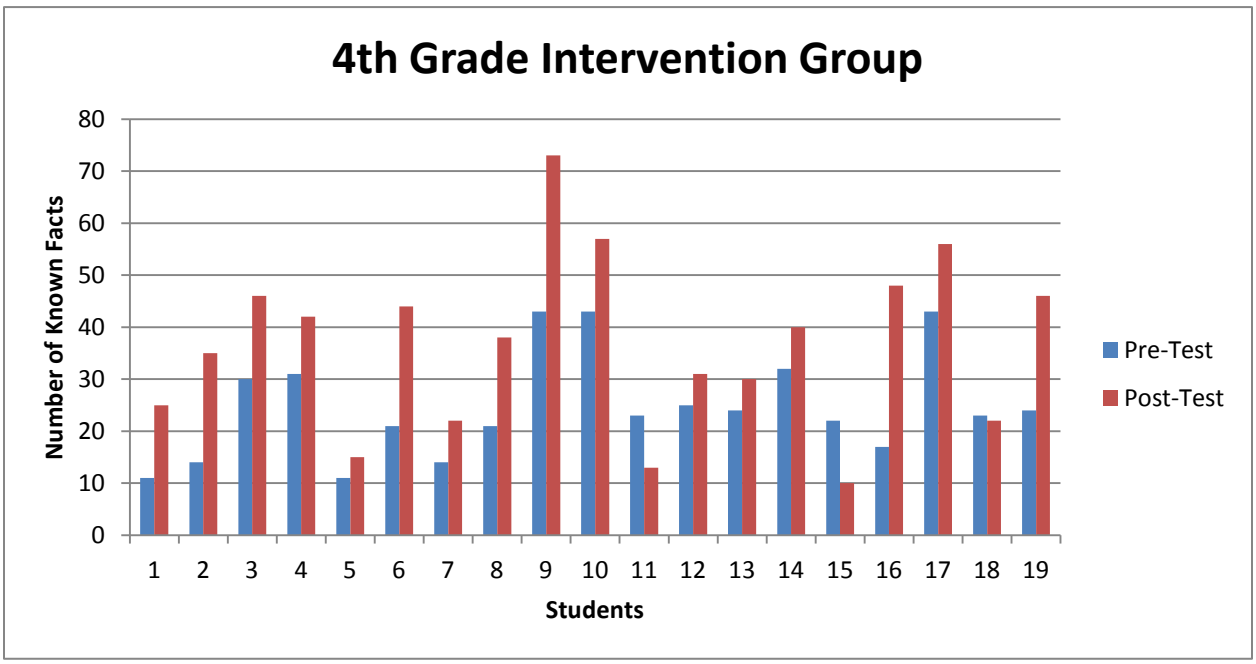
Timed Test 8
Multiplication Facts Through 12s

