

MATHEMATICAL TIMED TESTS AND AUTOMATICITY

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MATHEMATICAL TIMED TESTS AND AUTOMATICITY

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Abstract

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This paper contains research on mathematical timed tests and whether or not they foster automaticity in concerns to mathematical facts, such as addition. Through action research, a study was conducted to see if students were able to produce addition math facts automatically when given a timed math test of 50 problems. There were six students with a learning disability in the test group, and the tests were given five days a week for a five week period. The students had a time limit of three minutes. A pre-test was given to form a baseline, and then consecutive math fact tests were given. At the end of each section, a post-test was given to see if improvement and retention was evident.

Also, a survey was given to the students at the end of the study to see if the concept of a timed test caused any anxiety or frustration. The data was compiled to form a summary of the student's attitudes toward the tests. In today's society students are under a great deal of pressure to perform to high expectations, and the concept of a timed test seemed to reflect this pressure.

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CHAPTER 1

INTRODUCTION

With more pressure being placed on students performing well on district and state-wide tests, it is imperative that students are able to quickly produce simple mathematic facts with ease. The use of mathematical timed tests is a subject of debate among current educators, especially if whether or not the use of these tests assists in producing automaticity of facts. For students with a learning disability, rote memorization and fact recall is something that is difficult to master. Thus, many researchers suggest implementing a program that contains a varied instructional approach that incorporates the use of these timed tests to measure comprehension and retention. John Woodward states, “timed practice drills as a method for developing automaticity offer a clear alternative to strategy instruction for academically low-achieving students and students with LD” (Woodward, 2006). Others suggest that the use of these timed tests do nothing more than produce anxiety and frustration towards mathematics. Joanne Tsui states that “math anxiety is one of the nonintellectual factors that affects a child’s performance on mathematics” (Tsui, 2007). This action research paper shows that the use of mathematical timed tests with students with a learning disability does not produce automaticity, in regards to addition facts. Also, it demonstrates the inconsistency in scoring from test to test, and it depicts the student’s attitude towards mathematics and the use of these tests.

Statement of the Problem

Many educators and researchers feel that the use of mathematical timed tests assist in producing automaticity of facts. For some students, this approach is beneficial. For those with a learning disability, this approach seems to produce unsuccessful results and unwarranted feelings toward mathematics in general.

Definition of Terms

Automaticity: Automaticity is when students can go quickly without errors and without much conscious attention, when they can perform other tasks at the same time and still perform quickly and accurately (Crawford, 2004).

Automaticity-Math: This means that students can answer any math fact instantly and without having to stop and think about it; it is “obligatory”-one can’t help but do it (Crawford, 2004).

Math anxiety: Math anxiety is “the feeling of tension and anxiety that interferes with manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (Tsui & Mazzocco, 2007).

Delimitations of Research

There are no delimitations of research.

Method of Approach

A study of six students with a learning disability was completed over a five week period. The students were given a three-minute timed addition test and a summative survey towards the tests in general. Research was conducted to observe attitudes towards the benefits and drawbacks of utilizing this approach. A review of literature and studies related towards the use of mathematical timed tests and mathematical anxiety was conducted. The findings were then summarized and synthesized, and recommendations were made.

CHAPTER 2

REVIEW OF RELATED LITERATURE

The Use of Timed Tests

The use of mathematical timed tests has come under a certain amount of debate. Many educators and researchers debate whether or not the utilization of these tests assists in producing automaticity of mathematical facts in young students, especially those with a learning disability. It appears as though current mathematical instruction involves a varied approach of instructional delivery methods in conjunction with timed tests. The ultimate goal of mathematics educators is to practice facts and fact retrieval with students to the level of automaticity (Crawford 2004). Crawford states,

Automaticity is the third stage of learning. First, students learn facts to the level of accuracy—they can do them correctly if they take their time and concentrate. Next, if they continue practicing, they can develop fluency. Then they can go quickly without making mistakes. Finally, after fluency, if students keep practicing they can develop automaticity. (Crawford 2004)

Thus, if educators use a combined approach of instructional practices and time to practice chunks of facts at a time, while using timed tests to monitor progression and retention, students will have a greater chance at developing automaticity.

