THE IMPACT OF ANXIETY AND INITIAL FLUENCY LEVEL ON THE EFFECTIVENESS OF EXPLICIT TIMING

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ABSTRACT

THE IMPACT OF ANXIETY AND INITIAL FLUENCY LEVEL ON THE EFFECTIVENESS OF EXPLICIT TIMING

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Explicit timing is an empirically-validated intervention used to increase problem completion rates by enhancing students' ability to quickly and accurately solve mathematic problems. Though explicit timing has proven to be effective for groups of students, some students may not respond well to explicit timing when social emotional factors such as anxiety are taken into account. This study will extend the research by examining anxiety and initial fluency level.

This study consisted of 81 fourth and fifth grade male and female students recruited from 4 suburban and 3 urban classrooms in two southeastern Michigan school districts. Participants completed baseline, control, and explicit timing math assignments consisting of 4 digit x 1 digit multiplication problems with regrouping in 3 of the columns, a writing fluency assessment, general anxiety measure, and math anxiety measure. Results indicated there was an increase in performance during explicit timing for participants at the instructional and frustration level. Explicit timing was more effective for participants with low anxiety than participants with high anxiety. However, the effectiveness of the intervention varied when both initial fluency and instructional level were examined collectively. Thus, it is essential for educators to consider student characteristics such as initial fluency and anxiety level when selecting appropriate intervention strategies.

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CHAPTER I

INTRODUCTION

Mathematics is one of the core educational components needed to navigate the academic arena. Although policy makers, educators, and parents emphasize the importance of mathematics in everyday life and within the workforce, U.S. students are consistently ranked below students in other countries on mathematics proficiency (Hanushek, Peterson, & Woessmann, 2010; Kelley, 2008). For example, only 42% of fourth graders and 36% of eighth graders were at or above proficiency in mathematics and 5-8% of school age students have a mathematics learning disability (Geary, 2004; National Center for Education Statistics, 2013). According to the results of fall 2012 *Michigan Educational Assessment Program* (*MEAP*) data, only 41% of third graders, 46% of fourth and fifth graders, 40% of sixth graders, 38% of seventh graders, and 35% of eighth graders were proficient in math (Michigan Department of Education, 2013). Given that mathematics proficiency impacts future career plans, thus creating a long-term impact on society; policy makers and educators have instituted a renewed focus on policies and procedures to reverse this negative trend. For example, No Child Left Behind (NCLB) emphasized mathematics as a core subject area and required that all students be proficient in mathematics by 2014 (NCLB, 2001). To assist in this goal, educators determined that high school algebra was a keystone course for advanced mathematics in college and employment in high-tech industries (Howell & Nolet, 2000). Therefore, many states now require students to take algebra I and II in order to receive a high school diploma (Kelley, 2008; Reys, Dingman, Nevels, & Teuscher, 2007). However, success in advanced mathematics (i.e., algebra) requires mastery of basic mathematic facts (National Mathematics Advisory Panel [NMAP], 2008). Specifically, students at the end of 3rd grade should be proficient with addition and subtraction

facts and students at the end of 5th grade should be proficient with multiplication and division facts (NMAP, 2008).

Math Instruction

To achieve these mathematic goals, effective mathematics instruction is paramount. Instructional design, instructional delivery, and classroom organization and management have been identified as key components of a successful mathematics program (Stein, Kinder, Silbert, & Carnine, 2006). First, students are taught a conceptual understanding of mathematics which involves learning definitions and rules while working with concrete objects (i.e., blocks) to create a mental representation of the number concept (Flores, 2009, 2010; Gersten et al., 2009; Witzel, Mercer, & Miller, 2003). Second, students are taught procedural knowledge involving sequential steps/strategies to complete mathematic problems accurately. Concrete objects are faded and mentally solving mathematic problems is required (Stein et al., 2006).

Haring and Eaton (1978) developed an instructional learning hierarchy to explain the sequential steps in learning a new skill and Shapiro (2004) developed objective guidelines for these stages. The first stage, acquisition, involves practicing the new skill until accuracy is obtained. Students in the acquisition stage obtain 19 or fewer digits correct with eight or more digits incorrect per minute (based on 4th grade and higher; labeled 'frustration level') (Shapiro, 2004). The second stage, fluency, involves completing the new skill quickly and accurately (Haring & Eaton, 1978). Students in the fluency stage obtain 20-39 digits correct with seven or fewer digits incorrect per minute (based on 4th grade and higher; labeled 'instructional level') (Shapiro, 2004). The remaining stages of the instructional learning hierarchy focus on applying the skill to new situations; hence, requiring mastery of basic mathematics facts (at least 40 digits correct with two or fewer errors per minute based on 4th grade and higher) (Howell & Nolet,

2000; Hudson & Miller, 2006; Shapiro, 2004; Stein et al., 2006). Using the instructional learning hierarchy stages, educators have developed instructional interventions targeted for each stage.

Explicit Timing

One intervention designed to target fluency is explicit timing. Explicit timing has been identified as a simple and effective intervention used to address mathematic computation problems (Codding, Hilt-Panahon, Panahon, & Benson, 2009). This intervention involves presenting students with a stopwatch and explicitly telling them of the time limit for the assignment (Van Houten & Thompson, 1976). Research indicates that 2nd grade students complete significantly more problems correct via explicit timing without impacting accuracy (Rhymer, Henington, Skinner, & Looby, 1999; Van Houten & Thompson, 1976). However, a study with African American 3rd graders produced a decrease in accuracy during explicit timing (Rhymer, Skinner, Henington, D'Reaux, & Sims, 1998). To examine this discrepancy, Rhymer and colleagues (1998) analyzed student's pre-intervention accuracy rate and found a relationship between per-intervention accuracy rate and effectiveness of explicit timing. When students in the acquisition stage of the instructional learning hierarchy were presented with explicit timing, their accuracy decreased. However, when students in the fluency stage of the instructional learning hierarchy were presented with explicit timing, their accuracy increased (Rhymer et al., 1998). Similarly, Codding et al. (2007) found explicit timing was ineffective for 2nd and 3rd graders in the acquisition stage but effective for students in the fluency stage. Therefore, it appears stage within the instructional learning hierarchy may dictate the effectiveness of the explicit timing intervention.

To examine this issue further, Rhymer et al. (2002) varied the difficulty level of mathematic problems during a control condition and explicit timing condition. Sixth graders completed significantly more problems during explicit timing as compared to control when the assignment consisted of mathematic problems at the mastery or instructional level (i.e., 1d+1d and 3d-3d, respectively). However, explicit timing had no effect on problems completed when the assignment consisted of mathematic problems at the acquisition level (i.e., 3d*3d) (Rhymer et al., 2002). Therefore, educators must assess students' mathematic instructional level prior to recommending the explicit timing intervention.

Writing Fluency

Although Shapiro (2004) does not include students' writing speed, other researchers have suggested that and assessment of students' mathematic instructional level should also include a measure of students' writing speed. Stein et al. (2006) recommended administering a one-minute writing assessment in which the student writes the digits one through nine as many times as possible. The criteria for mastery of basic mathematic facts would be obtained by multiplying the number of digits written on the one-minute writing assessment by two-thirds (Stein et al., 2006). Therefore, criteria for mastery of basic mathematic facts must be customized for each student factoring in the speed at which the student can write the answer. Hudson and Miller (2006) also recommended administering a one-minute writing assessment to determine the criteria for mastery of basic mathematic facts; however, they recommended multiplying the number of digits written on the one-minute writing assessment by 50% for students in kindergarten through 3rd grade or 75% for students in 4th grade and above. Consequently, it is unknown if the assessment of writing speed is an important factor when examining mastery criteria of basic mathematic facts and if it is measured, how the results should be calculated.

Furthermore, it is unknown if other factors such as anxiety may interfere with the effectiveness of explicit timing. Plass and Hill (1986) found that boys with high-anxiety performed poorly and inaccurately under time pressure; whereas, boys with low anxiety and girls with high anxiety performed better under time pressure. However, Kellogg, Hopko, and Ashcraft (1999) found that timing negatively impacted the performance of individuals with and without high levels of math anxiety. Therefore, the effectiveness of explicit timing may be limited for individuals with anxiety.

Anxiety is a psychological state that evokes intense emotional and physiological reactions that can be clinically significant and warrant a psychiatric diagnosis. According to the *Diagnostic and Statistical Manual of Mental Disorders*, (5th ed.; *DSM-5*; American Psychiatric Association, 2013), most anxiety disorders share common cognitive (worry, emotionality), somatic (increased heart rate, sweating, feelings of nausea) and behavioral (flight or fight response) components (American Psychiatric Association, 2013). Overall, lifetime prevalence rates in adults average 16.6% with higher rates in women (Somers, Goldner Waraich, & Hsu, 2006). Approximately 12.5% of children and 32% of adolescent are reported to have an anxiety disorder (Anxiety and Depression Association of America,2013; Merikangas, et al., 2010). In fact, they are one of the most common mental illnesses for children, particularly separation anxiety and generalized anxiety disorders (Beedso, Knappe, & Pine, 2009; Cartwright-Hatton, McNicol, & Doubleday, 2006; Mash & Wolfe, 2005).

There are two commonly referenced forms of anxiety: state and trait. State anxiety deals with momentary feelings of anxiety precipitated by a threatening situation (Hedberg, 1972). For instance, encountering an aversive stimulus such as a vicious dog would evoke nervousness and

bodily tension (e.g., increased heart rate, increased sweat production, and other physiological responses); however, once the aversive stimulus was removed heart rate and other physiological responses would return to normal levels. Thus, this type of anxiety is situational and temporary. Trait anxiety is a pattern of responding with anxiety to situations that do not pose a threat (Hedberg, 1972). Individuals with trait anxiety are said to be "anxiety prone" and often experience feelings of anxiousness (Zeidner & Matthews, 2011). High trait anxiety has been known to impact individuals' performance in high stress conditions (e.g., math tests) by increasing the likelihood of errors (Fox & Houston, 1983).

Test Anxiety

More specific to the educational setting, test anxiety can impact students' school performance. Test anxiety is classified as excessive anxiety about a particular test or about assessment in general (Ormrod, 2008). It is accompanied by the arousal of both cognitive and physical responses during situations in which a person believes he or she is being evaluated. Though general anxiety and test anxiety share common associated features, researchers have indicated the two are different constructs (Putwain, 2008). Test anxiety impacts students' stress levels, attitude toward testing, attitude toward self, test behavior, and academic motivation (Cizek & Burg, 2006). Prevalence rates indicate approximately 25-40% of individuals have test anxiety with rates higher in females and ethnic minorities (Zeidner & Matthews, 2011). Therefore, many students are experiencing test anxiety in an educational environment dominated by student assessment and evaluation.

