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Technology or Pencil and Paper: How do fifth graders best learn math facts?

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Technology or Pencil and Paper: How do fifth grade students best learn math facts?

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By

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Dedication

This work is dedicated to my parents, Richard and Diane Opperman, who were my first and best teachers. They taught me to love learning and to be a lifelong learner, able to find a “teachable moment” in everything. Thanks for your support and love, Mom and Dad!

Abstract

This research was conducted in order to answer two questions. First, technology or pencil and paper: how do fifth grade students best learn math facts? The second question asked was: How does fact fluency affect feelings about math? The group of 20 students (13 boys, 8 girls) was divided into two groups. One group worked with a technology-based intervention. The second group used the paper and pencil intervention called Cover, Copy, Compare. The study revealed that both interventions were effective at increasing fact fluency, however the technology based intervention showed greater growth. The students were also surveyed about their feelings about their math skills, and their positive feelings increased as their fact fluency increased. The study indicates that a technology intervention can be helpful for teaching fact fluency which in turn helps students grow their confidence in the subject area of mathematics.

Chapter One

Introduction

General Problem/Issue

My current teaching position has me teaching Math to two different homerooms of fifth graders, and therefore places me in a spot of being a "math specialist." As I have been teaching this class for only one and a half years, I have noticed that the knowledge of basic facts is greatly lacking in my students. I was also a Title 1 interventionist two years ago, and in that position I had two small groups of math students who struggled in math, one of their biggest struggles being knowledge of their facts. This was a Tier 1 intervention, with students identified by the teachers as requiring a little bit of extra help with math concepts, but who did not qualify for Special Education Services. A resource that I used that year and brought with me into the regular classroom is a website called "Xtramath.org." This is a free website on which I create a profile for each of my students and they go on and practice facts, beginning with addition and then progressing through subtraction, multiplication and division. During the third quarter of last school year, I was fortunate to have a Partnering for Equity, Engagement and Rigor (PEER) teacher - an instructional coach - come work in one of my math classes. She noticed that facts were a problem as well, and suggested we use paper "triangles" as flashcards for the students to practice. These triangles are used in curriculum such as Everyday Math (Basic Math Facts, n.d.).

As I was thinking about action research, I began to wonder if either of these methods of practicing facts was useful or helpful to the students. I wondered how they felt about each of the methods and if either of the methods helped them to increase

their fact knowledge, or even if they helped them do better in math in general. Was spending 5-10 minutes a day on these flashcards even worth it? We were intending to do a fact test toward the end of third quarter, but Distance Learning caused everything to get mixed up and that never happened.

During my research of the literature for this project and through another project I did for a different grad school class, I was introduced to an intervention called “Cover, Copy, Compare” (CCC) that shows a lot of promise in helping students to improve fact fluency. I discovered this resource on Intervention Central and did some research on it, finding that there have been several studies done on this intervention, including one by Joseph et al. (2012) that show growth for students in both the regular education classroom, and when working with students with learning disabilities. I am going to use this program in my classroom in the coming year.

My study was to see if Xtramath or CCC seems to work better to help students learn their basic facts. As Xtramath works through problems, it shows the students the correct answer if they do not answer correctly or quickly enough. This is very similar to how the students will check their work in the CCC method. The two programs do basically the same thing, one being on the computer while the other uses paper and pencil. The basic question being: Do students better learn math fact fluency through the use of technology or a traditional pencil and paper method?

This study is important to me and my fellow teachers because it will help us to find a way to help our students learn their math facts, and in turn feel more successful when attempting more difficult math tasks. Although this might be considered overlearning, we know that overlearning things like our math facts helps with higher

level thinking as we move to more complex math problems (Woolfolk, 2018). Using the method that works best will help us to use our time wisely and give our students what they need to be prepared to continue in their math studies. To measure their feelings of success, I will be giving a survey at the beginning of the study. This survey will ask students just two questions. One question will ask, “On a scale of 1-5, how well do you feel you know your multiplication facts?” The other question will ask, “On a scale of 1-5, how successful do you feel in math class?” My hope would be that the average response on this survey would increase when I give the survey at the end of the study.

