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## Computer Assisted Drill and Practice: An Instructional Aid to Increasing Rate of Acquisition of Addition Math Facts

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COMPUTER ASSISTED DRILL AND PRACTICE: AN  
INSTRUCTIONAL AID TO INCREASING RATE OF  
ACQUISITION OF ADDITION MATH FACTS

by

Paula G. Frandsen

A Project Report  
Submitted to the  
Faculty of The Graduate College  
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requirements for the  
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Department of Psychology

Western Michigan University  
Kalamazoo, Michigan  
December 1989

COMPUTER ASSISTED DRILL AND PRACTICE: AN  
INSTRUCTIONAL AID TO INCREASING RATE OF  
ACQUISITION OF ADDITION MATH FACTS

Paula G. Frandsen, Ed.S.

Western Michigan University, 1989

This study supplemented existing math instruction and drill and practice (flash cards and worksheets) with computer assisted drill and practice (CADP) to facilitate addition math fact attainment of first grade students. The six students selected were introduced to (CADP) on an individual basis using a multiple baseline across subjects research design. Timed tests were used to select subjects, as baseline measures, and as probes throughout the study to measure the students' rate correct per minute (the dependent variable).

All subjects showed an increase in their individual rate correct per minute after the introduction of CADP. This rate increase is important when considering the educational possibilities of using computer assisted drill and practice as a supplemental activity to increase the amount of student engaged time and thus increase the rate of student success.

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Paula G. Frandsen

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## CHAPTER I

### INTRODUCTION

The impact of computer technology on society cannot be ignored. "Computers are so pervasive in every walk of life that an understanding of the technology . . . associated with their use will soon be a necessity for all individuals if they are to keep pace within the society in which they live" (Zeller, 1987/1988, p. 1). Few would dispute this claim.

Along with this realization comes increased confirmation that all the possible benefits of such a powerful tool have not been explored. "In addition to the many known uses of computers, it is estimated that there are thousands of applications of the computer still awaiting discovery" (Klassen & Anderson, 1982, p. 26). Many questions lie unanswered as society strives to make efficient, intelligent, productive, and humane decisions regarding computer use. Our educational system has struggled with these same issues. Through all the debate, it has become apparent to educators that schools must not only educate young people to understand computer technology (become computer literate), but must also search for the most meaningful ways to become skilled in its use (Hofmeister, 1984).

As the computer revolution progressed, many educators began turning their primary focus from "teaching about the computer" or computer literacy to "teaching with computers" (Alessi & Trollip, 1985). One of the main factors responsible for the rapid adoption of the computer as a medium for delivering instruction stemmed from education's desire to tailor the instructional process to meet the different abilities among students (Atkinson & Wilson, 1969). Educators began to view the computer as an answer to the "most pressing need in education--the individualization of instruction" (Atkinson & Wilson, 1969, p. 3).

#### Background Information

The early search for pedagogical efficacy of computer use typically involved big computer systems with several terminals which were bought or leased by the local school district from other computer users or a commercial source. Due to the size of the systems, the computer would usually reside in one room and the terminals in another. Students would be brought in and seated in front of an individual terminal (Peterson, 1984). These computerized teaching systems were soon described with a "mildly forbidding, technical-sounding term: . . . Computer-Assisted-Instruction. In acronym form, the term became hardly more compelling: CAI" (Peterson, 1984, p. 7).

Soon, any time spent by students on these computers became known by the generic term (CAI), whether the students were engaging in drill and practice, programing, or tutorial activities.

#### CAI: The Beginning

Educational psychologists entertained high hopes for the computer when it first began to be used as a teaching device (Niemic & Walberg, 1987). Time proved these lofty expectations to be unrealistic. When researchers began to study the early effects of CAI on learning the actual results proved disappointing. CAI did not appear to live up to the "limitless potential" first envisioned by educators (Niemic & Walberg). This is not to say that CAI was ineffective. It only serves to point out the limitations with these old computerized teaching machines. As Atkinson and Wilson (1969) state: "many problems remain to be solved; the obvious problems of hardware and costs as well as the deeper problems of understanding the learning process more fully and applying that knowledge in both curriculum development and evaluation" (p. 3). In other words, the systems themselves (in terms of cost and technical efficiency) and the programs run by these systems did not meet education's demands.