Evaluative procedures are introduced very early in the school setting. Legislation such as the No Child Left Behind Act require students in grades 3 through 8 to be tested annually in reading, math, and science (NCLB, 2001). In Michigan, this is accomplished by requiring

students in grades 3 through 9 to take the *Michigan Educational Assessment Program* (*MEAP*) (Michigan Department of Education, n.d.). High-stakes testing has been known to evoke nervousness, worry and anxiety in elementary age children (Triplett & Barksdale, 2005). However, the introduction of formal assessments in elementary school exposes students to the evaluative processes likely to be encountered throughout one's educational journey. For example, the *ACT*, the *Scholastic Assessment Test* (*SAT*), and the *Graduate Record Exam* (*GRE*) are three high-stakes tests often required for admissions to college and universities. There is often a great deal of internal and external pressure to perform well on these exams which can adversely impact students' performance. For example, individuals with higher anxiety levels tend to have lower performance on these high-stakes tests (Powers, 2001).

Worry and emotionality are two key features of test anxiety. Worry involves the cognitive reaction of individuals during evaluative situations or one's internal dialogue prior to, during, and after an evaluative event. Emotionality involves the physiological responses (e.g., increased heart rate, dizziness, and nausea) experienced during evaluative situations for individuals with high levels of test anxiety (Cassady & Johnson, 2002; Cizer & Burg, 2006). Test performance is more strongly related to worry than emotionality; thus, worry is more predictive of performance on high stakes tests (Powers, 2001). However, high emotionality has been linked to significantly lower scores on the math portion of the *SAT* (Cassady & Johnson, 2002).

Math Anxiety

Math has been identified as the academic area most likely to be associated with anxiety (Green, 1990). According to Richardson and Suinn (1972), math anxiety is characterized by tense and anxious feelings that hinder manipulation of numbers which negatively impacts

students' ability to pass basic mathematic courses or take advance mathematics and science courses in the future. Therefore, students who struggle with mathematics in the primary grades are likely to continue to struggle with mathematics as they navigate the academic arena (Wu, Barth, Amin, Malcarne, & Menon, 2012). These individuals often receive lower grades in mathematics and avoid taking mathematics as an elective in future high school and college courses (Ashcraft & Kirk, 2001; Ashcraft, 2002). Regrettably, even students who receive high grades in mathematics tend to avoid taking additional mathematics courses in high school and college (Betz, 1978; Meece, Wigfield, & Eccles, 1990).

It is hypothesized that individuals with higher levels of math anxiety experience a reduction in working memory capacity for processing numbers and therefore have more difficulty quickly and accurately completing problems involving multiple steps (Ashcraft & Kirk, 2001). Researchers examining brain activity have found significant differences in children with high or low anxiety. For example, Young, Wu, and Menon (2012) found that children with high math anxiety had significantly greater activation in the right amygdala which is associated with the processing of negative emotions and fearful stimuli and significantly less activation in areas of the brain related to emotional regulation. Therefore, current brain research has documented the psychological distress that children with high math anxiety experience. Given these empirical results, educators and psychologists must ensure that academic interventions are appropriate for all students, especially those with math anxiety.

Present Study

Therefore, the purpose of the current study was to examine the effectiveness of explicit timing as compared to baseline. Secondly, this study examined the relationship of explicit timing based on initial fluency. This study also compared the performance of participants with low

anxiety to participants with high anxiety. This study examined anxiety level and its impact on the effectiveness of explicit timing as well as examined the effectiveness of explicit timing when considering initial fluency and anxiety level. Additionally, the study examined the relationship between initial math instructional level and writing fluency. This study also examined the relationship between general anxiety and math anxiety. Furthermore, this study examined the relationship between math *MEAP* scores and performance. Lastly, this study examined treatment acceptability using student and teacher ratings.

Hypotheses

It was hypothesized that 1) there will be a significant difference in digits correct during explicit timing as compared to baseline, 2) there would be a significant difference in the performance of participants with higher initial fluency compared to those with lower initial fluency, 3) there would be a difference in performance of participants with low anxiety as compared to participants with high anxiety, 4) explicit timing would improve the performance of participants with low anxiety but not participants with high anxiety 5) the impact of explicit timing would vary based on participants' initial fluency level and anxiety level and 6) there would be no significant difference in accuracy across conditions.

It was also hypothesized that 7) there would be a positive correlation between writing fluency and digits correct and 8) there would be a moderate correlation between anxiety measures.

Additionally, it was hypothesized 9) there would be a negative correlation between math *MEAP* scores and anxiety scores 10) there would be a positive correlation between math *MEAP* scores and digits correct, 11) there would be a positive correlation between math *MEAP* scores and accuracy, 12) there would be a positive correlation between math *MEAP* scores and digits

correct for participants with low and a negative correlation between math *MEAP* scores for participants with high anxiety and 13) there would be a positive correlation between math *MEAP* scores and accuracy for participants with low anxiety and a negative correlation between math *MEAP* scores and accuracy for participants with high anxiety.

Lastly, it was hypothesized that 14) participant and teachers would rate explicit timing as an acceptable intervention.

CHAPTER II

METHOD

Participants

Participants were recruited from 4 suburban (n=116) and 3 urban (n=79) classrooms in two southeastern Michigan school districts. Parent consent forms granting permission to participate were returned by 110 participants. Of those participants, 2 denied student assent and were excluded from the study. Additionally, participants who did not complete all four sessions were excluded from data analysis. A total of 81 fourth (n=42) and fifth (n=39) graders were included in the study. The average age of participants was 10.07 with a range of 8 to 12 years. Fifty-two percent of the participants were male while 48% were female. Additionally, 54% identified themselves as Caucasian, 40% as Black/African American, 4% as Biracial, 1 % as Native American, and 1% as other.

Consent for participation was obtained from school administrators and classroom teachers (See Appendix A and B). Parent consent and student assent was required for researchers to use students' data (See Appendix C and D). All students received a pencil and eraser upon returning a signed parent consent form regardless of whether or not their parents allowed their data to be used in the study. Additionally, participating teachers received a $10.00 gift certificate to purchase school supplies. All students completed the math assessments and writing fluency assessments; however, only data from students with assent and parent consent was analyzed. Furthermore, only students with assent and parent consent completed the demographic survey and anxiety measures and had their 2012 math *MEAP* scores recorded.

Each student was assigned an identification number and this number was recorded on all data. No personally identifiable information was recorded on data. The coding key matching the student's name to their identification number was only available to the researcher and was shredded at the conclusion of the study to ensure confidentiality.

Materials

Demographic Survey

The demographic survey consisted of questions regarding age, race/ethnicity, and gender (See Appendix E).

Math Assessment

Math sheets consisted of 25 4 digit x 1 digit multiplication problems with regrouping in 3 of the columns with problems printed on the front of a 8 ½ by 11 sheet of paper (See Appendix F). A total of 9 equivalent math sheets were created: 3 for baseline, 3 for explicit timing, and 3 for control. These problems were selected based on Michigan Grade-Level Content Expectations along with input from the fourth and fifth grade teachers.

Writing Fluency Assessment

Three writing fluency sheets were created (see Appendix G). Each sheet consisted of directions, a place for student identification numbers to be recorded, and numbers 1,2, and 3 to indicate the order in which the sheets were completed. The sheets also consisted of blank lines for students to record the numbers 1 through 9.

Stop Watch

A stopwatch with a silent mode was used for timing sessions.

Revised Children's Manifest Anxiety Scale, Second Edition

General anxiety was measured using the *Revised Children's Manifest Anxiety Scale, Second Edition* (*RCMAS-2*). The *RCMAS-2* is a 49 item self-report scale that can be administered individually or to groups in 10-15 minutes. The scale is written at a second grade reading level and measures the level and nature of anxiety in individuals between the ages 6 to19. During administration, respondents provide "yes" or "no" answers to a list of questions related to general anxiety. The standardization sample consisted of 2,368 individuals stratified into three age groups (6-8, 9-14, and 15-19). The measure yields *T* scores (*M*=50, *SD*=10) on six scales: Total Anxiety, Physiological Anxiety, Worry, Social Anxiety, Inconsistent Responding Index, and Defensiveness. Scores of 71 and higher are extremely problematic, 61-70 are moderately problematic, 40-60 are no more problematic than most students, and 39 and lower are less problematic than for most students. Reliability data suggests the scale is reliable in terms of Total Anxiety, Worry, and Social Anxiety; however, coefficients for Physiological Anxiety and Defensiveness were slightly lower (*RCMAS-2;* Reynolds & Richmond, 2008). Internal consistency data based on the current study suggest the items on the *RCMAS-2* are related with an alpha of .87.

Mathematics Anxiety Rating Scale-Elementary Form

Math anxiety was measured using the Suinn *Mathematics Anxiety Rating Scale-Elementary Form* (*MARS-E*). The *MARS-E* is a 26 item self-report measure for 4^{th}-6^{th} graders and requires 15-20 minutes to complete. The *MARS-E* was standardized on 1,119 Colorado

students (*n*=326 fourth graders, *n*=381 fifth graders, and *n*=412 sixth graders). The normative sample consisted of 87.9% Caucasians, 9.4% Hispanics, 1.7% Asians, 0.7% Blacks, and 0.3% American Indian-Alaskan Native. Items consist of potential anxiety producing situations related to math both in and out of the classroom and participants use a 5-point Likert scale ranging from "not at all nervous" to "very, very nervous" to rate how nervous they would be in each situation. Scores on the *MARS-E* range from 26 to 130 with higher scores reflecting more anxiety (*M*=54.8; *SD*=12.93). The *MARS-E* has two factors: Mathematics Test Anxiety and Mathematics Performance Adequacy Anxiety (Suinn, Taylor, & Edwards, 1988).

According to the normative data, females (*M*=55.7, *SD*=13.54) have a higher mean score than males (*M*=53.8, *SD*=12.19). Scores are also reported as percentile equivalents which allows for interpretation of the relative position of any individual student's score. The relationship between math anxiety and math achievement was used to determine the validity of the *MARS-E*. Scores on the *MARS-E* had significant negative correlations with the *Stanford Achievement Test* (*SAT*) mathematics skills showing that as math anxiety increased, math achievement decreased (Suinn et al., 1988). Internal consistency data based on the current study suggest the items on the *MARS- E* are related with an alpha of .94.

Children's Intervention Rating Profile

Student intervention acceptability was obtained via an adapted version of the *Children's Intervention Rating Profile* (See Appendix H) (Elliott, Witt, Galvin, & Moe, 1986). The scale consists of six items rated on a 3- point Likert scale ranging from "agree" to "disagree." Internal consistency data on explicit timing ratings suggests the items were moderatedly related with an alpha of .52.

Intervention Rating Profile

Teacher intervention acceptability was obtained via an adapted version of the *Intervention Rating Profile* (See Appendix I) (Martens & Witt, 1982). The scale consists of 15 items rated on a 6-point Likert scale ranging from "severely disagree" to "severely agree." Internal consistency data based on the current study suggest the items were highly related with an alpha of .99.