These mathematical timed tests can be utilized with addition, subtraction, multiplication and division facts. There are fifty to one hundred problems on the tests, and the students are given a time limit. It is best to give a pre-test to the students to determine where exactly their present level of performance is at. After a pre-test is given, fact practice and repetitious activities

can be utilized during instructional time to further the memorization and accuracy of the facts. After a given time period, a timed fact test can be given. The goal is for the students to be meeting the benchmark given by the educator. Usually students continue to take a timed fact test until the benchmark is obtained before proceeding to the next chunk of facts.

Again, mathematical timed tests can be utilized in conjunction with instructional time to assist in producing automaticity; “Students who are automatic with their math facts can’t help but think of the answer to a math fact when they say the problem to themselves. This automaticity allows them to focus their mental energies on the problem solving steps rather than the facts. Students who are automatic with math facts find learning new computation algorithms much easier and are able to use mental math to solve problems as well (Crawford 2004).

Positive Aspects of Using Timed Tests

Using mathematical timed tests can bring about positive, enriching experiences for students who are learning chunks of facts. In conjunction with instructional methods (whole group instruction, individual practice time, review games, hands on practice, etc.), mathematical timed tests can offer students a chance to demonstrate their mathematical abilities and intelligence. The results of the timed tests can give educators an insight into the amount of retention and accuracy a student has. Also, the timed tests can show the students what he/she is capable of doing, and what he/she needs to practice and review.

Mathematical timed tests can be utilized with all age groups and all learning abilities and levels. Although “children with a learning disability may need additional time or assistance, or will need modified instruction or activities, to help them acquire the skills and concepts that other children attain with relative ease,” they too will be able to benefit from participating in

timed tests (Tsui & Mazzocco, 2007). Odds are that as an educator you will have students with a learning disability in your classroom, due to the fact that “approximately 6 to 10% of individuals in the general population have a persistent mathematical learning disability,” thus one should prepare alternate activities and practices (Tsui & Mazzocco, 2007). Perhaps the student takes half of the timed test to reduce anxiety, or perhaps the student works on the accuracy of two sets of facts instead of four. Either way, the students are still participating in the timed tests and are able to demonstrate their accuracy and mathematical ability.

Overall, mathematical timed tests can be utilized in an elementary and/or middle school mathematics classroom as an assessment to assist educators in seeing how well students have mastered automaticity with a chunk of facts. All students are able to participate in taking a timed test, yet the test level and length may vary.

Negative Aspects of Using Timed Tests

Every debatable topic has a positive and a negative side. There are some educators and researchers that believe that using mathematical timed tests can produce more harm than good for students who participate in them. One fear that researchers have about providing students with timed tests is that the test itself will produce an anxiety towards mathematics. Marilyn Burns feels that using timed tests “makes no instructional sense. Children who perform well under time pressure display their skills. Children who have a difficulty with skills, or who work more slowly, run the risk of reinforcing wrong learning under pressure. In addition, children can become fearful and negative toward their math learning” (Burns 1995). She is one of the researchers who feel that mathematical timed tests produce no positive end result for the student. Instead, it creates an anxiety for the students when they are given a timed test, thus they will not

perform to their ability, and they will not demonstrate automaticity.

Negative feelings towards mathematics are another fear that researchers have about educators who utilize timed tests as an assessment tool for their students. Popham states, “given the fact that so many young people regard math with distaste these days, the last thing educators should do is pressure kids to be math-perfect in minutes... we need our students to regard mathematics positively, to realize that the basic operations in math are not only important, but also readily mastered” (Popham 2008). Educators want their students to be able to perform mathematical computations with ease and with little to no distaste. There is not an educator out in today’s world who wants to see a student fail or who wants to see a student frustrated with an assessment tool.

Another fear that researchers have about timed tests is that it does not truly assess a student’s mathematical abilities. They feel that it focuses on having students memorize facts instead of learning how to solve problems. Burns feels that “timed tests do not measure children’s understand... It doesn’t ensure that students will be able to use the facts in problem-solving situations. Furthermore, it conveys to children that memorizing is the way to mathematical power, rather than learning to think and reason to figure out answers.” Although timed tests require some sort of memorization, students have to have had practice learning how to form the correct response in order to ensure accuracy. Thus, knowing simple addition, subtraction, multiplication and division facts will allow students to compute and solve multi-step problems with ease.