In spite of these limitations, many educators and researchers continued to believe in the merits of CAI. A synthesis of the research done during the 1960's and 1970's indicates that this belief was justified. The consensus among researchers reviewed was that CAI could be used to boost achievement scores (especially for low-achievers) in a variety of subject areas in a shortened period of time with generally favorable student response (Edwards, Norton, Weiss, Taylor, & Dusseldorp, 1975; Feldhusen & Szabo, 1969; Jamison, Suppes, & Wells, 1974; Thomas, 1979; Vinsonhaler & Bass, 1972). Even though early high expectations were not met, this initial research showed promise for CAI. Enough so, that by the end of the 1970's CAI was beginning to be a widely accepted and extensively used strategy for providing supplemental instruction in U.S. public schools (Chambers & Bork, 1980).

It became clear that all the varied instructional uses of the computer subsumed under the broad category of CAI had in common these two elements: "the repetition of similar exercises and immediate reinforcement (cognitive and affective feedback regarding performance)" (Becker, 1982, p. 16). Soon these common characteristics shared by all CAI programs became benchmarks for using the computer as a medium for delivering instruction. As Becker (1982) states, "programs to drill students or to examine



student responses and provide appropriate feedback are the most 'easily conceived applications of computers for the classroom" (p. 16).

Computer Assisted Drill and Practice:  
Theory and Application

Such applications, in turn, led to the rapid development of drill and practice CAI software programs. Researchers and educators alike began to narrow their expectations of CAI and focus on specific use of the computer for providing drill and practice as a complement to standard educational practice. In an effort to make the determination whether this use of the computer was effective, several studies were conducted which examined whether computer-based drill and practice programs, which pre-dated microcomputers in the classroom, could produce increased student achievement.

Vinsonhaler and Bass (1972) reviewed 30 controlled studies which supplemented traditional language arts and mathematics programs with CAI drill and practice for elementary students. They came to the conclusion that "there seems to be rather strong evidence for the effectiveness of CAI [augmentation of] traditional instruction where effectiveness is measured by standardized achievement tests" (Vinsonhaler and Bass, 1972, p. 29). All the studies reviewed used a group/control group experimental design where the experimental group received traditional

instruction supplemented by CAI drill and practice for five to 15 minutes per day. The control groups received traditional instruction without any special assistance.

Jamison, Suppes, and Wells (1974) found that the use of computer-based drill programs could lead to increased student achievement, particularly for students who started below grade level. They concluded that CAI is "apparently effective as a supplement to regular instruction", even though it may not necessarily be more cost-efficient.

A study of the drill and practice curriculum utilized in the Los Angeles schools conducted by Ragosta, Holland, and Jamison (1974) found that CAI had a more positive impact on mathematics achievement than on language arts and reading achievement. Becker (1982) substantiates that this discovery correlates with the results generally found in the literature. As Melmed (1980) points out, it appears that CAI drill and practice more closely simulates traditional practice of math (flashcards, worksheets) than practice for reading and language arts activities.

Mevarech and Rich (1985) propose that "the most basic usage of computers in mathematic instruction is in the area of drill and practice to the regular curriculum" (p. 6.). There is an empirical basis for the logical progression of using computers for drill and practice to

using computer drill and practice programs to supplement traditional math instruction. Math is a subject that requires repeated practice and memorization of isolated facts. In turn, the use of computer assisted drill and practice (CADP) programs seems to hold several advantages over using more traditional forms of drill; i.e., workbooks, ditto sheets, and flashcards. "Their interactive nature and their flexible and visually appealing display formats make them more enjoyable experiences. Student feedback is direct and immediate." (Becker, 1982, p. 17).

#### Microcomputers Enter the Classroom

The endless possibilities promised by the early computers were stymied by drawbacks like technical problems, prohibitive cost, and poorly developed computer software. In spite of these problems, many educators still continued to hold out hope for the utility of CAI. With the advent of the microcomputer revolution in the mid 1970's advocates of CAI were given cause for renewed hope. Advances in technology and manufacturing lowered costs so that by the 1980's CAI became readily available in many school districts (Niemic & Walberg, 1987).