Michigan Educational Assessment Program

Fall 2012 *MEAP* math scores were obtained and used for data analysis. The *MEAP* is a standardized assessment completed by students in grades 3 through 9. Fall 2012 fourth grade math scores ranged from 283 to 539 while fifth grade ranged from 363 to 668. The scores were categorized into 4 levels based on scaled score ranges. Fourth grade scores ranging from 283 to 422 were considered not proficient, 423 to 433 were considered partially proficient, 434 to 469 were considered proficient, and 470 to 539 were advanced. Fifth grade scores ranging from 363 to 515 were considered not proficient, 516 to 530 were considered partially proficient, 531 to 583 were considered proficient, and 584 to 668 were advanced (Michigan Department of Education, n.d.b).

Procedures

During session one, all students completed 3 baseline math assessments for 3 minutes each and 3 writing fluency assessments for one minute each. During session two, only students with parent consent and student assent granting researchers permission to use their data completed the demographic survey, *MARS-E*, and *RCMAS-2*. All remaining students completed work assigned from their teacher. During session three and four, all students received either the

3 explicit timing math assessments along with the *Children's Intervention Rating Profile* or the 3 control math assessments along with the *Children's Intervention Rating Profile*. Half of the classrooms received the explicit timing condition followed by the control condition while the remaining classrooms received the control condition followed by the explicit timing condition. Counterbalancing of conditions decreases the likelihood of order effects (Shadish, Cook, & Campbell, 2002). At the conclusion of session four, debriefing occurred.

The researcher read the following instructions for baseline math assessments and control math assessments: 1) correctly complete as many math problems as possible on the sheet, 2) work as quickly as possible, 3) complete the problems beginning from left to right without skipping any, and 4) raise your hand if you complete all of the problems before being told to stop. The researcher covertly timed the students for three minutes before instructing them to stop and put their pencils down.

The researcher read the following instructions for written fluency assessments: 1) write the numbers 1 through 9 over and over, as many times as you can, until I tell you to stop, and 2) start in the top left corner and work from left to right. The researcher conspicuously timed the students for three, one-minute intervals before instructing them to stop and put their pencils down.

The researcher read the following instructions for the explicit timing math assessments: 1) correctly complete as many math problems as possible on the sheet, 2) work as quickly as possible, 3) complete the problems beginning from left to right without skipping any, 4) raise your hand if you complete all of the problems before being told to stop, 5) you will be timed with this stopwatch (show stopwatch to students), 6) there will be a three minute time limit to complete the sheet, and 7) you will be told when you have two minutes remaining and then one

minute remaining. The researcher conspicuously timed the students for three minutes before instructing them to stop and put their pencils down.

Dependent Variables

Dependent variables included digits correct, digits incorrect, accuracy, digits written per minute, general anxiety score, math anxiety score, student intervention acceptability, teacher intervention acceptability, and fluency categories. Digits correct (DC) was obtained by summing the number of digits correct in the answer on the math assessment. Digits with the correct numeral in the appropriate placeholder were summed to determine digits correct. Digits incorrect (DI) was obtained by summing the number of digits incorrect in the answer on the math assessment. Digits with the incorrect numeral in the incorrect placeholder were summed to determine digits incorrect. Accuracy was obtained by dividing DC by the total DC and DI and multiplying by 100. The median DC math assessment was used in data analysis. Digits written per minute (DW) was obtained by summing the number of digits written on the written fluency assessment. The median DW written fluency assessment was used in data analysis. General anxiety was obtained based on total anxiety *T* scores on the *RCMAS-2.* Math anxiety was obtained based on raw scores the *MARS-E.* Student intervention acceptability was obtained by scoring the *Children's Intervention Rating Profile.* Teacher intervention acceptability was obtained by scoring the *Intervention Rating Profile.* Fluency categories were obtained by examining DC and DI on the median baseline math assessment and categorizing students into either frustration (0-19 DCM and 8+ DIM), instructional (20-39 DCM and 3-7 DIM), and mastery (40+ DCM and $\leq$ 2 DIM) (Shapiro, 2004).

Treatment Integrity and Interscorer Agreement

Treatment integrity was measured by another researcher completing the treatment integrity checklist during 50% of the treatment sessions (See Appendix J). The data obtained from the check list indicated 100% of the treatment implementation steps were followed. Research assistants were trained to score DC, DI, and accuracy. Interscorer agreement was obtained by having another researcher independently score 20% of the assignments. Interscorer agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. Interscorer agreement was 94% for math worksheets.

Data Analysis

The average of participants' median scores were used to analyze digits correct, digits incorrect, accuracy, and digits written. Median scores were used to account for variability in performance. Explicit timing and baseline conditions were used for data analysis.

A paired samples t-test was used to compare mean performance across conditions (i.e., baseline and explicit timing). A paired samples t-test was used to study performance across conditions based on initial fluency level. Participants completing 0-19 digits correct were considered to be at the frustration level, 20-39 digits correct at the instructional level, and 40 or more digits correct at the mastery level (Shapiro, 2004). An independent samples t-test was used to study the performance of low anxiety participants and the performance of high anxiety participants during baseline. Participants were categorized as low anxiety or high anxiety based on their raw scores on the *MARS-E*. Fourth grade participants with a raw score of 63 or higher were categorized as high anxiety and those below 63 as low anxiety. Fifth grade participants with a raw score of 59 or higher were categorized as high anxiety and those below 59 as low

anxiety. Both sets of cut scores are at the 75th percentile for their respective grades. A paired samples t-test was used to study participants' performance across conditions (i.e., baseline and explicit timing) based on anxiety level (i.e., low anxiety and high anxiety). A paired samples t-test was used to compare participants' performance across conditions based on instructional level and anxiety level.

To study the relationship between writing fluency and initial math fluency, a linear regression was conducted. To study the relationship between general anxiety and math anxiety, a Pearson correlation was conducted on the *RCMAS-2* and the *MARS-E*. Descriptive statistics were calculated to study student and teacher acceptability. An alpha level of .05 was used to determine statistical significance. Refer to Appendix K for an outline of hypotheses and data analysis procedures.

CHAPTER III

RESULTS

Overall

Table 1 presents the average of the median number of digits correct, digits incorrect, and accuracy within each condition (i.e., baseline, control, and explicit timing).

Table 1. *Median Digits Correct, Digits Incorrect, and Accuracy Across Conditions*

	Baseline	Control	Explicit Timing
	M(*SD)*	*M*(*SD)*	*M*(*SD)*
Median Digits Correct	*25.70 (15.32)	26.38(16.19)	*29.58(17.22)
Median Digits Incorrect	3.22(5.03)	4.40(11.03)	4.64(12.10)
Median Accuracy	84.15(22.85)	84.06(24.37)	85.43(23.45)

Note: * $p < .05$

A paired samples t-test was conducted on digits correct during explicit timing and baseline and there was a statistically significant difference, t (80) = - 4.40, p = .00. Participants completed significantly more digits correct during explicit timing (M = 29.58, SD = 17.22) as compared to baseline (M = 25.70; SD = 15.32). A paired samples t-test was conducted on accuracy during explicit timing and baseline. There was no statistically significant difference in accuracy, t (80) = - .67, p = .50. Thus, accuracy remained constant from baseline (M= 84.15; SD=22.85) to explicit timing (M= 85.43, SD=23.45).

Initial Fluency Level

Table 2 presents the average median digits correct and accuracy across conditions based on participant initial fluency level.

Table 2. *Median Digits Correct and Accuracy Across Conditions by Initial Fluency*

Median Digits Correct	N	Baseline *M*(*SD*)	Control *M*(*SD*)	Explicit Timing *M*(*SD*)
Frustration	31	*10.94(5.27)	11.45(6.11)	*13.84(6.68)
Instructional	34	*27.97(5.38)	29.29(8.90)	*32.85(9.06)
Mastery	16	49.50(8.12)	49.13(10.85)	53.13(13.59)
Median Accuracy				
Frustration	31	66.13(28.14)	65.61(30.87)	68.03(30.63)
Instructional	34	94.06(6.66)	94.88(6.82)	95.82(3.84)
Mastery	16	98.00 (2.19)	96.81(4.09)	97.06(3.21)

Note: * $p < .05$

Frustration

A paired samples t-test was conducted on digits correct for participants at the frustration level during explicit timing and baseline and there was a statistically significant difference, t (30) = -2.90, p = .01. Participants at the frustration level completed significantly more digits correct during explicit timing (M = 13.84, SD = 6.68) as compared to baseline (M = 10.94, SD = 5.27). A paired samples t-test was conducted on accuracy for participants at the frustration level during explicit timing and baseline and there was no statistically significant difference, t (30) = -.40, p = .70. Thus, accuracy levels remained constant for participants at the frustration level during explicit timing (M =68.03, SD = 30.63) and baseline (M = 66.13, SD = 28.14).

Instructional

A paired samples t-test was conducted on digits correct for participants at the instructional level during explicit timing and baseline and there was a statistically significant difference, t (33) = -3.75, p = .00. Participants at the instructional level completed significantly more digits correct during explicit timing (M = 32.85, SD = 9.06) as compared to baseline (M = 27.97, SD = 5.38). A paired samples t-test was conducted on accuracy for participants at the instructional level during explicit timing and baseline and there was no statistically significant difference, t (33) = -1.45, p = .16. Thus, accuracy levels remained constant for participants at the instructional level during explicit timing (M =95.82, SD = 3.84) and baseline (M =94.06, SD = 6.66).

Mastery

A paired samples t-test was conducted on digits correct for participants at the mastery level during explicit timing and baseline and there was no statistically significant difference, t (15) = - 1.21, p = .24. Participants at the mastery level completed approximately the same number of digits correct during explicit timing (M =53.13, SD = 13.59) as compared to baseline (M = 49.50, SD = 8.12). A paired samples t-test was conducted on accuracy for participants at the mastery level during explicit timing and baseline and there was no statistically significant difference, t (15) = 1.06, p = .31. Thus, accuracy levels remained constant for participants at the mastery level during explicit timing (M = 97.06, SD = 3.21) and baseline (M = 98.00, SD = 2.19).

Low Anxiety vs. High Anxiety

Table 3 displays the average median digits correct and accuracy levels of participant with low anxiety and high anxiety during baseline.

Table 3. *Median Digits Correct and Accuracy during Baseline by Anxiety Level*

	Low Anxiety n = 56 *M*(*SD*)	High Anxiety n = 25 *M*(*SD*)
Median Digits Correct	*29.71 (13.65)	*16.72 (15.29)
Median Accuracy	*90.45(13.80)	*70.04 (31.69)

Note: * $p < .05$

An independent samples t-test was conducted on digits correct to compare the performance of participants with low anxiety to the performance of participants with high anxiety during baseline. There was a statistically significant difference, t (79) = - 3.81, p = .00. Participants with low anxiety (M = 29.71, SD = 13.65) completed significantly more digits correct than participants with high anxiety (M = 16.72, SD = 15.29) during baseline. An independent samples t-test was conducted on accuracy to compare the accuracy levels of participants with low anxiety to accuracy levels of participants with high anxiety during baseline. There was a statistically significant difference, t (79) = - 4.06, p = .00. Participants with low anxiety (M = 90.45, SD = 13.80) were more accurate than participants with high anxiety (M = 70.04; SD = 31.69) during baseline.