Subjects and Setting

In order to do this study, I used one of the homeroom classes to practice using Xtramath for approximately 5 minutes a day. The program itself gives only a specific number of problems per session. I have found that on average, these sessions take about 5-7 minutes. The other homeroom class was taught the method of Cover, Copy, Compare to use three times a week. These sessions take slightly longer, closer to 10 minutes a day. For this reason, I only did it 3 times a week, so that the on-task time for each group would be fairly equal. I continued this process throughout the seven and a half week study period.

The students involved in the study were selected simply by being a part of one of my fifth grade math classes. I had all students participate in the two methods (either Xtramath or CCC) but only those whose parents/guardian gave permission had their data included in the study. I wanted to have two full classes of students to study - which means about 20 students (sizes are greatly reduced this year) in each class.

Ideally, the setting for this study is my classroom. It included all the students in the class during the math time, and students were seated at desks/tables to do their work. Students in our school each have their own device and they are used to using them often, so setting up the Xtramath portion was something that happened naturally.

One thing that I considered as I planned this study is the fact that we could have been quarantined or in distance learning at some point during the study. This would have changed how the setting looked and how well I could control whether students participate in the activity.

Informed Consent

Parents/Guardians of students were asked to give consent before the students participated in the study. All students did the fact fluency practice, but only those with permission were included in the data collection. All information about the students was kept confidential, and no names were used at all within the data.

Chapter Two

Review of Literature

Research has shown that many students struggle with fact fluency. This seems to hinder their ability to do more difficult math problems, and therefore several ways to help them become more fluent have been developed. One of those ways is by using online fact fluency programs, such as one called “Xtramath.” There are also more traditional methods such as the use of flashcards or paper and pencil interventions. Many wonder if knowledge of basic facts does affect the student’s abilities in other areas or if they can figure out how to solve problems in a different way.

Definition of Terms

Fact Fluency - the ability to recall the answers to basic math facts quickly and without hesitation (Allen-Lyall, 2018).

Xtramath.org - a math fact practice website. Students are assessed on which facts they know and which they need more time on. The program then flashes facts, waits for students to answer and gives them the correct answer when they don’t answer in a certain amount of time (xtramath.org, 2020).

Cover, Copy, Compare - a math intervention in which students are given a list of 10 facts to look at, then cover as they copy it from memory. They then compare what they wrote with the original fact to be sure they got it correct. If they did not, they repeat the process, if they did, they go on to the next problem (Joseph et al., 2012).

Fact Fluency

Many studies have been done that show that fact fluency is an important skill for students to obtain (Allen-Lyall, 2018, Mustio-Rao &Plati, 2015, Riccomini et al., 2017).

Being able to automatically give an answer to a math fact such as addition or multiplication gives students strong foundations for later math computation. It has even been shown to give students a greater path toward future education and better careers (Allen-Lyall, 2018, 2018). When students know their facts well, it allows them to work through more difficult problems with less intensive brain power (Allen-Lyall, 2018).

In other studies, however, strong fact fluency did not have a relationship with ability to do more advanced skills, even though it does help them to move on to more difficult parts of a math problem (Burns et al., 2012).

No matter the ultimate goal, it does seem that fact fluency is a foundation skill for students to succeed in math (OK & Bryant, 2016). Many teachers have experienced the struggle that students seem to have in fact fluency and watch students use strategies that they have learned that include drawing pictures and counting on fingers. As much as the strategies are helpful in understanding the underlying concepts, Riccomini et al. (2017) points out that when students have to count on their fingers in higher level computation, they can't understand the mathematical meaning of those computations.

The things that teachers see in their classrooms seems to be normal across the board, according to research. The use of fingers to add or subtract, or the need for manipulatives or pictures are common. Musti-Rao & Plati (2015) found that American students are struggling with basic computation skills. They believe that automatic recall of facts needs much more attention in our schools.