Even though researchers are hesitant to see educators utilize mathematical timed tests in their classrooms, it does happen. Students can develop an anxiety or negative feelings towards any subject or specific practice. Outlook and feelings can be altered or swayed to a positive light

if the educator is reassuring and offering positive reinforcement to the students, and no educator means to produce these feelings by using this type of assessment. Students are going to get anxiety and negative feelings towards many things throughout their school years; timed tests just might be one of them.

RtI and Its Effects

RtI, Response to Intervention, is a new and upcoming component in today's educational system. It has been evident that there has been an overpopulation of students diagnosed with a learning disability, and educators and researchers feel it has to do with the ineffective instructional practices rather than the child's ability to learn. Also, with the push from NCLB to have all students proficient within the next few years, there is an inundation of pressure on educators to decrease the achievement gaps, especially in reading and mathematics. Thus, a three tiered approach has been designed to assist in eliminating this gap, while decreasing the amount of students labeled and placed into a special education classroom. By looking at the graph below, one can see that there should be 80-90% of students in the general curriculum that succeed with no supplemental interventions. The second tier holds 5-10% of students who need some type of intervention to assist in achieving success with the grade level curriculum. The third tier holds 1-5% of students who need varied intensive interventions to assist in achieving success. All interventions utilized should be research based interventions.

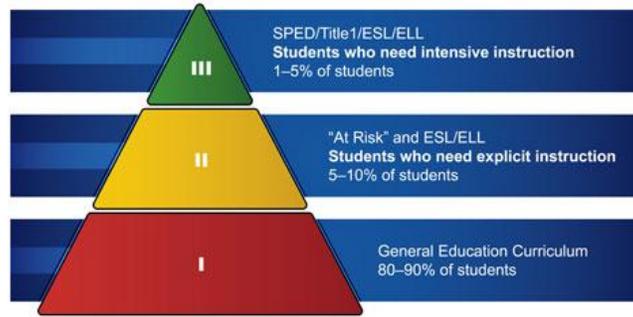


Figure 1. Response to Intervention Tiered Approach.

This figure illustrates the tiers of the interventions used within this approach.

In order to determine which of our students is in need of interventions, whether it is a modification of curriculum or an intensive change, an assessment needs to occur. Wilburne states that,

RtI requires a systematic assessment process whereby teachers collect frequent data on each student to track their academic progress throughout the curriculum. Through the use of weekly or bi-weekly progress monitoring instruments, teachers identify where students' learning problems occur, pinpoint specific weaknesses or learning gaps, and monitor the effects of intervention strategies. (Wilburne, 2006)

Thus, students will be assessed frequently to determine their present level of academic performance, and where they need to be in order to achieve the benchmark in place. Also, many researchers have stated that the earlier an intervention is able to take place, the more effective the results will be.

Because of the necessity to increase our students' performance, there is a number of progress monitoring instruments and research based interventions available to utilize. One progress monitoring instrument for educators instructing mathematics is a fact timed test. By giving students a pre-assessment to gauge where the student is currently performing, meaning

what do they already know how to do, it can lead the educator's instruction within the classroom. Once a current level of performance is established, an educator can determine what mathematical facts still need improvement and what mathematical facts have been mastered. By giving the students a fact timed test once a day, once a week, or whichever frequency the educator chooses, it will provide the educator with sound data to monitor progress and achievement; "periodic monitoring assists teachers in identifying the effectiveness of the instruction in a timely manner, rather than waiting for the child to fail, at which point the intervention may be too late" (Wilburne, 2006). Again, intervening at an early stage can alter the result to assist in granting more success, as well as altering a student's perspective on a task that might appear frustrating and difficult.

As for educators and the classroom, RtI will soon be a requirement. It is essential that educators monitor their students with both formative and summative assessments. By assessing students educators learn their strong and weak points. Educators learn what the students enjoy and what the students dislike. When educators know their students and their learning styles, it can assist an educator in modifying curriculum activities and assessments so that students are able to comprehend and perform to the best of their ability. Also, it places the student's confidence in the educator that he/she is there for the student and that the educator wants to see the student succeed to his/her potential.

Study Results

During the summer of 2011, I conducted a study with my summer school class; would my students be able to gain automaticity of their math facts by using a combined approach of instruction and timed tests. I had a mixed age level of students with learning disabilities, four

students would be in third grade in the fall, and one student would be in fifth grade in the fall. The mathematics class was ability grouped so that the students could receive the necessary interventions over the summer so that by the time the school year started they would be closer to their peers. The students had a math class for an hour and ten minutes a day, five days a week, for a period of six weeks. There was then a week break, and the students returned for another six week block of instruction.