Anxiety Level

Table 4 presents the average median digits correct and accuracy across conditions based on participants' anxiety levels.

Table 4. *Median Digits Correct and Accuracy Across Conditions by Anxiety Level*

	n	Baseline *M*(*SD*)	Control *M*(*SD*)	Explicit Timing *M*(*SD*)
Median Digits Correct:				
Low Anxiety	56	*29.71(13.65)	31.16(15.29)	*34.41(16.45)
High Anxiety	25	16.72(15.29)	15.68(12.87)	18.76(13.87)
Median Accuracy				
Low Anxiety	56	90.45(13.80)	91.14(14.50)	92.27(13.14)
High Anxiety	25	70.04(31.69)	68.20(33.45)	70.12(32.94)

Note: * $p < .05$

Low Anxiety

A paired samples t-test was conducted on digits correct during explicit timing and baseline for participants with low anxiety and there was a statistically significant difference, t (55) = - 4.02, p = .00. Thus, participants with low anxiety completed significantly more digits correct during explicit timing (M = 34.41, SD = 16.45) as compared to baseline (M = 29.71, SD = 13.65). A paired samples t-test was conducted on accuracy during explicit timing and baseline for participants with low anxiety and there was no statistically significant difference t (55) = - 1.30, p = .20. Accuracy levels of participants with low anxiety remained constant from explicit timing (M = 92.27, SD = 13.14) to baseline (M = 90.45, SD = 13.80).

High Anxiety

A paired samples t-test was conducted on digits correct during explicit timing and baseline for participants with high anxiety and there was no statistically significant difference t (24) = - 1.88, p = .07. Thus, there was no difference in the number of digits correct achieved for

participants with high anxiety during explicit timing (M = 18.76, SD= 13.87) and baseline (M = 16.72, SD= 15.29). A paired samples t-test was conducted on accuracy during explicit timing and baseline for participants with high anxiety. There was no statistically significant difference, t (24) = -.02, p = .99. Thus, accuracy levels for participants with high anxiety remained constant during explicit timing (M = 70.12, SD = 32.94) and baseline (M = 70.04, SD = 31.69).

Anxiety Level and Initial Fluency Level

Table 5 presents average median digits correct based on both participants anxiety level (i.e., low anxiety or high anxiety) and there instructional level (i.e., frustration, instructional, or mastery.

Table 5. *Median Digits Correct and Accuracy Across Conditions by Initial Fluency and Anxiety Level*

	n	Baseline *M*(*SD*)	Control *M*(*SD*)	Explicit Timing *M*(*SD*)
Median Digits Correct:				
Low Anxiety Frustration	13	13.23(3.39)	14.08(5.14)	16.54(5.24)
Low Anxiety Instructional	30	*28.30(5.31)	29.80(9.19)	*33.07(9.46)
Low Anxiety Mastery	13	49.46(7.24)	51.38(8.77)	55.38(13.02)
High Anxiety Frustration	18	*9.28(5.83)	9.56(6.19)	*11.89(7.06)
High Anxiety Instructional	4	*25.50(6.03)	25.50(5.69)	*31.25(5.91)
High Anxiety Mastery	3	*49.67(13.43)	39.33(15.63)	*43.33(13.80)
Median Accuracy:				
Low Anxiety Frustration	13	74.46(19.49)	76.15(22.53)	78.38(21.80)
Low Anxiety Instructional	30	94.00(6.90)	94.80(7.25)	95.90(3.66)
Low Anxiety Mastery	13	98.23(1.88)	97.69(2.29)	97.77(2.92)
High Anxiety Frustration	18	60.11(32.21)	58.00(34.31)	60.56(34.33)
High Anxiety Instructional	4	94.50(5.20)	95.50(1.73)	95.25(5.68)
High Anxiety Mastery	3	97.00(3.61)	93.00(8.19)	94.00(3.00)

Note: * $p < .05$

Low Anxiety: Frustration

A paired samples t-test was conducted on digits correct for participants with low anxiety at the frustration level and there was no statistically significant difference, t (12) = -1.81, p =.10. Participants with low anxiety at the frustration level completed approximately the same number of digits correct during explicit timing (M =16.54, SD = 5.24) as compared to baseline (M =13.23, SD = 3.39). A paired samples t-test was conducted on accuracy for participants with low anxiety at the frustration level during explicit timing and baseline. There was no statistically significant difference, t (12) = -.74, p = .47. Thus, accuracy levels remained constant for participants with low anxiety at the frustration level during explicit timing (M =78.38, SD = 21.80) and baseline (M =74.46, SD = 19.49).

Low Anxiety: Instructional

A paired samples t-test was conducted on digits correct for participants with low anxiety at the instructional level and there was a statistically significant difference, t (29) = -3.25, p = .00. Participants with low anxiety at the instructional level completed significantly more digits correct during explicit timing (M =33.07, SD = 9.46) as compared to baseline (M = 28.30, SD = 5.31). A paired samples t-test was conducted on accuracy for participants with low anxiety at the instructional level and there was no statistically significant difference, t (29) = - 1.46, p = .15. Thus, accuracy levels remained constant for participants with low anxiety at the frustration level during explicit timing (M = 95. 90, SD = 3.66) and baseline (M =94.00, SD = 6.90).

Low Anxiety: Mastery

A paired samples t-test was conducted on digits correct for participants with low anxiety at the mastery level and there was no statistically significant difference, t (12) = - 1.76, p = .10.

Participants with low anxiety at the mastery level completed about the same number of digits correct during explicit timing (M =55.38, SD = 13.02) and baseline (M =49.46, SD = 7.24). A paired samples t-test was conducted on accuracy for participants with low anxiety at the mastery level and there was no statistically significant difference, t (12) = - .54, p = .60. Thus, accuracy levels remained constant for participants with low anxiety at the mastery level during explicit timing (M = 97.77, SD = 2.92) and baseline (M =98.23, SD = 1.88).

High Anxiety: Frustration

A paired samples t-test was conducted on digits correct for participants with high anxiety at the frustration level. There was statistically significant difference, t (17) = - 2.27, p = .04. Participants with high anxiety at the frustration level completed significantly more digits correct during explicit timing (M =11.89, SD = 7.06) as compared to baseline (M = 9.28, SD = 5.83). A paired samples t-test was conducted on accuracy for participants with high anxiety at the frustration level and there was no statistically significant difference, t (17) = - .06, p = .95. Thus, accuracy levels remained constant for participants with high anxiety at the frustration level during explicit timing (M = 60.56, SD = 34.33) and baseline (M =60.11, SD = 32.21).

High Anxiety: Instruction

A paired samples t-test was conducted on digits correct for participants with high anxiety at the instructional level and there was statistically significant difference, t (3) = - 3.85, p = .03. Participants with high anxiety at the instructional level completed significantly more digits correct during explicit timing (M =31.25, SD = 5.91) as compared to baseline (M = 25.50, SD = 6.03). A paired samples t-test was conducted on accuracy for participants with high anxiety at the instructional level. There was no statistically significant difference, t (3) = - .19, p = .86.

Thus, accuracy levels remained constant for participants with high anxiety at the instructional level during explicit timing (*M* = 95.25, *SD* = 5. 68) and baseline (*M* =94.50.11, *SD* = 5.20).

High Anxiety: Mastery

A paired samples t-test was conducted on digits correct for participants with high anxiety at the mastery level. There was a statistically significant difference, *t* (2) = 19.00, *p* = .00. Participants with high anxiety at the mastery level completed significantly fewer digits correct during explicit timing (*M* = 43.33, *SD* = 13.80) as compared to baseline (*M* =49.67, *SD* = 13.43). A paired samples t-test was conducted on accuracy for participants with high anxiety at the mastery level during baseline and explicit timing. There was no statistically significant difference, *t* (2) = .98, *p* = .43. Thus, accuracy levels remained constant for participants with high anxiety at the mastery level during explicit timing (*M* = 94.00, *SD* = 3.00) and baseline (*M* =97.00, *SD* = 3.61).

MEAP Scores and Performance

Table 6 displays the results of correlational data examining the relationship between math *MEAP* scores and digits correct and accuracy.

Table 6. *Math MEAP Scores, Digits Correct, and Accuracy Correlational Data*

Math *MEAP* Scores	Digits Correct	Accuracy
Overall	*.49	*.33
Low Anxiety	*.48	.25
High Anxiety	*.46	.42

Note: * $p < .05$

A Pearson correlation was conducted on math *MEAP* scores and baseline digits correct. A statistically significant correlation was observed, r (74) = .49, p = .00. As math *MEAP* scores increased, digits correct increased. A Pearson correlation conducted on math *MEAP* scores and accuracy during baseline was statistically significant, r (74) = .33, p =.00. Thus, as math *MEAP* scores increased, accuracy also increased.

A Pearson correlation was conducted on math *MEAP* scores and digits correct for low anxiety participants during baseline. There was a statistically significant correlation, r (52) = .48, p =.00. As math *MEAP* scores increased, digits correct also increased for participants with low anxiety. A Pearson correlation was conducted on math *MEAP* scores and accuracy for low anxiety participants during baseline. There was no statistically significant correlation, r (52) =.25, p = .08. Thus, there was no relationship between math *MEAP* scores and accuracy for participants with low anxiety.

A Pearson correlation was conducted on math *MEAP* scores and digits correct for participants with high anxiety during baseline. There was a statistically significant correlation, r (20) = .46, p = .03. Therefore, as *MEAP* scores increased digits correct also increased for participants with high anxiety. A Pearson correlation was conducted on math *MEAP* scores and accuracy for participants with high anxiety during baseline. There was no statistically significant correlation, r (20) = .42, p = .05. Thus, there was no significant relationship between math *MEAP* scores and accuracy for participants with high anxiety.

Anxiety Measures

Twenty-five participants fell in the high anxiety category while 56 participants fell in the low anxiety category as measured by the *MARS-E*. An independent samples t-test was conducted on *MARS-E* scores to compare low anxiety (M = 43.12; SD = 11.24) and high anxiety

(*M* = 79.04, *SD* = 15.01) participants and there was no significant difference, *t* (79) = 11.95, *p* = .06.

Nine participants had general anxiety as measure by the *RCMAS-2.* This was approximately 1% lower than the reported prevalence (12.5%) of anxiety disorders in children (Anxiety and Depression Association of America, 2013). Additionally, five participants had both math anxiety and general anxiety. A Pearson correlation was conducted on the *RCMAS-2* and *MARS-E* raw scores and there was a statistically significant correlation, *r* (79) = .48, *p* = .00. As general anxiety increased, math anxiety also increased.

Table 7 displays the results of correlational data conducted on *MEAP* scores and general and math anxiety.

