1988

Timed testing and its effects on first grade students' mathematics computational skills

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TIMED TESTING AND ITS EFFECTS ON FIRST GRADE STUDENTS' MATHEMATICS COMPUTATIONAL SKILLS

MASTERS PROJECT

Submitted to the School of Education
University of Dayton, in Partial Fulfillment
of the Requirements for the Degree
Master of Science in Education

By

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UNIVERSITY OF DAYTON

Dayton, Ohio

July, 1988

Approved By:

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Official Advisor

ACKNOWLEDGEMENTS

We would like to gratefully acknowledge the help and guidance given to us by Dr. Herman Torge, our advisor, on this project.

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CHAPTER I

INTRODUCTION

First grade students at New Lebanon Elementary School are required to pass, with 100% accuracy, addition and subtraction timed math tests on the basic facts through ten. The writers believe that this is a problem worth examining because many students have difficulty accomplishing this requirement. The students who are unsuccessful in meeting The required criteria have both computational errors as well as errors due to incompletion of the timed test. The writers further believe that this lack of success is not necessarily a problem in computation but may be a problem due to nonmemorization of math facts and/or timed testing anxiety.

The timed test, which consists of approximately thirty-six problems, is administered four times for each set of math facts which have been introduced, practiced, and reviewed in daily math instruction. The students are given a time limit of two and one half minutes to complete the problems. The student is given a percentage score on the number of problems completed and correct based on the total number problems given. This score is then used to determine one third of the student's grade along with his/her daily grades and test score averages. The number of tests passed

also determines whether the student is considered on grade level, above grade level or below grade level, on parental reports. The Montgomery County Competency Test contains a section of addition and subtraction math facts which must be completed in a limited time. The student must obtain a total score of 80% to be considered competent in first grade math skills.

The writers used this study to decide whether timed testing of basic math facts made a significant difference in the computational achievement test scores of the sample groups.

Statement of Problem

The purpose of this study was to determine whether first grade students who were required to pass math timed tests were more proficient in computational skills than students who were not required to pass these timed tests.

Significance of Problem

There is much controversy in the New Lebanon School district concerning the use of timed basic facts math tests. Many parents feel these tests create unnecessary stress for their children. The teaching staff is divided over this issue. All teachers want their students to memorize the basic facts, however some feel the anxiety caused by the pressure of timed testing does not promote memorization. Others feel that if the desired memorization has taken place the timed testing will not cause undue test anxiety. By

doing this investigation the writers hope to justify or refute the use of these timed basic facts math facts tests, both to the school district and to the parents of the students.

Hypothesis

There will be no significant difference in the math concept and computation scores on the Iowa Test of Basic Skills and the Montgomery County Competency Based Education Math Test between a group of first grade students required to pass math time tests and by a comparable group that is not required to pass math time tests.

CHAPTER II

REVIEW OF THE LITERATURE

After an extensive review of the literature there are three areas that need to be considered in this study. They are memorization, timed testing, and anxiety, and their relationship to student achievement. Research will be cited in each of these areas as they affect the topic being studied.

Memorization

The writers found that the reviewed literature supported the argument for the necessity of memorization of math facts (Heddens, 1977; Lazerick, 1981; Boxall, et al, 1979; Rathmell, 1977; Greene, 1985). The ease of performance in computation is the desired outcome of the student's mathematics education (Boxall and others, 1979).

To learn is to remember; therefore learning is dependent on memory. In education there is a belief among many that if information can be looked up there is no reason for memorization. Some students and parents have carried this idea too far in that they believe it is not important to memorize any information at all. The average and poor students are the ones most affected by this change in thinking. If memory is properly used it can be a powerful

tool in the learning and teaching of any subject. In certain aspects of mathematics particularly when it comes to basic facts in the elementary school an emphasis on memorization is important (Sharma, 1985). In the primary grades there comes a time when students are expected to increase the speed and accuracy of their computational performance. The only way to increase the speed of computation is by memorization (Greene, 1985).