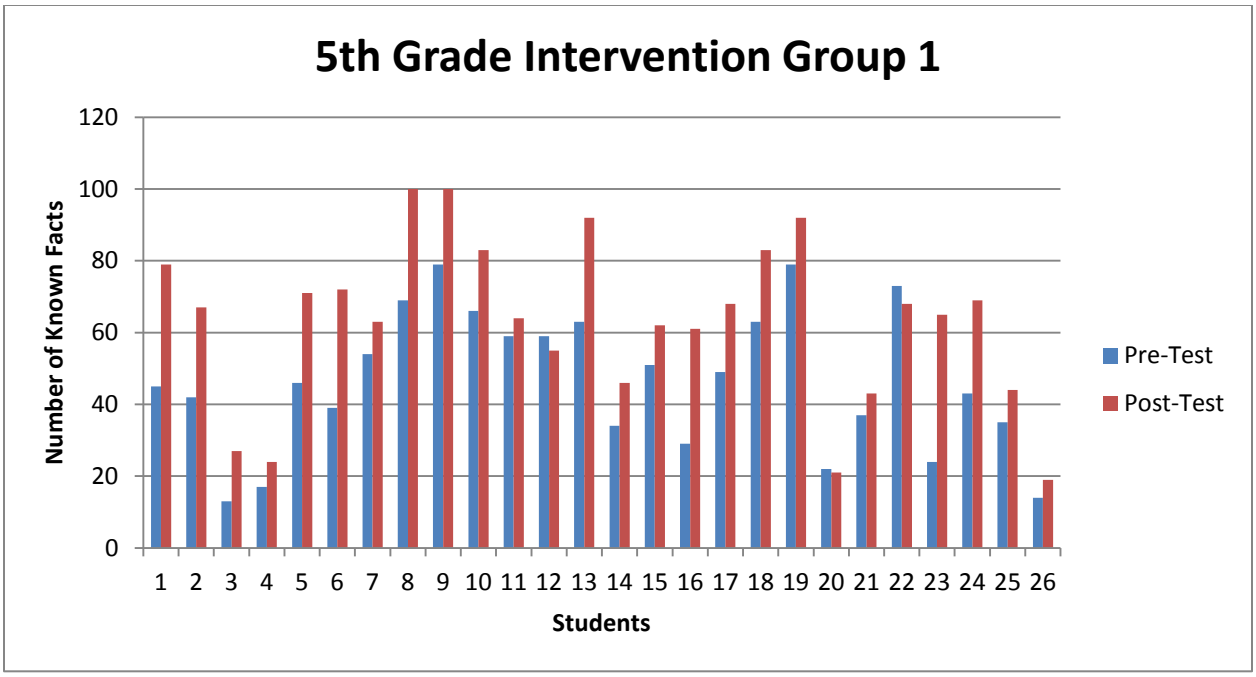
Time: _____ Number Correct: _____

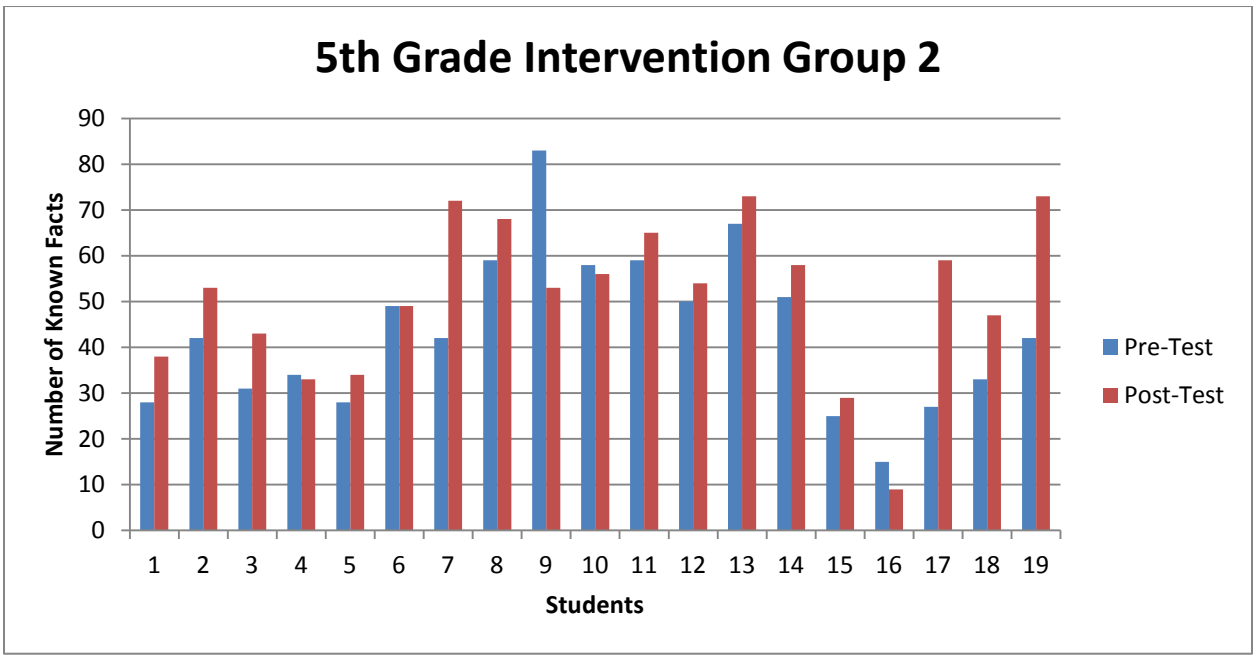
4 × 7 = _____	8 × 12 = _____	3 × 4 = _____	3 × 6 = _____
5 × 6 = _____	9 × 5 = _____	2 × 8 = _____	9 × 11 = _____
7 × 8 = _____	4 × 11 = _____	9 × 2 = _____	4 × 12 = _____
3 × 3 = _____	2 × 6 = _____	6 × 2 = _____	11 × 10 = _____
8 × 10 = _____	2 × 12 = _____	3 × 11 = _____	1 × 8 = _____
12 × 9 = _____	8 × 4 = _____	9 × 6 = _____	7 × 11 = _____
3 × 8 = _____	3 × 10 = _____	2 × 9 = _____	4 × 10 = _____
9 × 9 = _____	12 × 8 = _____	2 × 11 = _____	6 × 1 = _____
1 × 10 = _____	8 × 3 = _____	1 × 11 = _____	5 × 3 = _____
4 × 9 = _____	9 × 8 = _____	8 × 9 = _____	12 × 11 = _____
6 × 3 = _____	3 × 5 = _____	12 × 2 = _____	7 × 4 = _____
8 × 2 = _____	2 × 2 = _____	11 × 1 = _____	9 × 3 = _____