Lack of Instruction in Fact Fluency

Part of the reason students seem to be struggling with fact fluency is that the skills are not being taught. Few of the published curriculum programs used in our

American schools give time specifically to practice facts (Musti-Rao & Plati, 2015). Many math programs used in schools today do not include fact fluency as part of the daily practice. Allen-Lyall (2018) agrees, in their study they found that very little help is given in published programs and because of this missing piece in the curriculum teachers are using the methods they experienced as students. These could be good, and useful, or not. It is difficult to find time to squeeze fact practice into the day and to find good methods for teaching fact fluency (Allen-Lyall, 2018).

Fact Fluency and Students with Learning Disabilities

Several researchers have studied the effect of fact fluency interventions on students with specific learning disabilities and have found great success. Ok and Bryant found that students with LDs tend to use immature strategies for finding the answers to basic facts for longer than students without these disabilities (2016). This makes it especially important for these students to have the opportunity for interventions with fact fluency. As many classrooms include students with some kind of learning disability, it is important for general education teachers to have access to interventions to help students of all different abilities.

Procedures for Practicing Fact Fluency

There are many different interventions out there for practicing facts (e.g., flashcards, computer programs, weekly fact tests). All of them need to be done with fidelity, and require teachers to be trained and spend time understanding what their plan is for teaching; in fact “effective fluency practice includes purposeful, planned and targeted activities” (Riccomini et al., 2017, p 321). Many studies have found differing amounts of time required to implement their programs, ranging from 30 minutes per

week in one day to 5-10 minutes at a time 3 or 4 times a week. Riccomini gives four elements to effective fluency practice:

1. Modeling
2. Multiple Opportunities to Respond
3. Immediate Feedback
4. Appropriate ratio of known to unknown facts

Modeling means that the teacher shows how to find the correct answer, perhaps through the use of manipulatives. A teacher should always give more than one opportunity for a student to respond, whether that is in a large group, small group or individual setting. Repetition is key to memorization. Getting immediate feedback is important because if a student is repeating the wrong information, that is what will get "stuck" in their brain and it will cause the intervention to be worthless. An appropriate ratio of known to unknown facts will help to build confidence in a student. These elements are an important part in making the decision of which type of intervention one may choose.

Types of Fluency Interventions

Cover-Copy-Compare

One of the interventions mentioned repeatedly in research is the Cover, Copy, Compare (Joseph et al., 2012, Poncey et al., 2012). For Cover, Copy, Compare, students study a list of 10 facts, then fold their paper to cover the list, then copy the facts one at a time from memory and then check if they are correct. If not, they go back and start the process over until they get each problem correct. This method is used in conjunction with some other steps in Musti-Rao and Plati's research. They called their

intervention Detect/Practice/Repair (DPR) and it consisted of the students taking a paced assessment to detect which problems needed work, then practicing those problems and using Cover-Copy-Correct to do this practicing to repair what was wrong. This method seemed to work to help students increase their fluency, but Musti-Rao and Plati (2015) found that it did not work as well as a technology they also tried.

Direct Instruction Programs

Allen-Lyall (2018) did a study in which they used multiple different direct instruction plans to teach students their facts. They used matching activities, fact flip books and the teaching of fact families. Their study had very good results, as the students who were trained on their multiplication facts in 3rd grade showed a higher retention of facts when they started 4th grade than the classes who did not have this intervention in the previous year. The conclusion in this study was that concept development needs to be combined with automaticity for students to show real growth.

Technology Interventions

A variety of studies have shown success in using technology in increasing fact fluency (Allen-Lyall, 2018, Burns et al., 2018). Several have even compared technology to more traditional “pencil to paper” methods (Ok & Bryant 2016, Riccomini et al, 2017). As mentioned earlier, Musti-Rao and Plati (2015) did a program they called “DPR.” They also used a program on iPads to have students practice facts. In the comparison of the two interventions they felt that technology worked better. It “increased motivation, increased time on task and gave immediate feedback (p.434).” They did feel, however, that more time and research were needed to determine the effectiveness of technology

on math overall. They did feel technology, in their case the use of iPads, was very beneficial for differentiating in inclusive settings.