Software programs were soon rapidly developed to meet the growing demand. These software programs began to receive their share of criticism. "Two defects appear to

predominate in current microcomputer software" (Becker, 1982, p. 21). The first major defect is that much of the educational software is poorly written (Becker, 1982; Hofmeister, 1984). Drill and practice programs are especially apt to fall into this category because "beginning CAI software programmers cut their teeth on drill-and-practice programs because they are short and often do not require sophisticated computer programming skills" (Hofmeister, 1984, p. 4-2). The second major defect of most microcomputer software is that many programs are boring and repetitious which may lead to lack of student interest and therefore discipline problems (Becker, 1982; Hofmeister, 1984).

"The question is whether it is possible to create effective drill activities which minimize boredom and are as engaging as the play activities that the children enjoy" (Becker, 1982, p. 23). Malone (1980) suggests, upon extensive analysis of computer games, that children can be intrinsically motivated by games that maximize both learning and enjoyment. According to Zeller (1987/1988), the interactivity of a software program is an important quality to examine when choosing software.

It is apparent that many researchers agree as to the possible benefits of using microcomputers for drill and practice for basic math skills in the classroom (Becker, 1982; Fisher & Lipson, 1984; Hofmeister, 1984). They all

caution; however, that while drill and practice programs have an important place in the classroom, the effectiveness of software programs must be closely examined. It is important to choose software programs which successfully combine learning of basic facts with highly interactive play activity.

In addition to software considerations, it is important to look at certain criteria before using the computer for drill and practice activities. Hofmeister (1984) states that CADP activities are most appropriately used:

(a) for subject matter that needs to be well mastered to facilitate the effective performance of higher-level skills; (b) after the concepts related to the skill have been taught; and (c) just prior to the application of these skills to higher-level skills in the curriculum hierarchy. (p. 4-2).

#### Current CADP Implications

Research prior to microcomputer use seems to demonstrate that CADP can lead to increased student achievement in comparison to prior years or to control group treatments. Few studies have been done to determine whether the microcomputers presently used in many classrooms are effective. As Becker (1982) states: "research should be conducted to determine whether most of the more typical drill-and-practice materials available for . . . microcomputers the schools are now buying are as educa-

tionally effective under more typical conditions of use as were the pioneer CAI programs" (pp. 20-21). In addition, many of these pioneer studies made no comparison with other nontraditional methods of instruction (Vinsonhaler & Bass, 1972).

In an attempt to answer some of these research questions, Watkins (1986) utilized the Math Machine software program to compare CADP to traditional drill and practice with first grade students experiencing no academic difficulties. The Math Machine program is set up such that math problems are presented to students on a screen and the students are allowed as much time as needed to solve each presented problem. The Math Machine also delivers reinforcement on a variable ratio schedule in the form of one minute's play of a video arcade game. Students selected for the study received traditional math instruction but only CADP while in school. The control group received only traditional drill and practice (flash cards, drill sheets, work books, and oral recitation) while in school. Watkins' study, which used a pretest/posttest design, found that the students involved in the study receiving CADP obtained higher achievement scores on the Iowa Test of Basic Skills than did the control group.

All previous research thus reviewed has studied the effectiveness of CADP in terms of student achievement as

measured by standardized achievement tests. Even though various researchers have proposed that CAI students gain mastery status in a shortened period of time (Feldhusen & Szabo, 1969; Jamison, Suppes, & Wells, 1971; Thomas; 1979) and that CADP may make more efficient use of instructional time (Orlansky, 1983) most CADP studies have not used time as a dependent variable (Bright, 1983).

This researcher is in agreement with Bright (1983) that "previous research that seems to have increased the academic learning time [engaged time] seems to have accomplished this goal more or less by accident" (p. 150). A purposeful look at the utility of CADP as a technique to increase the amount of engaged time or the rate of success (Bright, 1983) is the aim of this particular research project. In this study, the relationship between CADP and math fact attainment will be examined by measuring the rate correct of first grade students (who are experiencing difficulty learning basic addition math facts) prior to and throughout the introduction of CADP.