Table 7. *Math MEAP Scores, RCMAS-2 and MARS-E Correlational Data*

Math *MEAP* Scores	*RCMAS-2*	*MARS-E*
Overall	.10	-.16
Low Anxiety	.22	.07
High Anxiety	.09	-.30

A Pearson correlation was conducted on *RCMAS-2* raw scores and math *MEAP* scores for all participants with math *MEAP* data. There was no statistically significant correlation, *r* (74) = .10, *p* = .41. Therefore, there was no relationship between general anxiety scores and math *MEAP* scores. A Pearson correlation was also conducted on *MARS-E* raw scores and math *MEAP* scores for all participants with math *MEAP* data. There was no statistically significant correlation, *r* (74) = -.16, *p* = .17. Thus, there was no relationship between math anxiety scores and math *MEAP* scores.

A Pearson correlation was conducted on *RCMAS-2* raw scores and math *MEAP* scores for participants with low anxiety. There was no statistically significant correlation, r (52) = .22, p = .11. Thus, there was no relationship between general anxiety and math *MEAP* scores for participants with low anxiety. A Pearson correlation was conducted on *MARS-E* raw scores and math *MEAP* scores for participants with low anxiety. There was no statistically significant correlation, r (52) = .07, p = .61. Therefore, there was no relationship between math anxiety and math *MEAP* scores for participants with low anxiety.

A Pearson correlation was conducted on *RCMAS-2* raw scores and math *MEAP* scores for participants with high anxiety. There was no statistically significant correlation, r (20) = .09, p = .68. Thus, there was no relationship between general anxiety and math *MEAP* scores. A Pearson correlation was conducted on *MARS-E* raw scores and math *MEAP* scores. There was no statistically significant correlation, r (20) = -.30, p = .18. Thus, there was no significant relationship between math *MEAP* scores and math anxiety.

Writing Fluency

A linear regression was conducted to determine the best fitting model for predicting digits correct based on writing fluency. The results indicated writing fluency explained 5% of the variance in digits correct, R^2 = 0.05, F (1, 79) = 4.16, p = .04. According to the equation, Y' = .20x+9.59, digits correct are predicted to increase by .20 for every one digit increase in writing fluency.

Treatment Acceptability

Table 8 displays participants' ratings of treatment acceptability. Most participants rated explicit timing and control as fair methods to practice math, good methods to use with children,

and good methods to help children do better in school. Overall, explicit timing and control were equally rated in terms of likability. Table 9 displays mean treatment acceptability data from teachers. According to the data, teachers found explicit timing to be acceptable.

Table 8. *Acceptability Ratings from Participants*

	Control			Explicit Timing		
Item	Agree (%)	Maybe (%)	Disagree (%)	Agree (%)	Maybe (%)	Disagree (%)
1.The __ method used to practice math was fair.	73	23	4	70	22	7
2. The ___ method used to practice math may cause problems with my friends.	6	37	57	12	43	44
3. There are better ways to practice math than the __ method.	44	46	10	41	47	12
4. The ___ method would be a good one to use with other children	61	33	6	63	36	1
5. I like the ___ method of practicing math	68	25	7	69	21	10
6. I think that the __ method used on this worksheet would help children do better in school.	53	42	5	44	35	2

**adapted from Elliott, Witt, Galvin, & Moe (1986) (Children's Intervention Rating Profile)*

Table 9. *Mean Treatment Acceptability Data from Teachers*

Item	Explicit Timing
1.This would be an acceptable intervention for improving math skills.	4.17
2. Most teachers would find this intervention appropriate for practicing math skills.	4.50
3. This intervention should prove effective in changing the child's math skills.	4.33
4. I would suggest the use of this intervention to other children.	4.33
5. My students' math difficulties are severe enough to warrant the use of this intervention.	4.33
6. Most teachers would find this intervention suitable for math difficulties.	4.33
7. I would be willing to use this intervention in the classroom setting.	4.33
8. This intervention would not result in negative side effect for my students.	4.67
9. This intervention would be appropriate for a variety of children.	4.33
10. This intervention is consistent with those I have used in classroom settings.	3.67
11. The intervention was a fair way to handle students math practice	4.00
12. The intervention is reasonable for the math skills described	4.33
13. I liked the procedures used in this intervention	4.50
14. This intervention was a good way to practice math facts.	5.00
15. Overall this intervention would be beneficial to the child.	4.17

**adapted from Martens & Witt (1982)*

CHAPTER IV

DISCUSSION

Overall

Explicit timing is an evidence-based intervention with an extensive history (Codding et al., 2009; Codding et al., 2007; Rhymer et al., 1999; Rhymer et al., 1998; Rhymer et al., 2002; Van Houten & Thompson, 1976). Explicit timing involves explicitly telling students the time limit for an assignment using overt indicators such as a stopwatch (Van Houten & Thompson, 1976). The majority of explicit timing research has found a significant increase in academic output without negatively impacting accuracy (Rhymer et al., 1999; Rhymer et al. 2002; Van Houten & Thompson, 1976). The findings of the current study replicate previous explicit timing research regarding increased productivity and maintained accuracy. The current study implemented explicit timing with fourth and fifth graders during 4 digit x 1 digit multiplication problems with regrouping in 3 of the columns. Students in this study completed significantly more digits correct during explicit timing as to baseline. Furthermore, accuracy remained consistent when explicit timing was implemented. Therefore, the current study replicated the efficacy of explicit timing as a mechanism to assist students in completing more academic output without compromising accuracy.

Initial Fluency

Some explicit timing research has found a decrease in accuracy and those researchers hypothesized a differential effect for explicit timing based on students' initial fluency level (Codding et al., 2007; Rhymer et al., 1998; Rhymer et al., 2002**)**. Students learning the skill (i.e., at the frustration level) experienced a decrease in accuracy during explicit timing; however,

students completing the new skill accurately (i.e., at the instructional level) experienced an increase in accuracy (Codding et al., 2007; Rhymer et al., 1998; Rhymer et al., 2002). The current study examined students' initial fluency level in relation to the effectiveness of explicit timing. In the current study, participants at the frustration level and participants at the instructional level completed significantly more digits correct during explicit timing while maintaining accuracy. However, explicit timing did not improve the performance of participants at the mastery level. Thus, teachers must consider students' initial fluency level before implementing explicit timing.

Writing Fluency

Participants' writing fluency scores (M =81.96) were used to examine the relationship between writing speed and mastery criteria for basic math facts. Stein et al. (2006) suggested mastery of basic mathematic facts for each participant would be determined by multiplying the number of digits written on the one-minute writing assessment by two thirds (i.e., 81.96 X .67). This formula suggests the average level of expected performance for all participants was approximately 55 digits correct. Hudson and Miller (2006) also support using a one-minute writing assessment but, recommend multiplying the number of digits written on the assessment by 75% for students in 4^{th} grade and above (i.e., 81.96 X .75). This formula suggests the mean level of expected performance for all participants was approximately 61 digits. Participants' actual mean performance of 27.50 was significantly less than the expected performance recommended by Stein et al. (2006) as well as Hudson and Miller (2006). Although there is a relationship between writing fluency and digits correct, the suggested formulas did not accurately predict participants' actual performance in this study.

When initial fluency level was examined, participants' expected performance did not coincide with actual performance for students. Participants at the frustration level wrote an average of 75.42 digits and achieved an average of 10.94 digits on the baseline assignment. Expected performance using the formula proposed by Stein et al. (2006) was 50.28 digits and 56.57 digits using formula proposed by Hudson and Miller (2006). The actual performance of participants at the frustration level during baseline was much lower than expected performance. Participants at the instructional level wrote an average of 84.21 digits and achieved an average of 27.97 digits during baseline. There expected level of performance using Stein et al. (2006) was 56.14 digits and 63.16 digits using Hudson and Miller (2006). Predicted performance was double the participants' actual performance. Participants at the mastery level wrote an average of 86.25 digits on the writing fluency assessment and completed an average of 49.50 digits during baseline. Participants expected level of performance was 57.50 using the formula proposed by Stein et al. (2006) and 67.68 using the formula proposed by Hudson and Miller (2006). The difference between predicted performance and actual performance for participants at the mastery level was less than the difference observed for participants at the frustration and instructional level. Therefore, the hypothesized formulas may be more appropriate for predicting performance of individuals at the mastery level.

Anxiety

Though current researchers have taken initial fluency into consideration, anxiety is another variable to consider when determining the effectiveness of explicit timing. Individuals with higher levels of math anxiety have more difficulty quickly and accurately completing problems with multiple steps (Ashcraft & Kirk, 2001). Participants with low anxiety completed

significantly more digits correct than participants with high anxiety which is consistent with research suggesting anxiety hinders performance (Powers, 2001).

It has been suggested timing negatively impacts the performance of both those with and without high levels of math anxiety (Kellogg et al., 1999). Introduction of the time component actually enhanced the performance of participants with low anxiety. They completed significantly more digits correct during explicit timing. However, explicit timing did not improve the performance of participants with high anxiety. These findings suggest explicit timing is beneficial for students with low anxiety but does not improve the performance of students with high anxiety.

This study also examined the impact of both initial fluency and anxiety level on the effectiveness of explicit timing. Participants with low anxiety at the instructional level completed more digits correct during explicit timing. However, explicit timing did not improve performance for participants with low anxiety at the frustration level and at the mastery level. Performance increased for participants with high anxiety at the frustration level and instructional level during explicit timing. Conversely, explicit timing hindered the performance of participants with high anxiety at the mastery level. These participants completed significantly less digits correct during explicit timing. The decrease in digits correct is consistent with research supporting the potential negative impacts of too much anxiety (Fox & Houston, 1983; Plass & Hill 1986; Powers, 2001). Despite having mastered the skill, anxiety may have interfered with performance. Thus, anxiety has the ability to hinder performance even when students have the skill set to complete the task.

Understanding anxiety is particularly important since anxiety disorders are the most common mental illnesses for children, impacting approximately 12.5% of children and 32% of adolescent (Anxiety and Depression Association of America,2013; Merikangas, et al., 2010). Math is suggested to be the academic area most likely to be associated with anxiety (Green, 1990). The results of this study indicated there was a positive relationship between general anxiety and math anxiety. As participants' general anxiety scores increased, math anxiety scores also increased. The correlation between general anxiety and math anxiety is not surprising as different types of anxiety often share common features (Putwain, 2008).

MEAP

In the educational setting, students may experience anxiety caused by standard evaluative assessments. High-stakes testing has been thought to evoke nervousness, worry and anxiety in elementary age children (Triplett & Barksdale, 2005). The *MEAP* is a standardized test administered to students in Michigan in grades 3 through 9 and mathematics is one area evaluated (Michigan Department of Education, n.d.). In order to examine the relationship between anxiety and performance, general anxiety and math anxiety raw scores were correlated with math *MEAP* scores based on participants' anxiety level. There was no significant relationship between general anxiety scores and math *MEAP* scores for participants with low anxiety and participants with high anxiety. Additionally, there was no relationship between math anxiety scores and math *MEAP* scores for participants with low anxiety and participants with high anxiety. Test re-test data were not provided for the *MARS-E* and the *RCMAS-2* coefficients ranged from .64 to .76 over a one week interval (Reynolds & Richmond, 2008; Suinn et al., 1988). The anxiety measures and the *MEAP* were not given concurrently. *MEAP* data were collected in the fall of 2012 while anxiety data were collected in the spring of 2013. The time

interval may have impacted the results. Math *MEAP* scores were, however, correlated with participants' performance on the math worksheets. The results indicated as math *MEAP* scores increased, digits correct also increased. Thus, there was a positive relationship between participants' performance on the math portion of a standardized test and performance on the math worksheets across each condition.