The studies mentioned found that the students preferred the iPads or other technology over pencil and paper activities. One student even said that the paper activities “made their hand hurt” (Allen-Lyall, 2018, p. 394). One study showed that students who used iPads to help them improve their fact fluency also seemed to just enjoy math more than those who didn’t (Ok & Bryant, 2016).

The one thing found to be a negative effect of using technology was that they did not like getting a bad score when they did the math activities on an iPad (Musti-Rao & Bryant, 2015). Teachers also liked the technology better in most cases. They found that its performance - monitoring tools and the automatic differentiation involved along with its ease of use was of great benefit (Riccomini et al., 2017). This research indicates that technology can be a useful way to help students increase their fact fluency.

Hypothesis

I hypothesize that the technology method (Xtramath) will be more effective at increasing the students’ fact fluency. The research that has been cited here seems to suggest that this should be the result. I also believe that students will be more interested and engaged when working on their chrome books versus working with paper and pencil.

Conclusion

Much work has been done in the field of fact fluency, its importance and ways to practice it. It will be interesting to do a study with a specific technology and to decide

what type of other intervention to compare it to. Research in an individual classroom can often be different from that done by others, so it will be important to collect data efficiently and study the findings.

Chapter Three

Methods

Research Questions

The main question that I focused on in this research is: Technology or Pencil and Paper: How do fifth grade students best learn math facts? I also asked the question: Do students feel better about their success as mathematicians when they have greater fact fluency?

Research Plan

I started working on this study shortly after the beginning of the second semester. As soon as I received permission from the IRB, I sent home the permission letter, and students took the baseline assessment. That week I also taught the procedures for using Xtramath and CCC. After that, I wanted to collect data for 8-10 weeks.

Data Collection

To collect baseline data for this research project, I first gave students a basic facts “timed test.” This test included a variety of multiplication facts. It had 40 problems, and I gave students 3 minutes to take the test. Students were also given a survey asking questions about their feelings about their math abilities and fact fluency.

Throughout the study, students were given fact quizzes similar to the one mentioned above every other week. Students were given 3 minutes to take each quiz, then I collected the quizzes and corrected them. Students in the CCC group were given back the corrected quizzes so they could write down which problems they still needed to work on on their own data sheets. I recorded the number correct for each student every other week, and charted the change on a google form.

Data Analysis

At the end of the research period, students took one final fact quiz to see how much growth they have shown throughout the research time. The percentage of facts correct for the individuals as well as the group as whole were compared to the percentages at the beginning of the study. Each class, the Xtramath group as well as the CCC group were compared separately. Students also took the survey that they took at the beginning of the study again at the end, to see if their practice of fact fluency has improved their overall feelings about themselves as a mathematician.

Ethical Considerations

This study had very few ethical issues. Student names were kept off of all the data, so it was very confidential. The only issue I had as a researcher is that I knew already that I liked the Xtramath platform because it collects data for me. I simply need to log in to see how many problems each child did correctly, and to evaluate their growth in fact fluency. I believe it is a strong instructional resource, and that may have caused me to want to see my students success in this program. CCC required a bit more effort on my part, and therefore I had to work harder to implement this strategy with fidelity. Students did occasionally share their results with each other, which could have been a confidentiality issue, but I did encourage students to keep their information to themselves.

Chapter Four

Results

Data Collection

Data were collected from two different groups of students. Group “A” used the technology based fact fluency practice, Xtramath.org. Group “B” used the pencil and paper method, Cover-Copy-Compare. Group A was a group of nine students, six boys and three girls. The group also included three students who are receiving special education services in math. These students are receiving special education services for specific learning disabilities. Group B consisted of twelve students. In this group there were seven boys and five girls. There were two students in this group who received special education services in math.