Many students develop a dependence on manipulatives (slash marks, counting with their fingers) while attempting to learn basic addition facts. Such students never achieve fluency in their use of these facts. They have no firm foundation upon which to build. As Hofmeister (1984) states, "it should be remembered that to function

at higher cognitive levels, certain preliminary skills have to be automatic. Long division cannot be done quickly or accurately if the subskill of subtraction is not mastered" (p. 4-2).

Students' without a solid knowledge of basic math facts may begin to lose confidence in their mathematical abilities. When faced with more complicated mathematical concepts these students may exhibit skill deficits and end up being referred for a special education evaluation. Special education is a very expensive process which often fails to remediate students so that they are equipped to return to regular education. CADP offers a preventative option in the regular education classroom for remediation of students having difficulty retrieving and retaining basic math facts.



## CHAPTER II

### METHOD

#### Participants

The participants of this study were first grade students enrolled in a public school regular-education classroom. The entire class had been receiving consistent drill and practice on basic addition sums for over half the school year using ditto sheets and flashcards. Several students in this classroom were identified by the teacher as having difficulty solving even basic sums (0-10). The students were expected to master the sums 0-18 by the end of the school year. This expectation was used as the criterion for the selection of timed tests consisting of 100 addition problems, testing the sums 0-18, given to the entire first grade class on two separate occasions. It was felt that such criterion would help prevent ceiling and maturation effects.

On the basis of their performance on these timed tests and teacher report, six subjects were selected to participate in this study. Those selected comprised a mixed ethnic group of students, primarily due to the mixed ethnic population in this school district. It also turned out that, due to their performance in class and on

the tests, three females and three males were selected to participate in this study.

#### Apparatus/Materials

This study utilized an Apple IIe Computer and a software package entitled Math Blaster by Davidson & Associates, Inc. (1986). This program offers drill and practice on basic addition, subtraction, multiplication, and division facts using a highly interactive and fast paced game playing format. In a study by Zeller (1987/1988) which examined the interactive capabilities of computer software programs 95 respondents were asked to identify high and low interaction programs. Math Blaster was rated by these respondents as one of the top five high interactive programs.

Math Blaster offers players the option of choosing whether they want to practice addition, subtraction, multiplication, or division facts. Another option offered is the level of difficulty. This level of difficulty involves the speed in which the problems are presented and the player's allowable response time to the presented problem. Throughout this entire study the students worked exclusively on addition facts and the level of difficulty was kept constant at Level 1. At this level students were allowed seven seconds to respond from the presentation of the problem to the presentation of the next problem.

The timed tests used in this study were selected from one of five possible tests. Each version of the test tests the sums 0-18, but they are presented in a different order in each test (see Appendix A). In order to reduce practice effects and experimenter bias the following procedure was used to select the order of presentation of the timed tests. A slip of paper with the numbers 8, 9, 10, 11, and 12 was put into a hat. An impartial selector picked a slip out of a hat and the number written on the slip was recorded. The slip was returned to the hat and another draw made. If the same test was selected twice in a row, then another slip was drawn. For example, if test #9 was selected the first time and then #11, and then #11 again, another test was selected. As long as a test wasn't selected twice in a row then it was recorded. Each test consists of 100 problems with an allowable response time of five minutes per test.

#### Dependent Variable

These timed tests were used to select subjects, as baseline measures, and as probes throughout the study to measure the students' rate correct (the dependent variable). The dependent variable of rate was measured per minute. Therefore the students' score on each test was divided by five to find the rate correct per minute.

### Procedure

A multiple baseline across subjects research design was used. With this design, a stable baseline measure was achieved for each subject on an individual basis before CADP was introduced to that subject. Computer assisted drill and practice (Math Blaster) was subsequently introduced to one student at a time when it was determined by the researcher that their baseline measure appeared stable. During the entire study the students continued to receive their existing math instruction and traditional drill and practice.

The students selected were scheduled to play the game a minimum of two times a week for 10 minutes each session. A timer was set when they began to play and if the timer went off at the end of 10 minutes during a game they were allowed to finish that game.

The timed test was given an average of twice a week to all six subjects selected. The students were assembled together at a round table away from the class and given a version of the timed test. A timepiece with digital read-out was used by the researcher to time the students.