Acceptability

Examining the acceptability of explicit timing was also an important component of the study. Most students reported liking the explicit timing method of practicing math. Additionally, most students reported explicit timing would be a good way to practice math and would be good to use with other children. These ratings suggest children found explicit timing to be an acceptable intervention. It was also important to measure teachers' views regarding the acceptability of explicit timing. Assessing teachers' opinions regarding the method is particularly important since the intervention is likely to be implemented by the classroom teacher. The results suggest teachers agreed explicit timing is a good way to practice math.

Conclusion

The current study has extended the research by examining the effectiveness of explicit timing when factoring participants' initial fluency level as well as participants' anxiety level. As a whole, participants in this study completed significantly more digits correct during explicit timing while maintaining accuracy. However, when participants were grouped based on initial fluency level, explicit timing appeared to be effective for participants at the frustration level and participants at the instructional level and ineffective for participants at the mastery level. To extend the research, participants were also grouped based on anxiety level. It was determined

participants with low anxiety outperformed participants with high anxiety on baseline measures. It was also determined that explicit timing improved the performance of participants with low anxiety but had no impact on performance for participants with high anxiety. When both initial fluency level and anxiety level were considered, explicit timing improved performance for participants with low anxiety at the instructional level. Additionally, the performance of participants with high anxiety at the frustration and instructional levels improved during explicit timing. The same was not true for participants with high anxiety at the mastery level. Explicit timing actually hindered the performance of the three participants with high anxiety at the mastery level causing digits correct to decrease during explicit timing as compared to baseline. Overall, explicit timing increased academic output when students were grouped based on the different factors such as initial fluency level and anxiety level.

Limitations

Sample size was a limitation of the study. The overall sample size was sufficient; however, once participants were grouped based on initial fluency and anxiety level, the number of participants within each group was relatively small. Increasing the overall sample would have likely increased participants belonging to each group. This would have been particularly helpful for the high anxiety participants. One of the main goals of the study was to examine the effectiveness of explicit timing when taking both initial fluency and anxiety level into consideration. There were a limited number of participants with high anxiety making it difficult to analyze this group's data using statistical procedures.

The technical adequacy of the measure used to determine math anxiety was another limitation. The *MARS-E* was standardized on fourth through sixth grade students in Colorado. Additionally, well over half of the participants in the sample described themselves as Caucasian.

Therefore, the normative sample was not representative of the U.S. population which raised concerns regarding generalizability of the measure. Additionally, test re-test data were not provided; therefore, the stability of the measure over time is unknown. This is particulary concerning because anxiety and *MEAP* assessments were not administered concurrently which could have impacted the correlation data.

The length of participants' exposure to the intervention was also a concern. Each participant received the explicit timing intervention for one session. The data suggested explicit timing improved performance of the overall sample; however, it cannot be determine whether the intervention will continue to increase academic output overtime. It is important to know whether an intervention will have a lasting impact on students' performance. Therefore, increasing participants exposure to explicit timing over more sessions would have been beneficial. To address this limitation, a longitudinal study is needed.

Future Research

Test anxiety rates are reported to be higher among females and ethnic minorities (Zeidner & Matthew, 2011). Researchers have argued the underperformance of disadvantaged groups such as racial minorities and females in traditionally male domains is a result of anxiety produced by a phenomenon known as stereotype threat (Osborne, 2001). Stereotype threat is defined as the awareness of negative stereotype about one's own group and accompanying uneasiness that low performance will confirm the stereotype (Jordan & Lovett, 2007; Ormrod, 2008). For instance, African American students generally score lower on academic achievement tests when compared to their White counterparts (Kellow & Jones, 2008) and are reported receiving lower grades in school (Osborne, 2001). As a result, stereotypes about the academic abilities of African American students have been formed. Additionally, negative stereotypes

pertaining to gender can influence the way in which women perform in tasks associated with math as a result of low expectancies (Smith, 2006). Therefore, future research should examine how stereotype threat impacts the performance of females and ethnic minorities during explicit timing. Explicit timing is reportedly effective for African American and Caucasian students; however, the study did not specifically examine stereotype threat (Rhymer et al., 1999). The study was also limited to two racial groups. Future studies should factor in gender, race, initial fluency, anxiety level and cultural beliefs about math performance when determining the effectiveness explicit timing.

APPENDICES

APPENDIX A

SCHOOL ADMINISTRATOR CONSENT FORM

CMU
CENTRAL MICHIGAN UNIVERSITY

Study Title: The Impact of Anxiety and Initial Fluency Level on the Effectiveness of Explicit Timing.

Research Investigators' Names and Departments:

Sharnita Grays, LLMSW
Doctoral Student, Psychology Department
Practicum Student, Fraser Public Schools

Katrina Rhymer, Ph.D.
Associate Professor
Psychology Department

Contact information for researchers:

Sharnita Grays
Sloan Hall 101
Central Michigan University
Mount Pleasant, MI 48859
(248) 910-6892
sgrays1@gmail.com

Dr. Katrina Rhymer
Sloan Hall 138
Central Michigan University
Mount Pleasant, MI 48859
(989) 774-6468
rhyme1kn@cmich.edu

Introductory Statement

I would like to ask your permission to conduct my thesis at Mark Twain Elementary, Salk Elementary, and Palmer Park Academy. This study is designed to investigate students' performance during an empirically-validated mathematics intervention (i.e., explicit timing) as a function of math anxiety. Effectiveness of the intervention will be measured by 1) accuracy on math sheets, 2) fluency on math sheets, 3) most recent *MEAP* math score for each student, 4) students' opinion about the intervention, 5) teachers' opinion about the intervention, and 6) students' self-reported levels of math anxiety.

What is the purpose of this study?

The purpose of this research study is evaluate a brief, empirically-validated math intervention that may be implemented by teachers in the classroom to determine if it is effective and preferred for students; specifically, students who may have math anxiety.

What will teachers/students do in this study? How long will it take?

Teachers will meet with the researcher prior to beginning the study to briefly review procedures. This meeting will require no more than 20 minutes. Parental consent forms will be sent home with the students. Students will receive a pencil and eraser when they return their parental consent form either granting or denying participation in the study. Student assent will be

obtained. The researcher will conduct 20-25 minute sessions in students' regular classroom for 2 days each week for 2 weeks. The researcher will provide all materials and instruction to students. During session one, all students will complete 3 baseline math assessments for 3 minutes each and 3 writing fluency assessments for one minute each. During session two, only students with parent consent and student assent granting researchers to use their data will complete the demographic survey, *MARS-E*, and *RCMAS-2*. Completing the surveys will assist with the interpretation of the data and all information will be kept confidential. Completing the surveys is voluntary and students will not be penalized for failing to answer every question. All students will participate in the math intervention given as these techniques are consistent with typical educational practices. However, researchers will only have access to the math sheets for students who have parental consent and student assent to participate. Demographic surveys, anxiety surveys, and *MEAP* scores will only be obtained for students with parental consent and student assent to participate. Teachers will be provided with a written description of the intervention and asked to rate the feasibility/acceptability of conducting the intervention in their classrooms.

Are there any risks of participating in the study?
The math problems in this study are very similar to math problems assigned by teachers; therefore, it is very unlikely that completing the math problems will harm the students. There is a slight possibility that answering questions on the general anxiety and math anxiety surveys may produce discomfort for students.

What are the benefits of participating in the study?
This research study will contribute to the field of education and psychology by determining if the empirically-validated academic intervention may have differential effects based on student characteristics (i.e., math anxiety). If so, psychologists can better assist teachers in designing academic interventions for students with diverse needs. Teachers will be educated about a brief, empirically-validated intervention for improving math facts fluency and teachers may decide to use this intervention after the study is complete. Students are likely to improve their math fluency and this positive result may extend to other areas of mathematics, such as division, fractions, and word problems.

Will anyone know what the teachers/students do or say in this study (Confidentiality)?
All information gathered will be kept confidential. On all documents, teachers and students will be assigned code numbers instead of using their names so they cannot be connected to the data by anyone other than the researchers. Only the researchers will have access to students' and teachers' personal information. Once the data is analyzed, the coding key that matches student/teacher names to numbers will be destroyed. When the results are presented and/or published, only group means will be discussed; the identities of participating schools, teachers, and participants will not be disclosed.

Will there be any compensation for participation?
Students will receive a pencil and an eraser when they return the parent consent form either granting or denying participation. Teachers will receive a $10.00 gift certificate for school supplies.

Is there a different way for teachers/students to receive this compensation or the benefits of this study?
No.

Who can I contact for information about this study?
Please contact Sharnita Grays (248-910-6892) or Dr. Katrina Rhymer (989-774-6468) with any questions about the research or about participants' rights.

Participation is voluntary. All administrators, teachers, parents, and students are free to refuse participation in this research project or to withdraw consent/assent and discontinue participation in the project at any time without penalty or loss of benefits. Your participation will not affect your relationship with the institution involved in this research project.

If you are not satisfied with the manner in which this study is being conducted, you may report (anonymously if you so choose) any complaints to the Central Michigan University Institutional Review Board by calling 989-774-6777, or addressing a letter to the Institutional Review Board, 251 Foust Hall Central Michigan University, Mt. Pleasant, MI 48859.

My signature below indicates that all my questions have been answered. I agree to allow the project to be conducted at Twain Elementary OR Salk School OR Palmer Park Academy as described above.

_____
Name (Please print)

_____
Title

_____ _____
Signature Date

A copy of this form has been given to me. _____ Administrator Initials

For the Research Investigator—I have discussed with this administrator the procedure(s) described above and the risks involved; I believe he/she understands the contents of the consent document and is competent to give legally effective and informed consent.

_____ _____
Signature of Responsible Investigator Date

APPENDIX B

TEACHER CONSENT FORM

CMU
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Study Title: The Impact of Anxiety and Initial Fluency Level on the Effectiveness of Explicit Timing.

Research Investigators' Contact Information:

Sharnita Grays, LLMSW
Doctoral Student, Psychology Department
Practicum Student, Fraser Public Schools

Katrina Rhymer, Ph.D.
Associate Professor
Psychology Department

Contact information for researchers:

Sharnita Grays
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Dr. Katrina Rhymer
Sloan Hall 138
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Introductory Statement

I would like to ask your permission to carry out a mathematics intervention in your classroom. This project will help to evaluate the effectiveness of a mathematic intervention. I will compare how many multiplication problems students complete and how accurately students complete these problems.

What is the purpose of this study?

The purpose of this research study is to assess the effectiveness of a math intervention that may be implemented by teachers in the classroom.

What will teachers do in this study? How long will it take?