Memorization of the basic facts greatly increases students' ability to perform computational operations. Some students are able to learn math facts readily while others require extensive support. If a student is having trouble learning the basic facts, the teacher needs to find out how the child is thinking (Rathmell, 1978). Using such methods as counting on, adding, zero, doubles, and one more or one less are extremely useful strategies that develop the bridge between concrete and abstract thinking and help the student commit the facts to memory.

Memorization takes place only after the student has internalized the concepts of addition and subtraction (Lazerick, 1981). To bridge the gap between concrete and abstract number concepts, the teacher must provide concrete, manipulative models, and questioning and thinking strategies until the student begins to predict outcomes, eliminating the need for manipulatives. After the student has been involved in developing and establishing the basic facts, instant recall is then required. This is facilitated

by a systematic and consistent program of practice and drill (Lazerick, 1981; Boxall, et al, 1979).

Timed Testing

According to a study done by Mellzer (1984), timed tests can be used to automize mathematics facts. Skills acquired in the early grades must be transferred and coded to rote memory, so when the basic processes become automatic, more advanced learning can occur. The child's ability to apply basic math operations rapidly and fluently were assessed through examples of the four basic operations (addition, subtraction, multiplication and division). These examples were presented orally and the students were required to solve the problems mentally. A forty-five second time limit was imposed. These findings suggested that specific mathematics deficits can be remediated by using instruction, rote drill, and rote memory in the basic operations. The study further suggested that when the basic mathematics processes become automatic, the academic skills become more proficient thus freeing processing space for the more abstract and cognitively demanding problem solving skills.

A score on a timed test has been recognized as a function of ability level and rate of work (Linn, 1986). The writers have long been concerned with the problem of incomplete learning for the student who passes the required timed test but uses counting methods rather than recall or facts. One study on timed testing indicated that although

students in some cases made gains in numbers of problems solved, the gains may not have reflected an increase in recall of facts. Some students were successful on timed tests who never used recall and other students were observed counting during the test (Steinberg, 1984). This might indicate some students were creative and innovative in their use of mathematical strategies and had a good understanding of mathematical concepts. Therefore, in this instance, the speed factor represented ability rather than a memorized response.

In the school district from which the sample population was taken, timed tests of the basic facts were given as a criteria for evaluation in mathematics computation. The only study found to support any form of evaluation was cited by Greene (1985) who suggested that students set their own goals and evaluate their own performance. This was accomplished by students taking daily timed tests, correcting their own work and graphing both the time and number of errors. Students set their own goals and the teacher rewarded those who achieved their goals. However, the writers could find no research to support the use of timed testing as a criteria to evaluate student achievement on memorization of basic facts.

Test Anxiety

Another factor found to affect timed test results on student achievement is test anxiety. Anxiety is defined as "tension that has no apparent cause" (Lasher, 1981). The writers define math anxiety as the tension that "disrupts the manipulating of numbers in solving math problems" (Buckley, 1982).

Test anxiety has been found to interfere significantly with performance on tests (Plass and Hill, 1986). In a study designed to eliminate the effects of debilitating test anxiety, four strategies were observed to be used by high anxious students to cope with achievement demands in an evaluation situation. The most common strategy was to begin a test and quit after completing only a few problems. An alternative strategy was slow progress with considerable off task behavior. This involved task avoidance with some interspersed effort. A third adopted strategy was cautious accurate on-task work. This resulted in a low total test score due to non-completion of the test. The last strategy was fast inaccurate performance. This strategy provides the following benefits to high anxious students: task avoidance, less threatening, did not really try, an excuse for failure, and positive attention from peers for finishing rapidly and seemingly doing well. Time pressure is one aspect of testing that has the potential for being powerfully related both to performance and to maladaptive strategies (Hill, 1980).

Relevant studies further indicate some students have high test anxiety. When under time pressure high-anxious students perform quite poorly taking more time and making more errors than low-anxious students. When time limits were removed, performance improved markedly and was comparable to the performance of students with low-anxiety during testing. Rather than being learning cognitive deficient, the high test-anxious students were hindered by time pressure due to

motivational or test taking factors (Eaton, 1979; Hill, 1984). Linn (1986) cited Baxter (1941) and Davidson and Carroll (1945) as reporting timed and untimed test scores as uncomparable because speed affects test behavior and is not necessarily a measure of ability.