All subjects who participated in this study were determined to have the required preskills necessary for beginning computer literacy. Each student had the necessary letter and number recognition skills needed to oper-

ate the correct keys on the keyboard to play the computer game. In addition, all subjects understood the directional concepts of left and right needed to operate the right and left cursor keys.

Intervention was said to have begun as soon as training on the Math Blaster computer game was started for each subject. Math Blaster requires the use of both hands to play the game. Some subjects picked up the game faster than other subjects due to differences in coordination and ability. All subjects were given support from the experimenter as necessary to allow for individual differences so that each subject was exposed to the game for the allotted time (10 minutes) from the first time they sat down to play the game. Eventually, all the subjects were independently playing the game.

By the end of the study (and the school year) all of the subjects had played the game at least eight times. Throughout the course of the study, each member of the class not involved in the study was given the opportunity for one turn on the computer to play the game with the experimenter. On the last test session the timed test was given to the entire class.

## CHAPTER III

### RESULTS

This chapter reports the findings of the study. The purpose of this study was to examine the relationship between computer-assisted drill and practice (specifically Math Blaster) and math fact acquisition. The subjects' attainment of addition math facts was measured through the use of timed tests. In turn, these tests were used to calculate the students' rate correct per minute for each test given (or session). The students' rate correct per minute for each session was plotted individually on a continuum across each subject. This information allowed the researcher to make judgements necessary to implement the multiple baseline across subjects research design. With this design, a stable baseline measure was achieved for each subject on an individual basis before CADP was introduced. The results from test sessions during baseline and CADP intervention for each subject are presented in Figure 1.

Once the computer game training was implemented, immediate rate increases began for all the students except for subjects two and three. The first data point collected for these two subjects showed a drop. However, their rate began to steadily increase after this initial drop (see Figure 1).