Both groups were given a “pre-test” of 40 multiplication facts to be completed in 3 minutes. This test was given on February 8th. After the test was given, Group A was instructed to begin each math class with Xtramath three or four days a week. They had already been trained on how to do Xtramath because the class had been using it to practice addition and subtraction facts. The settings were changed for all students so that they would begin working on multiplication facts on February 9th.

Group B was trained on how to use the pencil and paper method “Cover, Copy, Compare” on February 9th. Students were given a group of facts to work on, without any data about which facts they needed practice with. I started this group of students with the 6 and 7 times tables, as those were facts with which I had noticed a weakness. All students were given the same ten facts to practice for the first two weeks. After each

of the timed tests that students were given, they added new facts to practice based on which ones they answered incorrectly.

After two weeks, four weeks, and seven weeks of practice with math facts, students in both groups were given a fact fluency timed test. The results of these tests were recorded.

In addition to testing fact fluency, the students were given a two question survey to gauge their feelings about their fact knowledge and their ability in math in general. This survey was given twice - on the same day as the pretest and then again on the day of the final timed test. The first question was: How would you rank your knowledge of multiplication facts on a scale of 1-5? Students could answer:

1 - I don't know them at all.

2 - I know a few facts.

3 - I know some facts, but struggle with others

4 - I know them pretty well.

5 - I am a master at multiplication facts!

The second question was: How do you feel about your math skills in general? Their answer choices for this question were:

1 - I am not good at math.

2 - I know a little bit about math.

3 - I am okay at math.

4 - I am pretty good at math.

5 - I'm great at math, it's easy.

Results

How do students best learn their math facts?

The results for both groups A and B showed growth in their fluency with multiplication facts. Group A, the technology use group, showed the greater growth, going from a class average after the pretest of 27.44/40 to a class average at the end of the research period of 35.67/40. This was an increase of 8.23 points, or 20.5%. You can see the specific data collected in Table 1. The instances where no number is recorded indicate a student was absent the day the test was given. Those numbers were averaged based on the number of students who took the test. On this chart it may be of interest to know that students 2, 4 and 9 were those who received special education in math.

Table 1

Group A Test Results - Pretest through Post Test

Student Number	Pretest	Test 1	Test 2	Posttest
1	40	40	40	40
2	20	19	24	27
3	31	40	38	39
4	6	14	16	25
5	26		34	40
6	29	30	30	40
7	36	33	35	39
8	34		33	33
9	25	40	35	38
Group Average	27.44	30.857	31.67	35.67

Group B also had positive results in regard to growth in their fact fluency. The class average increased from 29.33/40 to 36.55/40. Their individual results are listed in Table 2. This is an increase of 6.33 points or 15.8%. It should be noted that student 3 was absent the day of the final test and because of that absence, the averages were recalculated, because student 3's scores were significantly lower than those of their peers throughout the testing period. With the new averages, the students increased their scores from 31.45/40 to 36.55/40, which is an increase of 5.1 points or 12.8%. It can also be noted that student 3 and student 11 are students who receive special education in math. That information will be taken into consideration in the analysis portion of this report.

Table 2

Group B Test Results - Pretest through Post Test

Student Number	Pretest	Test 1	Test 2	Posttest
1	14	26	27	36
2	34	40	38	40
3	6	5	3	
4	36	40	35	37
5	40	40	38	39
6	15	26	18	26
7	40		40	40
8	34	40	39	38
9	40	40	39	40
10	37	40	38	39
11	16	20	14	27
12	40	40	35	40
Average	29.33	32.45	30.333	36.55
Average without student 3	31.45	32	32.82	36.55

Do students feel better about their success as mathematicians when they have greater fact fluency?