The research cited indicates contrary results, thus suggesting that further research needs to be conducted concerning timed testing. If timed testing does not always require memorization and creates test anxiety, is it complementary or detrimental to student achievement? The writers are concerned with this question and have undertaken this study in order to make some statement to their school district concerning the timed test policy.

CHAPTER III

METHODOLOGY

New Lebanon is a village with a population of approximately 4500. The Village has one elementary school that houses grades Kinderarten through fourth. The school is in a middle-lower socio-economic rural-suburban community in southwestern Ohio. Several low-income multi-family dwellings have been completed in New Lebanon, causing an influx of transient students in the school system. The population includes a variety of social and economic segments of society. The racial make-up of the community is 99 percent Caucasian.

The subjects of this study were first grade students from two heterogenously grouped classrooms. The only students selected for this study were students who attended Kindergarten at New Lebanon Elementary School. No students identified as having a learning disability were included in the study.

One group was required to take the teacher prepared timed math tests (See Appendix) and served as a control group. The other class, serving as the experimental group, was not required to take a timed test of any kind. Due to the study

and a change in administration, the timed tests were not used as an evaluation score of students' performance. They were neither used to determine student's grades on parental reports nor student's level of performance, indicated by above, on, or below grade level. The timed tests were used by the control group as a motivator to encourage memorization of math facts.

This study was conducted during the 1987-88 school year. The data were collected from the students' Kindergarten and first grade scores on the Iowa Basic Skills test and the Montgomery County Competency Based Education Test in Mathematics.

Mathematics instruction occurred for a one hour period, on a daily basis, for both groups. The basic addition math facts were presented in a hierarchy beginning with addition facts to six and ending with addition facts to ten. The subtraction facts were taught in the same manner. Both the experimental and the control groups were introduced to a new set of facts every two weeks. During the exploratory stages of concept development both groups used several types of manipultives to facilitate the transition from concrete to abstract thinking. Flash cards were also used to help develop automation of the basic facts. Both classes used the consumable Heath Mathematics Textbook for first grade, the accompanying basic and enrichment worksheets, and chapter pretests and posttests. Methods from the book Mathematics Their Way were used to supplement learning of math concepts and to connect these concepts to real life situations.

The instructors of the two classes met on a weekly basis to plan daily math lessons. The difference in instruction was kept to a minimum. This similarity was maintained to insure that the differences in test scores were not influenced by instructional methods or curriculum. The instructors exchanged feedback on a daily basis and adjusted premade plans accordingly. Intervention was done as needed in small groups or individually.

CHAPTER IV

FINDINGS

This study was done in the New Lebanon School System, New Lebanon, Ohio, with two first grade classrooms of heterogeneously grouped students. The students were evaluated using pretest and posttest scores taken from the Iowa Test of Basic Skills and the Montgomery County Competency Based Education Mathematics Test. One group was used as the experimental group and labeled as Group A. This group did not take the teacher prepared timed tests. The control group, labeled as Group B, were given the timed tests. This method was used to test the hypothesis, that there would be no significant difference in the math concept and computation scores between a group of first grade students required to pass math timed tests and by a comparable group that was not required to pass the math timed tests.

The first test score used in the findings, in this study, was the Kindergarten Montgomery County Competency Based Education Test for Mathematics. This test was given during the last nine weeks of 1986-87 school year to all Kindergarten students. It was used as an indicator of the student's competency of minimum skills which were determined through

the New Lebanon Kindergarten Course of Study. The researchers used these scores as a pretest. The comparison shown in Table 1 indicates no significant differences were found in test scores between Groups A and B before the study.