The instructional delivery methods varied so that all learning styles were incorporated. The class started with a problem of the day on the smart board, which allowed students to move around the classroom and to play an active role in their learning. Then, fact practice was a large portion of the instruction. Stories, sayings and touch points were utilized to assist in eliminating the counting of fingers. Also, flashcards and games involving quick fact recall were implemented. Also, the students utilized a web-based supplemental program called Compass Learning to assist in improving general mathematical skills. At the end of the class, the students were given a mathematical fact timed test (see Appendix). The students had three minutes to complete as many single digit addition problems as possible. By this grade level, single digit addition should be mastered with ease.

For my study, I gave the students a pre-assessment to discover at which point each student was at. After determining their present level of performance, this guided me into forming ability groups so that fact practice was done with peers who needed similar instructional methods.

One third grade girl, one third grade boy, and one fifth grade girl were paired up due to similar test scores. They proved to stay rather even and close to their initial assessment. The graphs below chart their percents received on each test day.

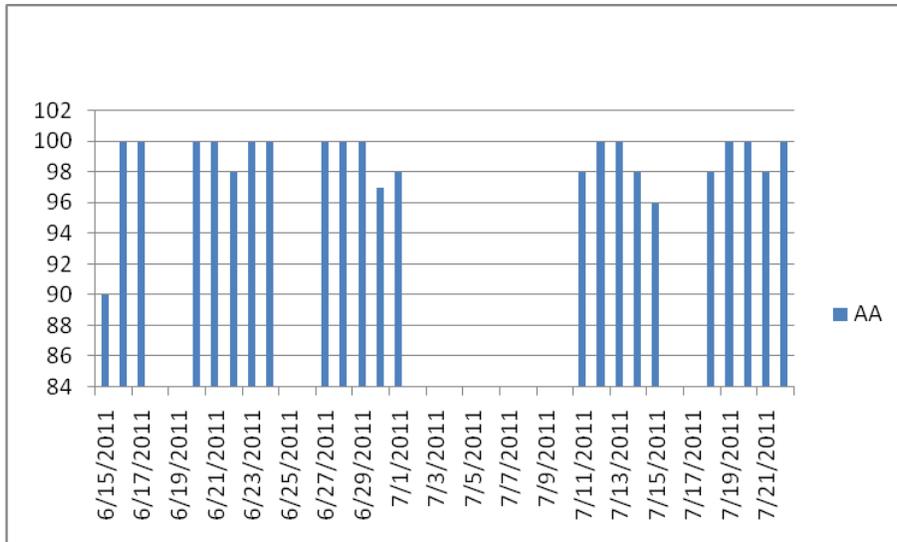


Figure 2. Third Grade Girl's Mathematical Timed Tests Scores.

This figure illustrates her performance on the timed tests.

The third grade girl raised her pre-assessment score, and although she fluctuated she did perform well.

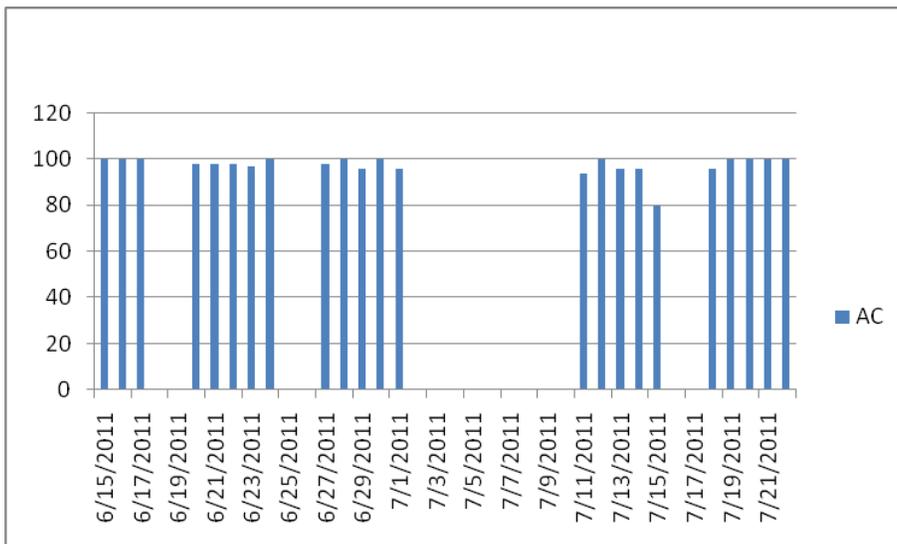


Figure 3. Third Grade Boy's Mathematical Timed Tests Scores.