At the beginning of the study, 6.3% of the students in Group A responded with a 5 to question one - stating that they are a master at multiplication facts. Secondly, 37.5% chose their answer as 4 - they knew their multiplication facts pretty well. The majority, 56.3% said that they knew some facts, but struggled with others. At the end of the study, this group reported 21.4% as masters at multiplication facts, while 42.9% said that they knew them pretty well. However, 28.6% still feel they struggle, and now 7.1% said they only know a few facts. Although the number who felt good about their facts increased, those who didn't feel good about their facts increased as well. These results can be seen in Table 3.

Table 3

Group A Pretest vs. Posttest Responses to the Question: How would you rate your knowledge of multiplication facts on a scale of 1-5?

Response	Pretest	Post-test
1 - I don't know them at all.	0%	0%
2 - I know a few facts.	0%	7.10%
3 - I know some facts, but struggle with others.	56.30%	28.60%
4 - I know them pretty well.	37.50%	42.90%
5 - I am a master at multiplication facts!	6.30%	21.40%

Note: Tables 3, 4, 5 and 6 were results from an anonymous survey. Because of the anonymity of the survey, it is unknown who took or did not take the survey. Therefore, the numbers may not align with the number of students who participated in the study.

Table 4

Group A Pretest vs. Posttest Responses to the Question: How do you feel about your math skills in general?

Response	Pretest	Post-test
1 - I am not good at math.	6.70%	0%
2 - I know a little bit about math.	13.30%	14.30%
3 - I am okay at math.	53.30%	50%
4 - I am pretty good at math.	20%	21.40%
5 - I'm great at math, it's easy.	6.70%	14.30%

Table 4 shows Group A's answers to the second question, how do you feel about your math skills in general? In Group A, there was one student at both the beginning and end of the study who answered they are a master at math (5). The other numbers changed quite a bit from beginning to end. Twenty percent of students reported that they are "pretty good at math" (4) at the beginning of the study, while at the end 21% said the same. At the beginning, 51% said they were okay at math (3) and at the end, 50% chose that answer. The biggest change was in the answers of 2 and 1, whereas at the beginning of the study one student stated that they were not good at math (1) and at the end no students had this answer. The answers of 2 "I know a little bit about math" increased from 13% to 14%. This increase could be a change simply because of the number of students who took the survey each time

Table 5

Group B Pretest vs. Posttest Responses to the Question: How would you rate your knowledge of multiplication facts on a scale of 1-5?

Response	Pretest	Post-test
1 - I don't know them at all.	5%	0%
2 - I know a few facts.	11%	6.30%
3 - I know some facts, but struggle with others.	31.60%	18.80%
4 - I know them pretty well.	31.60%	50.00%
5 - I am a master at multiplication facts!	5.30%	25.00%

In Group B there were more dramatic changes. This group's answers are detailed in Table 5. The greatest percentage of responses were in both responses 3 and 4, each getting about 31% of the responses. Post study the responses changed as follows: 1 - 0%, 2 - 6.3%, 3 - 18.8%, 4 - 50% and 5 - 25%. This is almost a 25% increase for those answering a 4 or 5, which means that 75% of the students in this group felt good about their knowledge of multiplication facts.

Table 6

Group B Pretest vs. Posttest Responses to the question: How do you feel about your math skills in general?

Response	Pretest	Post-test
1 - I am not good at math.	5.30%	0%
2 - I know a little bit about math.	21.10%	18.80%
3 - I am okay at math.	26.30%	6%
4 - I am pretty good at math.	26%	37.50%
5 - I'm great at math, it's easy.	21.10%	37.50%

Table 6 shows that Group B showed similar growth in their feelings about math in general. At the beginning of the research 47.4% said they either were pretty good or great at math. By the end of the study 75% of the students responded that way. At the beginning of the study there was one student who said they were not good at math, and at the end no one responded with a 1. This could, again, have been a factor of a student who was absent, however the increase from 47% to 75% of students feeling positive about math is significant.