Table 1

Comparison of Kindergarten Competency Scores

Group	Mean	Standard Deviation
A	36.21	1.13
B	36.53	1.02
$t = .916$, $p \geq .05$		

The test scores of Groups A and B on the First Grade Montgomery County Competency Based Education Mathematics Test were used as a determiner in posttest results. This test was given during the last nine weeks of the 1987-88 school year to all first grade students. It was used as an indicator of the student's competency of minimum skills which were determined through the New Lebanon First Grade Course of Study. The comparison shown in Table 2 indicates no significant differences were found in test scores between Groups A and B after the study.

Table 2

Comparison of First Grade Competency Score

Group	Mean	Standard Deviation
A	94.68	3.54
B	93.58	6.16
$t = .675$, $p > .05$		

Another test used as a pretest was the Kindergarten Mathematics Test on the Iowa Test of Basic Skills, level 5. This test included objectives covering numeration and number systems, geometry and measurement, and operations. The test was administered in March of 1986-87 school year and evaluated on mid-year norms. Table 3 shows a comparison of the test scores of Groups A and B and shows no significant differences were indicated in these test scores before the study was undertaken.

Table 3

Comparison of Kindergarten Mathematics Test Scores on the Iowa Test of Basic Skills - Level 5

Group	Mean	Standard Deviation
A	25.11	6.87
B	28.37	4.04
$t = .975$, $p > .05$		

As computation was the focus of this study, the researchers compared the Kindergarten Operation Test scores on the Iowa Test of Basic Skills, level 5. The Operation Test scores, which were a partial test score of Table 3 scores, were used to determine if there were any significant computational differences in the two groups before the study began. Table 4 indicates there was no significant difference between the two group's scores.

Table 4

Comparison of Kindergarten Operation Test Scores on the Iowa Test of Basic Skills - Level 5

Group	Mean	Standard Deviation
A	4.37	1.38
B	4.53	1.17
$t = .385$, $p>.05$		

The first grade mathematics test scores on the Iowa Test of Basic Skills, level 7, included the skills objectives of numeration, number systems and sets, equations, inequalities and number sentences, whole numbers, integers, and single and multiple-step addition and subtraction problems. This test was used as a posttest and was given in March of the 1987-88 school year and evaluated on mid-year test norms. Table 5 shows a comparison of those scores and indicates no significant difference was found between the two groups tested.

Table 5

Comparison of First Grade Mathematics Test Scores on Iowa Test of Basic Skills - Level 7

Group	Mean	Standard Deviation
A	54.95	9.22
B	51.26	9.91
$t = 1.146$, $p>.05$		

In order to obtain a purer measure of computational level, the researchers further investigated Table 5 test scores by comparing the separate scores on the mathematics computation section of the Iowa Test of Basic Skills. This comparison also indicated that there was no significant difference between Groups A and B after the study was completed as shown in Table 6.

Table 6

Comparison of First Grade Computation Test Scores on Iowa Test of Basic Skills - Level 7

Group	Mean	Standard Deviation
A	16.74	5.29
B	17.26	4.32
$t = .332$, $p > .05$		

According to all the data collected, the findings indicate that there were no significant differences in Groups A and Groups B, either before the study began or after the

study was completed. These results indicate that the null hypothesis, made by the researchers, was supported by the findings.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The researchers undertook this study to determine whether scores on timed tests of the basic facts of addition and subtraction in mathematics were indicators of proficiency in computational skills. The study used two classrooms of heterogenously grouped first graders as the sample population. Group A was the experimental group, not given any timed tests on basic facts. Group B, the control group, was required to take the timed tests.

The study began in August 1987 and continued for one school calendar year. The students in both groups had similar instruction and equal instruction time. The pretest and posttests used for comparison were given to both groups. After the data were compared, the statistics found no significant difference between groups A and B on mathematics scores. Therefore, in this study, the null hypothesis was supported. There was no significant difference in the math concept and computation scores on the Iowa Test of Basic Skills and the Montgomery County Competency Based Education Mathematics Test between the two groups.

This study may need to be repeated at a higher grade level to determine if memorization frees processing space

for more abstract and cognitively demanding problem solving skills (Mellzer, 1984). If this statement is valid, then memorization of basic facts may be necessary for more advanced math students to be successful. But for the lower primary grades, this study seems to indicate that timed tests do not appear to be a determiner of mathematics success.