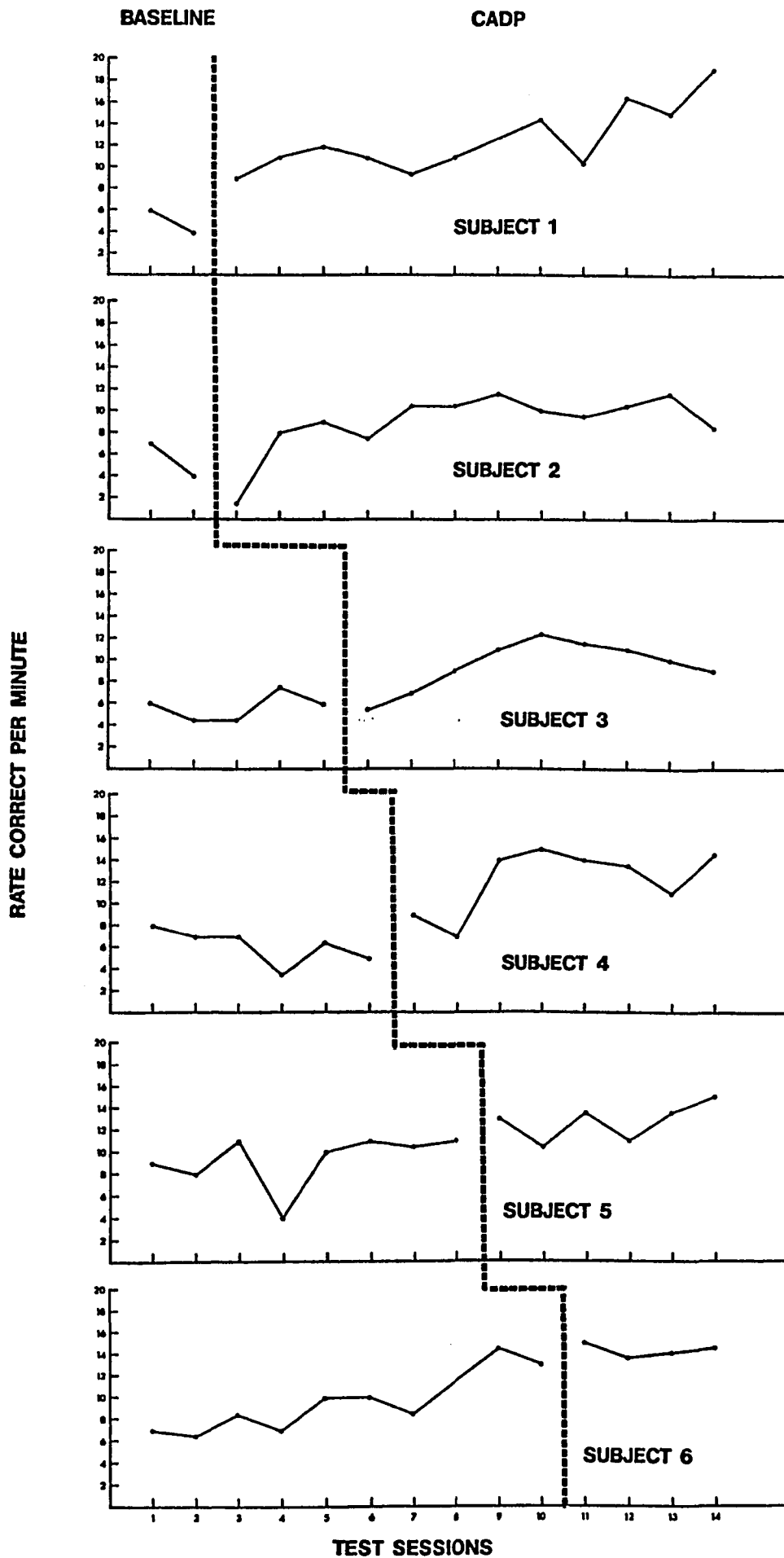


FIGURE 1 - INDIVIDUAL SUBJECT RATE CORRECT PER MINUTE ACROSS BASELINE AND INTERVENTION

All subjects showed increases in mean rate correct per minute from the baseline condition to the treatment condition (see Tables 1 and 2).

Table 1

Individual Mean Rate Correct per Minute  
During Baseline and Treatment

Subject	<u>Baseline</u> (Mean)	<u>Treatment</u> (Mean)
1	5.0	12.6
2	5.5	9.0
3	5.5	9.6
4	6.2	12.2
5	9.4	14.2
6	8.1	12.7

Table 2

Individual Difference in Mean Rate Correct per Minute  
Between Baseline and Treatment

Subject	Mean Rate Difference
1	7.6
2	3.5
3	4.1
4	6.0
5	4.8
6	4.6



As mentioned previously, the timed tests were given to the entire class on 3 separate occasions. The first two times the test was given to select subjects. The test was also given to the entire class the last session in the interest of collecting comparison data. The mean rate per minute for the initial two test sessions (subject selection) was calculated for the group that eventually received CADP and the remainder of the class, which did not receive the CADP intervention. The mean rate per minute for the final test session was also calculated for both groups. This comparison is shown below in Table 3.

Table 3  
Group Mean Rate Correct per Minute From Initial Test Sessions and Final Test Session

Subjects	<u>Initial</u> (Mean)	<u>Final</u> (Mean)
CADP Group	6.4	13.4
Other	12.0	14.5

A graphic comparison of the cumulative initial mean rate to the cumulative final mean rate between the group that received CADP and the group that did not illustrates the rate correct per minute difference achieved by the two groups (see Figure 2).