Data Analysis

Overall, the results of this study were as I expected. The technology Xtramath.org helped my students to become more fluent with their multiplication facts. Both groups in the study showed growth over the period of practicing their facts, which I

also expected. I was surprised that their fluency increased at such a high percentage, especially with the technology-based procedure, but this did confirm the results found in some of the literature I studied prior to this project (Allen-Lyall, 2018, Burns et al., 2018).

One of the students (student 1) did even “pass out” of the Xtramath program during the study. That student’s scores continued to be high even though he was not still practicing his facts every day with Xtramath. This finding is consistent with that of Allen-Lyall (2018) who found that students retained their facts even after ending the intervention.

I did struggle some to use the CCC tool with fidelity. Because I was unable to watch all of the students in my classroom closely while they used the CCC program, and because at the beginning students were given a random set of facts, I do think it could have been implemented more effectively with a small group of students. If it was possible to give a pretest and then assign facts to each student that they did not know right from the beginning, I feel like it would have been a more effective tool.

The groups that I studied ended up being smaller than I would have liked, due to the fact that only about half of each class returned their consent forms. I don’t know what was the cause of this. We do not send home very many paper forms in our school - almost everything is emailed, and maybe parents and students just aren’t used to returning papers.

There was some concern at the beginning of the research period that students being placed in quarantine would cause an issue with attendance and participation in the study. There was one week where students were absent, but other than that the COVID-19 pandemic caused very little issue with the research.

It is also interesting to see that the average scores on Test 2 for Group B were higher than those of Test 3. There were also a few members of Group A who scored higher on this specific test. This could be due to several reasons, for example, the test could have had a higher number of commonly known multiplication facts on it (i.e. 0's, 1's or 5's facts) because the fact tests were randomly generated. It also could have just been a good day for many of the students. Whatever the reason, the final test still showed a higher average for both groups.

As I mentioned earlier in the results portion, the students 2, 4 and 9 in Group A were those who receive special education in math. Student 2 seemed to have growth about equal to that of their peers, however 4 and 9 each showed greater growth than their peers, with an increase of 19 and 13 points over the course of the research period, respectively. These results are similar to that of the study by Ok and Bryant (2016) as mentioned in the literature review. Also of note is the fact that those students who started the study with high scores were not negatively affected by the practice, and that not a single student saw scores decrease over the course of the study. The scores in test two will be discussed later in these results.

In Group B, students 3 and 11 were those who are identified as having learning disabilities in math. Student 3 did not increase scores throughout the research period, but student 11 increased a total of 11 points over the course of the study. In this group, there were a couple of students whose scores at the end were lower than those at the beginning. This makes me wonder if using Xtramath would have benefits for these specific students.

One final issue was that my study time ended up being shorter than I would have liked. We ran into the week of spring break, and rather than test after a week off of school, I ended my research about 5 days earlier than I had originally intended.

Conclusion

I believe that despite the small groups that were studied, either of these interventions are helpful for students who need work on their fact fluency. I feel that Xtramath was more beneficial, not only because that is what the data showed, but also because it was adapted to each student individually without much work for the teacher. Once the teacher set up accounts for them, each student was able to simply log on and get started. As students answered problems right and wrong, the computer program logged that and adjusted the problems accordingly. Doing this on paper with CCC was more difficult, and I had to trust students that they were recording things correctly throughout the process. With a small group, CCC would be more effective because a teacher could watch what students were doing more closely.

I also believe that the data showed that when students feel better about their fact fluency, they feel more confident about their math skills as a whole. I think it is important to notice this and find ways to improve the instruction in fact fluency throughout our math curriculum. The strongest piece of evidence for this conclusion is that Group B increased from 47% of students reporting positive feelings about math at the beginning to 75% having positive feelings at the end of the study.

Chapter 5

Implications for Practice

Action Plan

After noticing the results of this study, I have had my Group B students start using Xtramath.org. My Group A has continued to use Xtramath three times a week as well. Because the study showed the impact that this program has on my students and their fact fluency, I think it is important to continue to use the program until all of my students pass out of the program. My hope is that the students will not only continue to improve their fluency, but will continue to have positive feelings toward math as a whole as they become more confident with their multiplication facts.