APPENDICES

Name _____ +0

1.	2 +2	4 +1	3 +2	5 +0	1 +3	0 +2
2.	2 +4	0 +3	3 +3	5 +1	1 +2	6 +0
3.	1 +1	2 +3	0 +0	0 +1	3 +1	0 +4
4.	4 +2	4 +0	1 +5	3 +0	1 +4	0 +6
5.	0 +5	2 +1	2 +4	1 +0	2 +0	6 +0

							+ 7
1.	3 + 2	2 + 4	6 + 0	5 + 2	3 + 3	2 + 2	1 +
2.	3 + 4	0 + 0	2 + 1	2 + 4	6 + 1	4 + 3	3 + 2
3	3 + 1	4 + 2	2 + 3	4 + 3	1 + 6	2 + 2	+
4.	4 + 1	2 + 1	0 + 5	3 + 1	4 + 2	3 + 2	+
5	3 + 3	5 + 1	4 + 2	2 + 5	4 + 0	2 + 3	3 + 4

1.	$\begin{array}{r} 4 \\ +3 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ +5 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ +2 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ +4 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ +3 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ +4 \\ \hline \end{array}$
2.	$\begin{array}{r} 2 \\ +6 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ +3 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ +2 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ +3 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ +5 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ +1 \\ \hline \end{array}$
3.	$\begin{array}{r} 6 \\ +0 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ +5 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ +3 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ +2 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ +6 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ +4 \\ \hline \end{array}$
4.	$\begin{array}{r} 1 \\ +4 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ +3 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ +4 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ +6 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ +2 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ +3 \\ \hline \end{array}$
5.	$\begin{array}{r} 0 \\ +8 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ +6 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ +3 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ +2 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ +4 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ +6 \\ \hline \end{array}$
6.	$\begin{array}{r} 3 \\ +5 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ +2 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ +4 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ +2 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ +5 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ +3 \\ \hline \end{array}$

+ 1

1.	2 + 3	3 + 6	5 + 2	1 + 5	3 + 4	3 + 3
2.	4 + 2	1 + 8	4 + 4	5 + 3	2 + 5	2 + 6
3.	4 + 3	5 + 2	1 + 5	3 + 6	0 + 9	3 + 2
4.	5 + 3	3 + 2	2 + 6	7 + 2	4 + 3	4 + 5
5.	7 + 1	2 + 7	6 + 1	2 + 5	5 + 4	0 + 6
6.	6 + 2	4 + 3	5 + 1	7 + 2	9 + 0	3 + 6

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

-6

1	$\begin{array}{r} 4 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -2 \\ \hline \end{array}$
2.	$\begin{array}{r} 6 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 0 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -3 \\ \hline \end{array}$
3.	$\begin{array}{r} 4 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -1 \\ \hline \end{array}$
4	$\begin{array}{r} 2 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -1 \\ \hline \end{array}$
5.	$\begin{array}{r} 5 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -3 \\ \hline \end{array}$
6	$\begin{array}{r} 4 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ -1 \\ \hline \end{array}$

1.	$\begin{array}{r} 7 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -5 \\ \hline \end{array}$
2.	$\begin{array}{r} 5 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -2 \\ \hline \end{array}$
3.	$\begin{array}{r} 6 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -7 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -3 \\ \hline \end{array}$
4.	$\begin{array}{r} 7 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -4 \\ \hline \end{array}$
5.	$\begin{array}{r} 5 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -6 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -1 \\ \hline \end{array}$
6.	$\begin{array}{r} 7 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -2 \\ \hline \end{array}$

-8

1.	8 -1	6 -3	7 -2	9 -4	8 -6	6 -3
2.	7 -3	5 -1	8 -5	4 -1	3 -1	5 -2
3.	6 -2	7 -3	6 -0	4 -2	7 -1	7 -4
4.	9 -6	8 -3	7 -5	9 -8	7 -3	6 -4
5.	9 -5	9 -2	7 -4	8 -4	9 -6	8 -3
6.	7 -6	4 -3	8 -2	7 -5	4 -1	6 -3