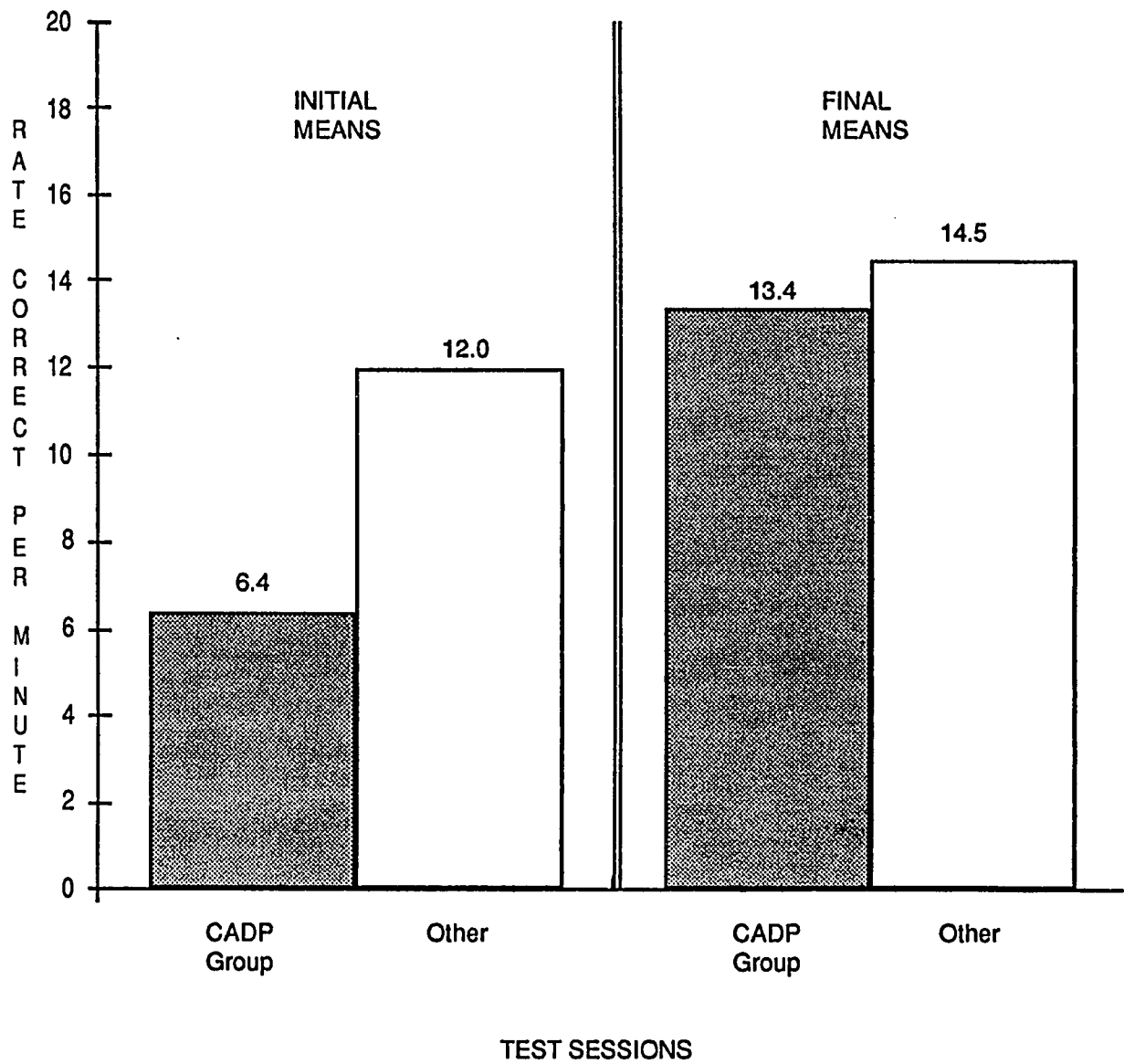


Figure 2. Comparison of Initial and Final Rate Correct per Minute Means for CADP Group and Other.

To determine whether the mean differences between the group that received CADP and the remainder of the class, which did not receive CADP, were influenced by a regression toward the mean, the following comparison was made. A group mean rate correct per minute calculation was done according to the overall class performance on the initial test sessions according to the following breakdown: group mean one (eight lowest performers), group mean two (eight middle performers), and group mean three (eight highest performers). A group mean rate correct per minute calculation was also done on the final test session for the same three groups of eight (see Figure 3).

A graphic depiction of these data (see Figure 3) seems to rule out the regression phenomenon since the group mean of the high performers increased, rather than decreased, from their initial mean performance.