Plan for Sharing

I have already shared with my partner teacher and my students that my research showed improvement for them in their fact fluency. I have explained to them that that is why we continue to use Xtramath, or for those who were doing CCC we are going back to Xtramath. I will also be sharing these findings with our entire 5th grade math team at our next team meeting. I have spoken with some of these teachers in the past about this program, but I am excited to let them know what I found and I hope that they will start to use this program in order to help their students feel success with their fact fluency.

References

Allen-Lyall, B. (2018). Helping Students to Automatize Multiplication Facts: A Pilot Study. *International Electronic Journal of Elementary Education*, *10*(4), 391–396.

Basic Math Facts (n.d.) University of Chicago School Mathematics Project. https://everydaymath.uchicago.edu/parents/understanding-em/facts/

Burns, M. K., Kanive, R., & DeGrande, M. (2012). Effect of a Computer-Delivered Math Fact Intervention as a Supplemental Intervention for Math in Third and Fourth Grades. *Remedial and Special Education*, *33*(3), 184–191.

Cover-Copy-Compare Resources Retrieved from: https://www.interventioncentral.org/academic-interventions/math-facts/how-master-math-facts-cover-copy-compare

Joseph, L. M., Konrad, M., Cates, G., Vajcner, T., Eveleigh, E., & Fishley, K. M. (2012). A Meta-Analytic Review of the Cover-Copy-Compare and Variations of This Self-Management Procedure. *Psychology in the Schools*, *49*(2), 122–136.

Musti-Rao, S., & Plati, E. (2015). Comparing Two Classwide Interventions: Implications of Using Technology for Increasing Multiplication Fact Fluency. *Journal of Behavioral Education*, *24*(4), 418–437.

Ok, M. W., & Bryant, D. P. (2016). Effects of a Strategic Intervention with iPad Practice on the Multiplication Fact Performance of Fifth-Grade Students with Learning Disabilities. *Learning Disability Quarterly*, *39*(3), 146–158.

Poncy, B. C., Skinner, C. H., & McCallum, E. (2012). A comparison of class-wide taped problems and cover, copy, and compare for enhancing mathematics fluency. *Psychology in the Schools*, *49*(8), 744–755.

https://doi-org.trmproxy.mnpals.net/10.1002/pits.21631

Riccomini, P. J., Stocker, J. D., Jr., & Morano, S. (2017). Implementing an Effective Mathematics Fact Fluency Practice Activity. *TEACHING Exceptional Children*, *49*(5), 318–327.

Woolfolk, A. (2018). Educational Psychology (14th Edition). Upper Saddle River, NJ: Merrill.

Xtramath website: home.xtramath.org

APPENDIX A

MINNESOTA STATE UNIVERSITY MOORHEAD

Institutional Review Board

DATE: February 3, 2021

TO: Ximena Suarez-Sousa, Principal Investigator
Carrie Hartwig, Co-Investigator

FROM: Lisa Karch, Chair
Minnesota State University Moorhead IRB

Lisa D. Karch

ACTION: DETERMINATION OF EXEMPT STATUS

PROJECT TITLE: [1709820-1] Technology vs. Paper and Pencil: How do students best learn their math facts?

SUBMISSION TYPE: New Project
DECISION DATE: January 27, 2021

Thank you for your submission of New Project materials for this project. The Minnesota State University Moorhead IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations under 45 CFR 46.104.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact the Minnesota State University Moorhead IRB. Please include your project title and reference number in all correspondence with this committee.

This letter has been issued in accordance with all applicable regulations, and a copy is retained within Minnesota State University Moorhead's records.

APPENDIX B

Name : _____ Score : _____

Teacher : _____ Date : _____

3 Minute Drill

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

Math-Aids.Com

APPENDIX C

Link to video with directions for administering Cover-Copy-Compare