-9

1.	9 − 7	8 − 4	6 − 4	9 − 3	7 − 3	8 − 1
2.	7 − 2	9 − 2	7 − 6	8 − 5	6 − 2	9 − 6
3.	6 − 3	8 − 3	6 − 5	9 − 5	7 − 5	8 − 6
4.	9 − 1	5 − 3	4 − 2	9 − 3	9 − 3	6 − 0
5.	9 − 1	7 − 4	8 − 4	9 − 2	7 − 3	9 − 7
6.	8 − 1	5 − 3	3 − 3	9 − 1	9 − 3	7 − 2

1.	10 -4	6 -4	9 -4	8 -2	6 -0	8 -3	10 -6
2.	9 -6	8 -6	5 -3	10 -10	7 -3	8 -5	10 -2
3.	7 -5	9 -7	10 -3	4 -2	8 -4	9 -5	7 -2
4.	6 -2	7 -4	10 -8	9 -2	5 -3	10 -5	9 -8
5.	10 -7	9 -3	10 -4	3 -1	7 -6	10 -2	8 -8
6.	6 -3	8 -3	10 -9	5 -2	10 -3	9 -6	10 -0

BIBLIOGRAPHY

Berebitsky, Roger D. (1985). An annotated bibliography of the literature dealing with mathematics anxiety. Requirement for a Master's Program, Indiana University.

Boxall, Ron; and others (1979). The learning of number facts: The primary school. Curriculum paper. Queenlands Dept. of Education, Brisbane (Australia).

Donlon, Thomas F. An exploratory study of the implications of test speediness. Graduate Record Examinations Board, Princeton, N.J. Education Testing Service, Princeton, N.J.

Friend, Kenneth E. (1982). Stress and performance: Effects of subjective work load and time urgency. Personal Psychology 35(3), 623-33, Fall.

Greene, Gary (1985). Math - Facts memory made easy. Arithmetic Teacher 33(4), 21-25, Dec.

Hill, K.T. (1980). Motivation, evaluation, and educational testing policy. In L. Fyans, Jr. (Ed.), Achievement Motivation, 34-95, New York: Plenum.

Hynes, Mary Ellen, ed. (1978). Topics related to diagnosis in mathematics for classroom teachers. Papers presented to the R.C.D.P.M. annual conferences, 4th College Park, MD. (April 1-2, 1977) and 5th, Scottsdale, AZ (April 1978). Research Council for Diagnostic and Prescriptive Mathematics, Kent, Ohio. Rathmell, Edward C. How do you get kids to quit using their fingers to add and subtract? Heddens, James W. A theoretical study of the organization of basic addition facts for memorization.

Lazerick, Beth E. (1981). Basic facts of addition: An alternate strategy. Arithmetic Teacher 28(7), 29-24, March.

Linn, Miau Hsiany (1966). The impact of time limits on test behaviors. Paper presented at the annual meeting of the American Educational Research Association (San Francisco, CA, April 16-20, 1966).

Mellzar, Lyn J., & others (1984). Automalization and abstract problem-solving as predictors of academic achievement. Paper presented at the annual meeting of the American Psychological Association (Toronto, Canada, August 24-25, 1984).

Plass, James W.; Hill, Kenneth T. (1986). Children's achievement strategies and test performance: The role of time pressure, evaluation anxiety and sex. Developmental Psychology 22(1) 31-36, Jan.

Sharma, Mahesh-C. (1985). Memorizing is not a dirty word: What should a mathematics teacher know to use it effectively in teaching and learning mathematics? Math - Notebook 4(7-8), Sept.-Oct.

Steinberg, Ruth M. (1984). Derived fact strategies in learning addition and subtraction. Paper presented at the annual meeting of the American Education Research Association (New Orleans, LA, April).

Suydam, Marilyn N. (1984). Research report: Learning the basic facts. Arithmetic Teacher 32(1), 19, Sept.

Vernon, Phillip A.; Jenson, Arthur R. (1983). Individual and group differences in intelligence and speed of information processing (University of Dayton Microfilms No. ED 237 624).

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