This figure illustrates his performance on the timed tests.

The third grade boy performed perfect on his pre-assessment, and although at times he went down a few percentage points, it was never a concern.

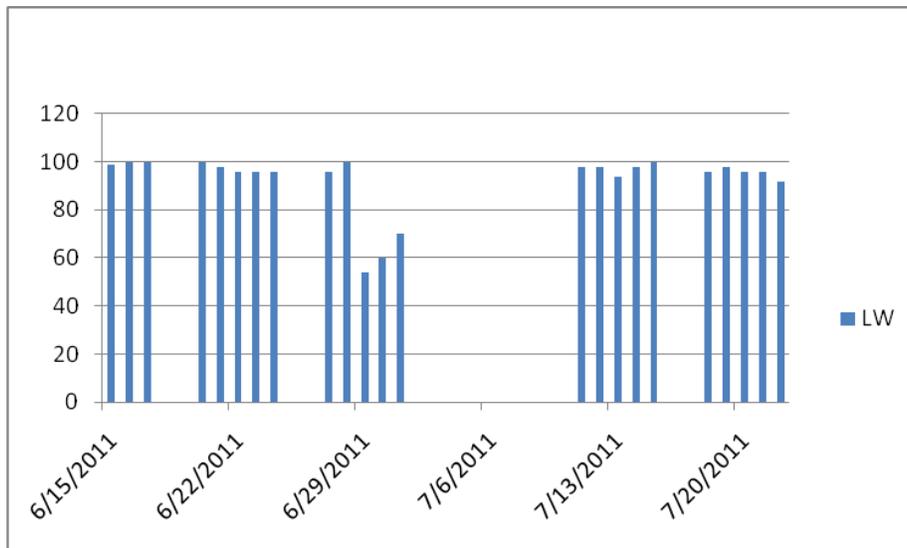


Figure 4. Fifth Grade Girl's Mathematical Timed Tests Scores.

This figure illustrates her performance on the timed tests.

The fifth grade girl did perform well on her pre-assessment. Although for a period of three days, her test scores dropped, she was having difficulties at home. All educators know that environmental and economic factors can alter a student's performance and behaviors, and she is a prime example of this.

The other group that was formed together included one third grade girl, and two third grade boys. This group had the most fluctuation of their test scores. Some days they would appear as though they had mastered their facts for the day, and other days they would appear as though they did not comprehend any of it. These students have a difficult home life, and the two boys are on medications for ADHD and hyperactivity. Again, medications and outside factors can play a role in student performance and drive.

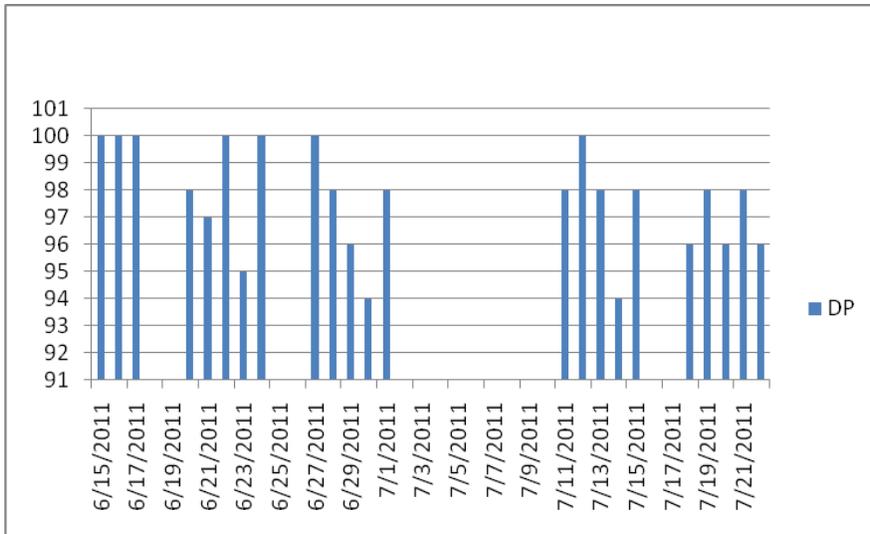


Figure 5. Third Grade Girl's Mathematical Timed Tests Scores.