5 × 10 = _____	1 × 12 = _____	3 × 2 = _____	10 × 9 = _____
11 × 12 = _____	5 × 8 = _____	6 × 8 = _____	12 × 10 = _____
10 × 2 = _____	11 × 11 = _____	10 × 7 = _____	2 × 5 = _____
11 × 8 = _____	7 × 9 = _____	11 × 9 = _____	7 × 3 = _____
6 × 10 = _____	7 × 12 = _____	8 × 7 = _____	7 × 10 = _____
2 × 10 = _____	9 × 7 = _____	3 × 9 = _____	11 × 6 = _____
11 × 7 = _____	3 × 7 = _____	6 × 6 = _____	10 × 5 = _____
8 × 5 = _____	2 × 4 = _____	12 × 7 = _____	5 × 4 = _____
11 × 5 = _____	12 × 6 = _____	7 × 6 = _____	10 × 10 = _____
6 × 5 = _____	11 × 2 = _____	12 × 12 = _____	11 × 3 = _____
1 × 9 = _____	2 × 7 = _____	8 × 6 = _____	4 × 8 = _____
1 × 4 = _____	11 × 4 = _____	4 × 5 = _____	1 × 3 = _____
9 × 1 = _____	4 × 2 = _____	4 × 1 = _____	1 × 1 = _____