Teachers will meet with the researcher prior to beginning the study to briefly review procedures. This meeting will require no more than 20 minutes. Parental consent forms will be sent home with the students. Students will receive a pencil and eraser when they return their parental consent form either granting or denying participation in the study. Student assent will be obtained. The researcher will conduct 20-25 minute sessions in students' regular classroom for 2 days each week for 2 weeks. The researcher will provide all materials and instruction to students. During session one, all students will complete 3 baseline math assessments for 3 minutes each and 3 writing fluency assessments for one minute each. During session two, only students with parent consent and student assent granting researchers to use their data will complete the demographic survey, *MARS-E*, and *RCMAS-2*. Completing the surveys will assist with the

interpretation of the data and all information will be kept confidential. Completing the surveys is voluntary and students will not be penalized for failing to answer every question. All students will participate in the math intervention given as these techniques are consistent with typical educational practices.

What will students do in this study?
Students will complete the worksheets in class as instructed. All students will complete the worksheets, regardless of whether parents provide consent and students provide assent. However, the researcher will only score and analyze the data for those students who provide assent and whose parents provide consent. During session one, all students will complete 3 baseline math assessments for 3 minutes each and 3 writing fluency assessments for one minute each. During session two, only students with parent consent and student assent granting researchers to use their data will complete the demographic survey, *MARS-E*, and *RCMAS-2*. Completing the surveys will assist with the interpretation of the data and all information will be kept confidential. Completing the surveys is voluntary and students will not be penalized for failing to answer every question. All students will participate in the math intervention given that these techniques are consistent with typical educational practices. However, researchers will only have access to the math sheets for students who have parental consent and student assent to participate. Demographic surveys, anxiety surveys, and *MEAP* scores will only be obtained for students with parental consent and student assent to participate. Teachers will be provided with a written description of the intervention and asked to rate the feasibility/acceptability of conducting the intervention in their classrooms.

Are there any risks of participating in the study? There are no risks, because the math problems used for this study are very similar to the types of problems assigned by teachers.

What are the benefits of participating in the study?
For students: Students are likely to improve their speed and accuracy of solving multiplication problems. This positive result may extend to other areas of mathematics, such as division, fractions, and multiplication word problems.
For teachers: Teachers will be educated about a brief intervention for improving fluency of math facts and calculation, which may be used in the future.
For the field of Education and School Psychology: This research will help determine what types of interventions are most helpful for improving computation fluency of upper elementary school students, as well as teachers' feasability for implementing this intervention. Thus, this research will contribute to the field of education and school psychology once the results are published and accessible to educators.

Confidentiality. All information gathered will be kept confidential. On all documents, students' and teachers' names will be replaced by assigned numbers so that they cannot be connected to the data by anyone but the principal student investigator. Only the principal student investigator will have access to the code sheet linking individual characteristics to the data. Once the data is analyzed, this code sheet will be destroyed.

Will there be any compensation for participation? Teachers will receive a gift certificate for school supplies upon completion of the project. Students will receive a minor reward (up to a

$.50 value) for returning signed parental consent forms, regardless of whether their parents provide consent.

Whom can I contact for information about this study? Please contact to call Sharnita Grays (248-910-6892) or Dr. Katrina Rhymer (989-774-6468) with any questions about the research or about participants' rights.

Participation is voluntary. Administrators, teachers, parents, and students are free to refuse participation in this research project or to withdraw consent and discontinue participation in the project at any time without penalty or loss of benefits. Your participation will not affect your relationship with the institution(s) involved in this research project.

If you are not satisfied with the manner in which this study is being conducted, you may report (anonymously if you so choose) any complaints to the Central Michigan University Institutional Review Board by calling 989-774-6777, or addressing a letter to the Institutional Review Board, 251 Foust Hall Central Michigan University, Mt. Pleasant, MI 48859.

Thank you for your time and consideration.

Sincerely,

Sharnita D. Grays, LLMSW
School Psychology Doctoral Candidate
Central Michigan University

Katrina Rhymer, Ph.D.
Associate Professor in Psychology
Central Michigan University

My signature below indicates that all my questions have been answered. I grant permission for Sharnita Grays to conduct her thesis project with students in my classroom(s) in the _____ Program.

Name: _____ School:_____

Grade(s) taught: _____ Number of math classes:_____

Approximate number of students:_____

Signature: _____ Date:_____

Please sign this form and initial the bottom of all pages (including this one). Then return this form via fax to the Psychology Department at 989-774-2553 c/o Sharnita Grays.

A copy of this form has been given to me. _____ Initials

APPENDIX C

PARENT CONSENT FORM

CMU
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Research Investigators' Names and Departments:

Sharnita Grays, LLMSW
Doctoral Student, Psychology Department
Practicum Student, Fraser Public Schools

Katrina Rhymer, Ph.D.
Associate Professor
Psychology Department

Contact information for researchers:

Sharnita Grays
Sloan Hall 101
Central Michigan University
Mount Pleasant, MI 48859
(248) 910-6892
sgrays1@gmail.com

Dr. Katrina Rhymer
Sloan Hall 138
Central Michigan University
Mount Pleasant, MI 48859
(989) 774-6468
rhyme1kn@cmich.edu

Introductory Statement
Your child is invited to participate in this research study. The following information is provided to help you make an informed decision on whether or not to allow your child to participate. If you have any questions, feel free to contact us via phone or email.

What is the purpose of this study?
The purpose of this research study is to evaluate a brief, empirically-validated intervention that may be implemented by teachers in the classroom to determine if it is effective and preferred for students; specifically, students who may have math anxiety.

What will teachers/students do in this study? How long will it take?
Teachers will meet with the researcher prior to beginning the study to briefly review procedures. This meeting will require no more than 20 minutes. Parental consent forms will be sent home with the students and students will receive a pencil and eraser when they return their parental consent form either granting or denying participation in the study. Student assent will be obtained. The researcher will conduct 20-25 minute sessions in students' regular classroom for 2 days each week for 2 weeks. The researcher will provide all materials and instruction to students.

During session one, all students will complete 3 baseline math assessments for 3 minutes each and 3 writing fluency assessments for one minute each. During session two, only students with parent consent and student assent granting researchers to use their data will complete the demographic survey, *MARS-E,* and *RCMAS-2*. Completing the surveys will assist with the interpretation of the data and all information will be kept confidential. Completing the surveys is voluntary and students will not be penalized for failing to answer every question. All students will participate in the math intervention given that these techniques are consistent with typical educational practices. However, researchers will only have access to the math sheets for students who have parental consent and student assent to participate. Demographic surveys, anxiety surveys, and *MEAP* scores will only be obtained for students with parental consent and student assent to participate. Teachers will be provided with a written description of the intervention and asked to rate the feasibility/acceptability of conducting the intervention in their classrooms.

Are there any risks of participating in the study?
The math problems in this study are very similar to math problems assigned by teachers; therefore, it is very unlikely completing the math problems will harm the students. There is a slight possibility answering questions on the general anxiety and math anxiety surveys may produce discomfort for students.

What are the benefits of participating in the study?
This research study will contribute to the field of education and psychology by determining if the empirically-validated academic intervention may have differential effects based on student characteristics (i.e., math anxiety). If so, psychologists can better assist teachers in designing academic interventions for students with diverse needs. Teachers will be educated about a brief, empirically-validated intervention for improving math facts fluency and teachers may decide to use this intervention after the study is complete. Students are likely to improve their math fluency and this positive result may extend to other areas of mathematics, such as division, fractions, and word problems.

Will anyone know what my child does or says in this study (Confidentiality)?
All information gathered will be kept confidential. On all documents, teachers and students will be assigned code numbers instead of using their names so they cannot be connected to the data by anyone other than the researchers. Only the researchers will have access to students' and teachers' personal information. Once the data is analyzed, the coding key that matches student/teacher names to numbers will be destroyed. When the results are presented and/or published, only group means will be discussed; the identities of participating schools, teachers, and participants will not be disclosed.

Will there be any compensation for participation?
Students will receive a pencil and an eraser when they return the parent consent form either granting or denying participation. Teachers will receive a $10.00 gift certificate for school supplies.

Is there a different way for my child to receive this compensation or the benefits of this study?
No.

Who can I contact for information about this study?
Please contact Sharnita Grays (248-910-6892) or Dr. Katrina Rhymer (989-774-6468) with any questions about the research or about participants' rights.

It is your right to decide whether or not your child can participate in this study. Your child will still receive the same services; however, their data will not be analyzed. You or your child may change your mind about participating in the study and the result will be discarded. You will be informed if the study design or use of the data is changed at which time a revised consent form will be obtained.

If you are not satisfied with the manner in which this study is being conducted, you may report (anonymously if you so choose) any complaints to the Central Michigan University Institutional Review Board by calling 989-774-6777, or addressing a letter to the Institutional Review Board, 251 Foust Hall Central Michigan University, Mt. Pleasant, MI 48859.

Signatures:
I have read this consent form in its entirety and understand my rights. I voluntarily consent to my child participating in this research study participate and will contact the researchers if I have any questions.

Child's Name:_____

____Yes, I allow my child to participate_____ Date:_____
Signature

____No, I do not allow my child to participate_____ Date:_____
Signature

A copy of this form has been given to me. _____ Parent Initials

For the Research Investigator—I have discussed with the parent procedure(s) described above and the risks involved; I believe he/she understands the contents of the consent document and is competent to give legally effective and informed consent.

_____ _____
Signature of Responsible Investigator Date

APPENDIX D

STUDENT ASSENT FORM

CMU
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Practicum Student, Fraser Public Schools

Katrina Rhymer, Ph.D.
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Psychology Department

Contact information for researchers:

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Dr. Katrina Rhymer
Sloan Hall 138
Central Michigan University
Mount Pleasant, MI 48859
(989) 774-6468
rhyme1kn@cmich.edu

What is this research about?
We would like to use your worksheets in a research study about improving math skills. I will pass out math worksheets for you to work on in class. All students in your class will be completing these worksheets, but you may decide if I can have your worksheets to use in my study once your parents also say it is okay. Please ask questions at any time about the study. It is okay for you to change your mind about allowing me to have your math worksheets.

What will I do in this research? How long will it take? On the first day, I will ask you to complete 3 math sheets. On the second day, I will ask you to write out some answers to question about yourself, including your age, birthday, and race/ethnicity. I will also ask you to answer questions about how math makes you feel and how you feel in general. For the next two school days, you will be assigned 3 math sheets each day in class and questions about the math sheets Each worksheet will take less than 5 minutes to complete. You will not have to spend extra time outside of math class on any worksheets.

Can anything bad happen to me? No, because these are the same types of problems your math teacher assigns you now.

Can anything good happen to me? There is a good chance you will improve your math skills.

Do I have other choices? Your teacher has decided all students will complete the math worksheets during your class, so you do not have a choice about doing the work. But, you may choose not to let me have your worksheets. You may also choose not to answer the questions that I give to you on the second day.

Will anyone know I am in the research? Only I will know if you gave me permission to use your worksheets in my study. I will take your names off the worksheets before I use them in my study. Your name will be crossed out and changed to a number. I will keep a key that matches your name to your number. But, once I finish writing my research report, I will destroy the key so that no one will be able to match your name to your number.