This figure illustrates her performance on the timed tests.

The third grade girl performed well on her pre-assessment and a few assessment following. But, after a few timed tests, her performance dropped. Home environment factors seemed to play role in her overall attitude towards summer school and her performance in general.

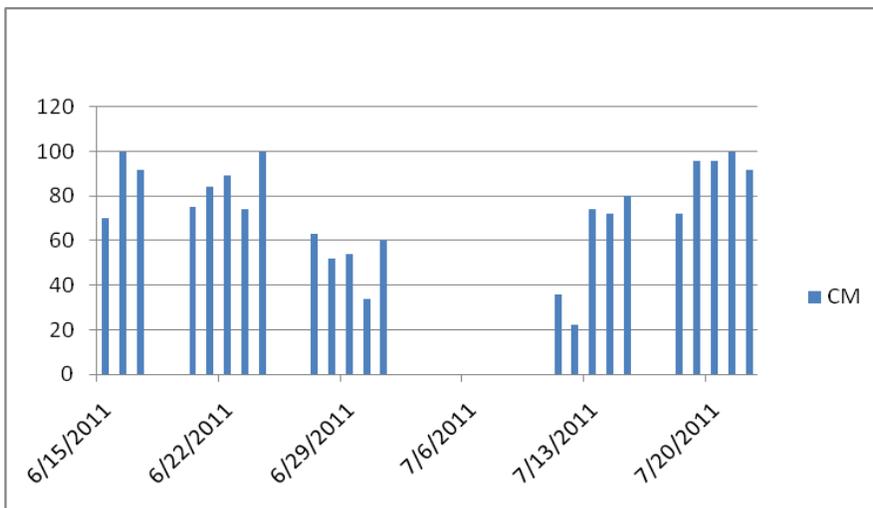


Figure 6. Third Grade Boy's Mathematical Timed Tests Scores.

This figure illustrates his performance on the timed tests.

The third grade boy performed low on his pre-assessment, and his scores continued to fluctuate each time. He was previously on medication, and he was not during the summer months. He had a negative attitude towards summer school, especially mathematics. We struggled to get the assessment taken, and many times he would rush. Thus, his scores are across the board.

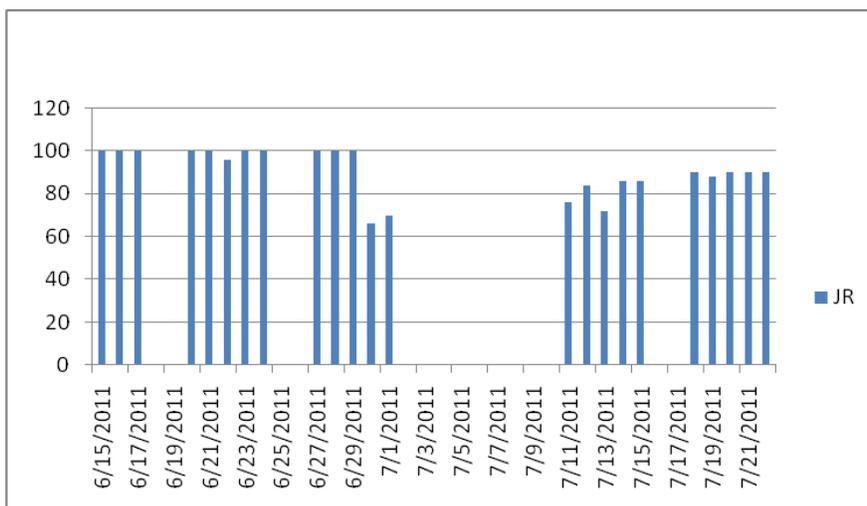


Figure 7. Third Grade Boy’s Mathematical Timed Tests Scores.

This figure illustrates his performance on the timed tests.

The third grade boy performed well on his pre-assessment, and his scores were stagnant for a couple of weeks. Then, he started to perform lower than normal. Again, his home life was not up to par, and he was on and off his medication. But, once we did get him re-focused, his scores started to increase and stay almost the same.