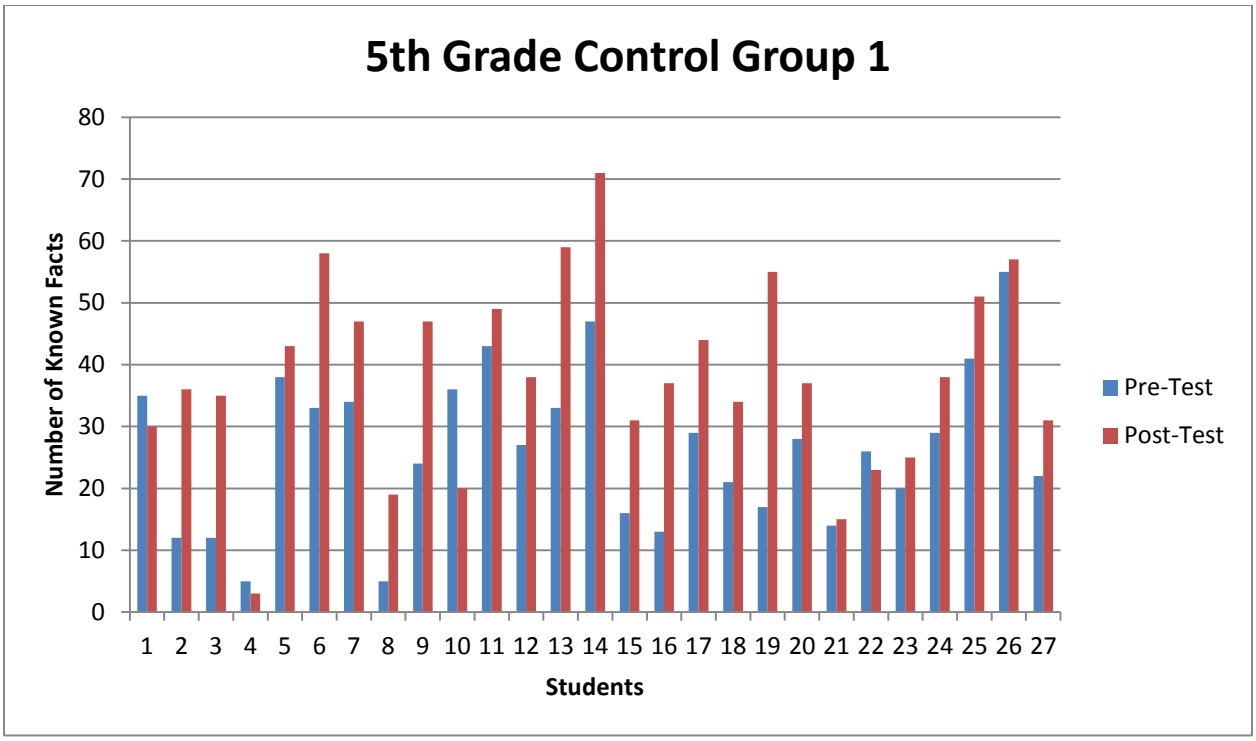
Appendix C: Student Results

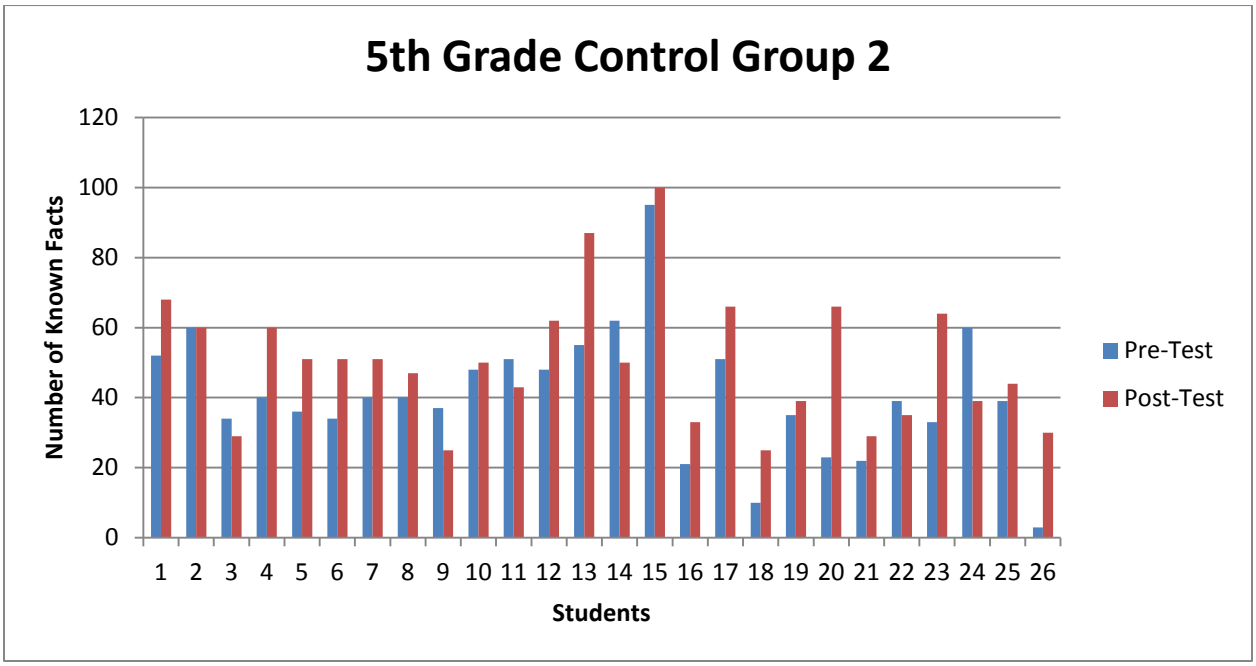


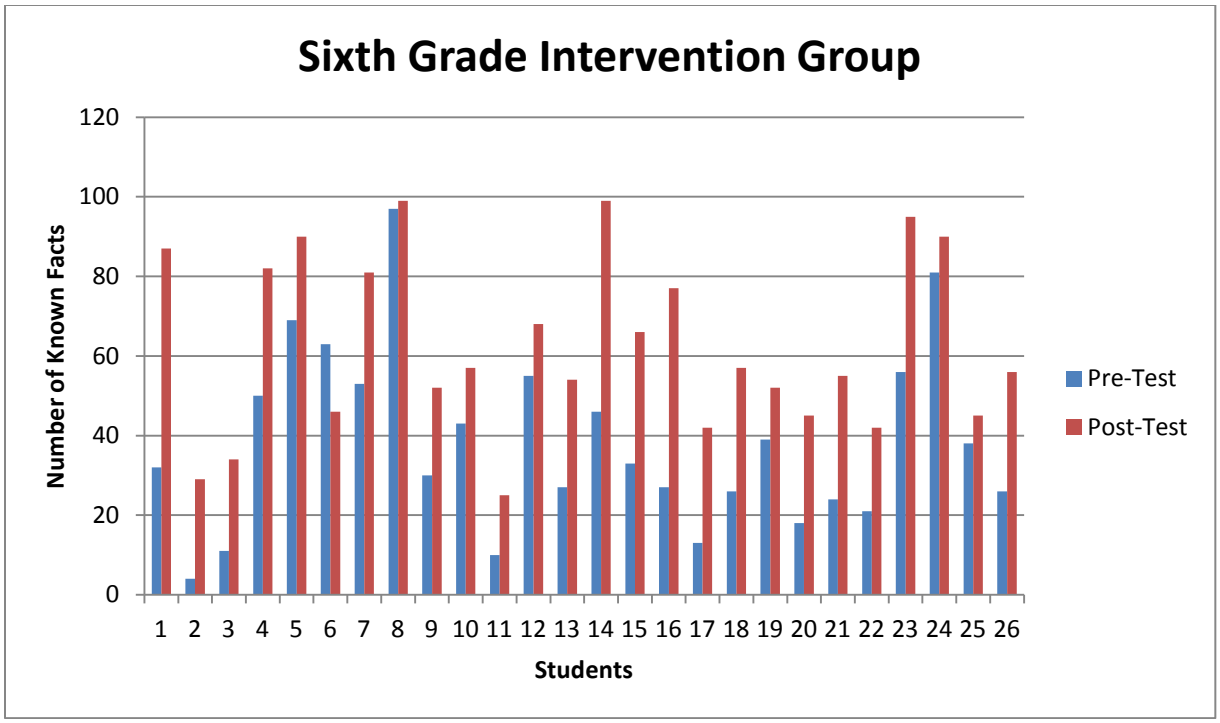


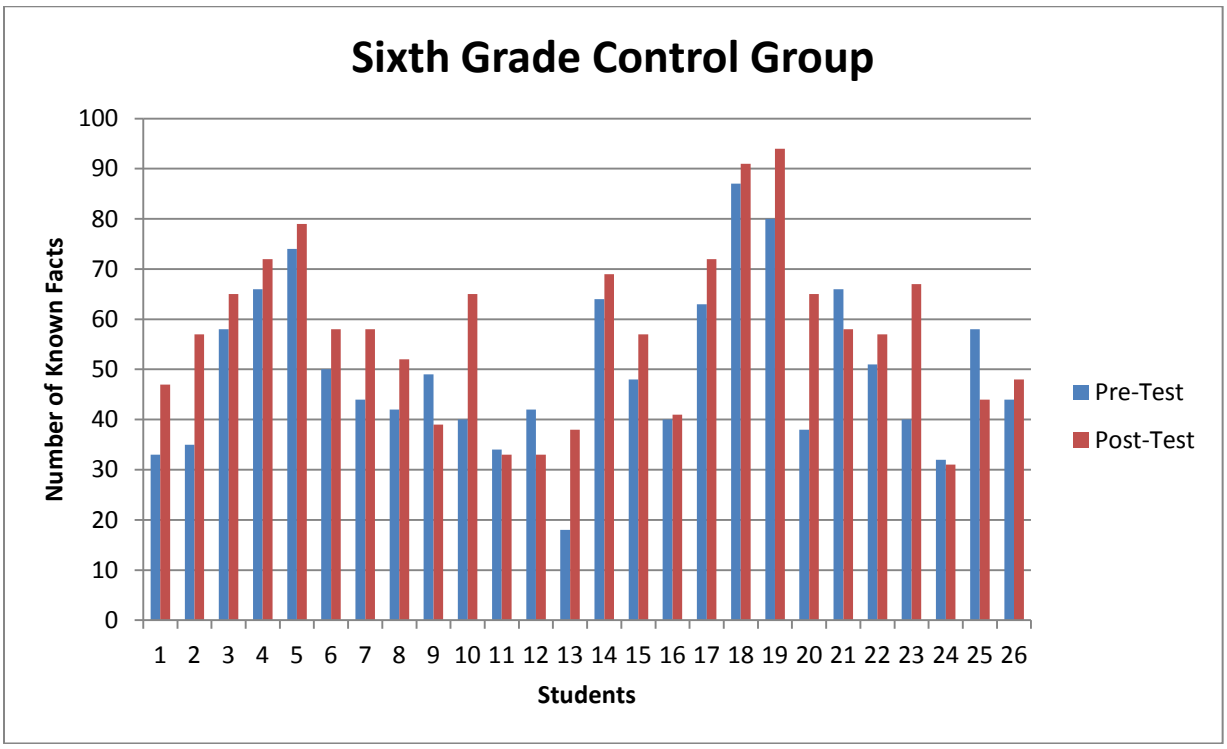

5th Grade Intervention Group 1
Number of Known Facts
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Students
Pre-Test
Post-Test


5th Grade Intervention Group 2
Number of Known Facts
90
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Students
Pre-Test
Post-Test


5th Grade Control Group 1
Number of Known Facts
0
10
20
30
40
50
60
70
80
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Students
Pre-Test
Post-Test


5th Grade Control Group 2
Number of Known Facts
0
20
40
60
80
100
120
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Students
Pre-Test
Post-Test


Sixth Grade Intervention Group
Number of Known Facts
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Students
Pre-Test
Post-Test


Sixth Grade Control Group
Number of Known Facts
100
90
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Students
Pre-Test
Post-Test