Will I be paid? No. You will only receive a small prize for returning the parent form I sent home yesterday.

Whom can I talk to about the research? You may contact me, Ms. Grays, at 248-910-6892 You may also contact Dr. Rhymer at 989-774-6468.

What if I do not want to do this? You do not have to let me have your worksheets. You can say no at any time. No one will be upset with you if you do not want me to have your worksheets, but you still have to do the work in class each day, along with all of your classmates.

SIGNATURE CLAUSE

Do you want to let me have your worksheets for my research? **Please check the box, sign below, and initial each page.**

☐ *Yes, I will let you have my worksheets for your research study.*
☐ *No, you may not have my worksheets for your research study.*

_____
Name of Student (Print)

_____ _____
Signature of Student Date

_____ _____
Signature of Person Explaining Assent Date

A copy of this form has been given to me _____Subject's Initials

APPENDIX E

DEMOGRAPHIC SURVEY

Student Demographic Survey

Student's ID #:_____

Teacher's Name:_____

Birthday (month, day, & year): _____

Grade in School:_____

Please circle your answers below.

Race/Ethnicity (you may select more than one)**:**

Caucasian/White African-American/Black

Hispanic/Latino Native American

Asian Native Hawaiian/ Pacific Islander

Biracial/Multiracial

Gender:

Male/Boy Female/Girl

APPENDIX F

MATH SHEET

3387 x 6	1655 x 2	3868 x 5	7562 x 1	5668 x 1
5672 x 7	6713 x 6	5321 x 8	1018 x 6	6230 x 4
6436 x 6	5685 x 6	8881 x 7	9120 x 4	9884 x 1
1436 x 7	7999 x 7	4808 x 2	7876 x 5	9245 x 1
8155 x 8	1573 x 6	1561 x 7	5197 x 7	6011 x 2

APPENDEX G

WRITING FLUENCY WORKSHEET

Student ID:_____

W 1, 2, or 3

DIRECTIONS: Please write the numbers 1 through 9 over and over, as many times as you can, until you are told to stop.

APPENDIX H

STUDENT ACCEPTABILITY RATING

ID NUMBER___

Please read the following statements and mark an X to indicate whether you *agree, maybe, or disagree.*

1. The Explicit Timing method used to practice math was fair.

____agree _____maybe ____disagree

2. The Explicit Timing method used to practice math may cause problems with my friends.

____agree _____maybe ____disagree

3. There are better ways to practice math than the Explicit Timing method.

____agree _____maybe ____disagree

4. The Explicit Timing method would be a good one to use with other children.

____agree _____maybe ____disagree

5. I like the Explicit Timing method of practicing math.

____agree _____maybe ____disagree

6. I think that the Explicit Timing method used on this worksheet would help children do better in school.

____agree _____maybe ____disagree

*adapted from Elliott, Witt, Galvin, & Moe (1986) (*Children's Intervention Rating Profile)*

APPENDIX I

TEACHER ACCEPTABILITY RATING

Please rate how severely you agree or severely disagree with each of the following statements by circling a response.

1. This would be an acceptable intervention for improving math skills.

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

2. Most teachers would find this intervention appropriate for practicing math skills.

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

3. This intervention should prove effective in changing the child's math skills

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

4. I would suggest the use of this intervention to other children

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

5. My students' math difficulties are severe enough to warrant the use of this intervention.

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

6. Most teachers would find this intervention suitable for math difficulties.

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

7. I would be willing to use this intervention in the classroom setting.

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

8. This intervention would not result in negative side effect for my students

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

9. This intervention would be appropriate for a variety of children.

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

10. This intervention is consistent with those I have used in classroom settings

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

11. The intervention was a fair way to handle students' math practice

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

12. The intervention is reasonable for the math skills described

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

13. I liked the procedures used in this intervention

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

14. This intervention was a good way to practice math facts.

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

15. Overall this intervention would be beneficial to the child.

Severely Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Severely Agree
1	2	3	4	5	6

*adapted from Martens & Witt (1982)

APPENDIX J

ADMINISTRATION INSTRUCTIONS

Instructions

Day 1:
Collect parent consent forms
Read the student assent form. Then ask, "**Are there are questions**?"
With the help of the teacher, distribute packets with 3 baseline math assessments and 3 writing fluency assessments.

Read the following instructions:
"**Please do not turn over the packet until I instruct you to. Please work as quickly as you can without making mistakes. Start in the top left corner of the first page and work from left to right without skipping any problems. Raise your hand if you finish before I tell you to stop. Turn over your packets and begin."**
(After 3 minutes) **"Stop. Put your pencils in the air."**
Read the following instructions for the 2nd baseline assignment:
"You may now turn the page. Ready, begin."
(After 3 minutes) **"Stop. Put your pencils in the air."**
Read the following instructions for the 3rd baseline assignment:
"You may now turn the page. Ready, begin."
(After 3 minutes) **"Stop. Put your pencils in the air."**

Read the following instructions for the writing fluency measure:
"Please turn the page. On this sheet of paper, write the numbers 1 through 9 over and over, as many times as you can, until I tell you to stop. Start in the top left corner and work from left to right. Ready, begin."
(After 1 minute) **"Stop. Put your pencils in the air."**
Read the following instructions for the 2nd and 3rd writing fluency measures:
"You are going to do the same thing on the next page. You may now turn the page. Ready, begin."
(After 1 minute) **"Stop. Put your pencils in the air."**

After the 3 baseline assignments and 3 writing fluency assignments are finished, collect the packets and the pencils, thank the students and teacher, and leave the classroom.

Day 2:
With the help of the teacher, distribute packets with the demographic questionnaire and anxiety measures. Provide students who do not provide consent or assent with alternative instructional materials on which to work.
Instruct the students participating in the study to: **"Please answer the following questions. If you have any questions while you are working, raise your hand and I will come over to your desk. When you are finished turn your packet over."**

When all students have finished, collect the packets, thank the students and teacher, and leave the classroom.

Days 3 and 4:

- **Control Condition:**

Place packets and a sharpened pencil on each student's desk.
Read the following instructions:
"**Please do not turn over the packet until I instruct you to. Please work as quickly as you can without making mistakes. Start in the top left corner of the first page and work from left to right without skipping any problems. Raise your hand if you finish before I tell you to stop. Turn over your packets and begin."**
(After 3 minutes) **"Stop. Put your pencils in the air."**
Read the following instructions for the 2nd control assignment:
"You may now turn the page. Ready, begin."
(After 3 minutes) **"Stop. Put your pencils in the air."**
Read the following instructions for the 3rd control assignment:
"You may now turn the page. Ready, begin."
(After 3 minutes) **"Stop. Put your pencils in the air."**

- **Explicit Timing Condition:**

Place a packet and a pencil on each student's desk.
Read the following instructions:
"Please do not turn over the packet until I instruct you to. You will have a three-minute time limit. Please work as quickly as you can without making mistakes. Start in the top left corner of the first page and work from left to right without skipping any problems. I will tell you when you have two minutes and one minute left. When I tell you to stop, put your pencils in the air. Raise your hand if you finish before I tell you to stop. Turn your packets over and begin."
(After one minute) **"Two minutes remain."**
(After two minutes) **"One minute left."**
(After the third minute) **"Stop. Put your pencils in the air."**

Read the following instructions for the 2nd and 3rd assignments:
"You may now turn the page. Ready, begin."
(After one minute) **"Two minutes remain."**
(After two minutes) **"One minute left."**
(After the third minute) **"Stop. Put your pencils in the air."**

"You may now turn the page. Please answer the following questions about the assignments you just finished. The explicit timing assignments tell you how much time you have to work on the worksheet and when one minute goes by, you are told how much time is left. If you have any questions, please raise your hand. When you finish, please turn your packet over."
When all students are finished, collect the packets and the pencils, thank the students and teacher, and leave the room.

APPENDIX J

TREATMENT INTEGRITY CHECKLIST

Teacher's name:_____ Date:_____

Person completing form:_____

Person administering worksheets: _____

Please check "yes" or "no" for each of the following:	**YES**	**NO**
1. Pencils were passed out to each student.	**YES**	**NO**
2. Assignments were passed out.	**YES**	**NO**
3. Students were instructed to fill out the cover sheet.	**YES**	**NO**
4. Directions for the Math Sheets were read aloud to students. Students did not begin working until instructed.	**YES**	**NO**
5. Students worked for a total of 3 three-minute intervals. During this time an adult walked around to make sure directions were followed.	**YES**	**NO**
6. Directions for the Writing Fluency Worksheets were read aloud to students. Students did not begin working until instructed.	**YES**	**NO**
7. Students worked for a total of 3 one-minute intervals. During this time an adult walked around to make sure directions were followed.	**YES**	**NO**
8. Assignments were collected.	**YES**	**NO**
9. Pencils were collected.	**YES**	**NO**

Teacher's name:_____ Date:_____

Person completing form:_____

Person administering worksheets: _____

Please check "yes" or "no" for each of the following:	**YES**	**NO**
1. Pencils were passed out to each student.	**YES**	**NO**
2. Assignments were passed out.	**YES**	**NO**
3. Students were instructed to fill out the cover sheet.	**YES**	**NO**
4. Directions for the Math Sheets were read aloud to students. Students did not begin working until instructed.	**YES**	**NO**
5. Students worked for a total of 3 three-minute intervals. During this time an adult walked around to make sure directions were followed.	**YES**	**NO**
6. Directions for Treatment Acceptability were read aloud to students.	**YES**	**NO**
7. Assignments were collected	**YES**	**NO**
8. Pencils were collected.	**YES**	**NO**

APPENDIX K

HYPOTHESES AND DATA ANALYSIS

Hypothesis	Statistical Procedure
1) There will be a significant difference in digits correct during explicit timing as compared to baseline	Paired samples t-test
2) There would be a significant difference in the performance of participants with higher initial fluency compared to those with lower initial fluency.	Paired samples t-test
3) There would be a difference in performance of participants with low anxiety as compared to participants with high anxiety.	Independent samples t-test
4) Explicit timing would improve the performance of participants with low anxiety but not participants with high anxiety.	Paired samples t-test
5) The impact of explicit timing would vary based on participants' initial fluency and anxiety level	Paired samples t-test
6) There would be no significant difference in accuracy across conditions	Paired samples t-test
7) Writing fluency would be related to digits correct	Pearson correlation
8) The anxiety measures would be moderately correlated	Pearson correlation
9) Higher anxiety scores would be related to lower math *MEAP* scores.	Pearson correlation
10) Higher math *MEAP* scores would be related to more digits correct	Pearson correlation
11) Higher math *MEAP* scores would be related to higher accuracy	Pearson correlation
12) Math *MEAP* scores and digits correct would be positively related for participants with low anxiety and negatively related for participants with low anxiety	Pearson correlation
13) Math *MEAP* scores and accuracy would be positively related for participants with low anxiety and negatively related for participants with low anxiety	Pearson correlation
14) Explicit timing intervention would be rated as acceptable.	Means

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