Overall, the students seemed to improve their mathematical facts. Not all students were able to gain automaticity of all facts within the five week period, yet students were able to gain automaticity of simple facts. Although not all students demonstrated success on their timed tests, students are using their fingers less to count and seem more confident that with practice that they will be able to compute facts with ease. If they continue to practice and take timed fact tests, they will ultimately gain automaticity.

Timed Tests and Anxiety

Some researchers and educators feel that the use of timed tests can create an anxiety towards tests in general. They feel that students do not need to take a timed test in order to demonstrate what they are capable of doing. This idea of a time constraint can place unneeded stress upon a student that results in poor performance and distaste towards a subject.

In regards to mathematics, timed tests are utilized frequently in regards to learning and assessing fact comprehension and automaticity. Again, some researchers disagree on the use of timed tests because of their restraint and pressure on students. Marilyn Burns stated that,

What about using timed tests to help children learn their basic facts? This makes no instructional sense. Children who perform well under time pressure display their skills. Children who have a difficulty with skills, or who work more slowly, run the risk of reinforcing wrong learning under pressure. In addition, children can become fearful and negative toward their math learning. (Burns, 1995).

Although there is a time constraint on students during timed tests, the idea of the test is not to have students rush so that they finish, the idea is to “force” the students to become quick and to become automatic with their responses. Students are not required to finish all problems on a timed test within the given time limit, yet they are encouraged to complete as many problems as they can correctly within the time limit.

Another concern by researchers is that students with a learning disability will become more frustrated with mathematics due to taking such a test. They feel as though these students already struggle in this subject, so why pressure them to perform well when it might be too difficult. Tsui feels that, “most school-based performance measures are administered with a time limit. Timed math performance is often worse than untimed math performance...this may be

because of insufficient time to complete all test problems or because the timed testing is sufficiently anxiety-provoking to hinder performance” (Tsui, 2007). She also comments in her article that “high math anxiety may lead students to avoid math by choosing not to enroll in advanced or elective math courses” (Tsui, 2007). Again, if students are in the second or third tier of the RtI model, these students can have modified interventions and activities so that they are able to be successful; perhaps the number of problems is cut down and when they master a certain fact family, they add more problems. There are many ways to modify a test so that the anxiety level can be minimized.

Also during my study, the students took a survey (see Appendix) at the end of their summer school class. The survey was short with five direct questions. The questions were read aloud to the class, and the concept of being nervous was discussed. The students did not have to place their names on their surveys. The goal of the survey was to see if anxiety and/or frustration were placed upon the students due to having to take a timed math fact test. In the chart below, you can see the responses that we tallied for each question.

Question	Yes	No
Number 1	3	2
Number 2	4	1
Number 3	3	2
Number 4	2	3
Number 5	2	3

Figure 7. Mathematical Timed Test Anxiety Survey.

This figure illustrates the results from the survey given to student who took mathematical timed tests.

By looking at the chart, you can see that over half of the students like summer school. Also 80% of the students like math, which is a great response seeing as how these students are there to complete remedial work. Only 60% of the students like to take math fact tests, yet what student really truly enjoys taking tests. I feel that it would be the students who scored well enjoy taking them, and those who do not score well would not enjoy taking them. As for anxiety and/or frustration, 40% of students responded yes. Again, an educated assumption would be those who struggle with math facts and test taking in general would respond negatively to these questions.

CHAPTER 3

CONCLUSIONS AND RECOMMENDATIONS

In summary and based on the review of existing literature related to mathematical timed tests the following conclusions can be drawn. Mathematical timed tests are a topic of hot debate. They are utilized in classroom across the country, and pose both positive and negative aspects towards educators and researchers alike. With NCLB pushing for all children to be proficient in reading and mathematics, students are going to be partaking in more timed assessments that require quick fact retrieval and automaticity of basic facts in order to complete multi-step tasks. Woodward states that, “Information-processing theory supports the view that automaticity in math facts is fundamental to success in many areas of higher mathematics. Without the ability to retrieve facts directly or automatically, students are likely to experience a high cognitive load as they perform a range of complex tasks” (Woodward, 2006). Mathematical timed tests are a tool that can be utilized during mathematics instruction to assist students in strengthening their basic fact knowledge.

Deciding whether or not to utilize timed tests in the classroom can be a decision that is difficult to come to. It appears as though a combined instructional approach works best for students when attempting to memorize basic mathematical fact families. For example, educators could utilize a combination of direct, whole group instruction, small group and partner refresher games and activities, and individual practice assignments to strengthen personal abilities. By combining these approaches, educators are able to reach out to all learning styles and ability levels. When instructing the whole group, general concepts, such as touch points and simple stories can be presented. This allows all students to receive the necessary information that can be recalled later when working on specific learning targets. When in small groups, students can be

ability grouped so that each group is focusing their learning upon which facts are still needed for mastery. Also, centers can be in place when students are in small group, one group working on a web-based program to strengthen skills and one group working on facts with an educator. When working individually, students are able to focus on what they need to know and how they can process it best. This allows time for self-reflection, and it allows time for the educator to work one-on-one with struggling students. By engaging students in different ways, it allows the students to work at their pace and to be comfortable in their learning styles.

With every topic come both positive and negative aspects. Timed tests are something that have been around for a long time and are something that will be around for a long time to come. It all depends upon how one would like to utilize this tool. By having students take timed math fact tests, students are able to demonstrate what knowledge they possess and what knowledge they still need to gain. The timed test gives educators an immediate response as to what facts the students has mastered and gained automaticity with. On the flip side, some researchers and educators feel that by imposing and pressuring students to participate in timed tests that frustration and anxiety will emerge. They feel as though the students' frustration with the test will ultimately lead to a negative resentment towards mathematics. Also, they feel as though the tests do not assess the students' mathematical abilities, but instead have the students learning under pressure. Again, either way the topic is presented is going to foster some resistance. Not all topics and concepts are black and white, thus it is up to the educator to determine what is best fit for his/her students.

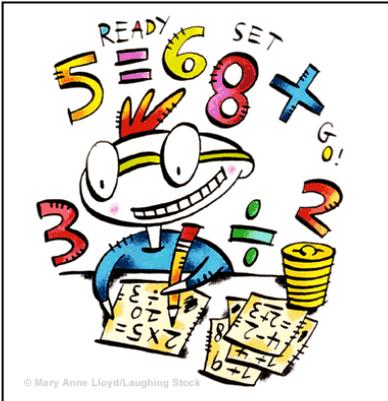
With the over population of students in the special education setting, the government has developed RtI, Response to Intervention. By implementing RtI in a school district, the district is stating that they are going to strive to reach out to students in need at an early stage. Facts have

proven that the earlier the intervention, the higher the success rate. RtI's tiered system proves to utilize scientific, research based interventions for struggling and at-risk students. Throughout the RtI process, educators need to be progress monitoring their students, thus students could take timed math fact tests as part of this monitoring. These tests offer immediate feedback and take the students a short amount of time to complete. This way, educators can alter and modify assignments and assessments to meet the needs of their students. RtI is going to be the way of the future in special education, thus we will be reaching out to our struggling learners earlier in hopes to minimize their potential to be label and placed.

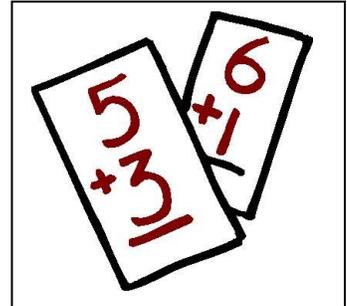
Based on these conclusions and findings, it is recommended that educators take a look at their individual teaching styles and practices. Also, educators should assess the students who are in the classroom so that all learning styles and ability levels are reached. Not all educators and researchers are going to agree on a topic, yet one has to render a decision. All students are capable of taking mathematical timed tests, and all students are capable of producing automaticity of their facts, yet it is the way in which getting to this point is done that is important. With NCLB, RtI and district and state-wide testing, it is a necessity for students to have automaticity of their facts. By engaging students in meaningful ways, students will enjoy mathematics, thus reducing any frustration or anxiety. Overall, students have the potential to do anything they desire, and they need positive and encouraging educators on their side.

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Timed Math Fact Test Survey



- | | | |
|---|-----|----|
| 1. Do you like summer school? | YES | NO |
| 2. Do you like math? | YES | NO |
| 3. Do you like taking fact tests? | YES | NO |
| 4. Do you get nervous when you take a fact test? | YES | NO |
| 5. Do you get frustrated when you take a fact test? | YES | NO |