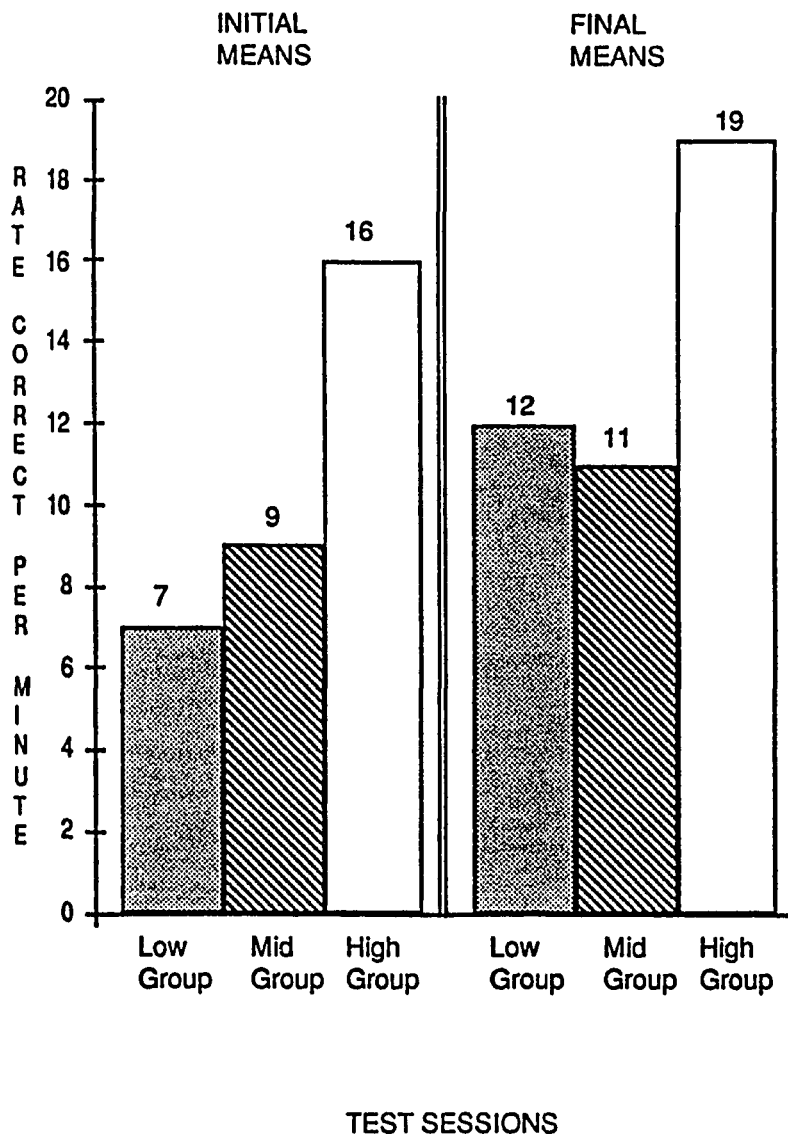


Figure 3. Comparison of Initial and Final Rate Correct per Minute Means for Low Performers, Middle Performers, and High Performers.

## CHAPTER IV

### DISCUSSION

The results of the study indicate an increase in rate correct per minute for each student in comparison to their individual rate prior to the introduction of computer assisted drill and practice (Math Blaster). The data show an average increase in rate correct per minute for all six subjects (from 3.5 problems per minute to 7.6 problems per minute) from the baseline condition with the use of CADP.

The results of the study also indicate an increase in rate correct per minute for the group that received CADP in comparison to the remainder of the class who did not receive CADP. The difference between the mean attained by the CADP group during the initial two sessions (prior to computer intervention) and the final session (after exposure to computer intervention) was 7.0 problems per minute. The difference between the mean attained by the remainder of the class during the initial two sessions and the final session was 2.5 problems per minute.

These data serve to reinforce the supposition that the gains made by the individual students exposed to CADP were due primarily to their exposure to the intervention.

If both groups had made gains of similar magnitude, then it could be argued that other variables were confounding the subjects' individual rate increases from baseline to intervention. Of course the data from those subjects not selected could have been influenced by a ceiling effect, as their initial rates were considerably higher than the subjects' initial rates. The subjects were selected specifically because of their low initial rates and their overall low math achievement as reported by the teacher. In general, the subjects were the low performers in the classroom. All but one subject was involved in the Title One remedial reading program.

It is important to note that all subjects responded well to the intervention. A simple reporting of the data cannot convey the enthusiasm with which the students spent their time on the computer. The dawdlers would hurry and finish their daily work in order to get computer time. Even on a nice spring day subjects would volunteer to stay in from recess for time on the computer. This researcher is convinced that math drill and practice with this particular game was enjoyable to the students.

Various researchers have reported that the amount of time students are willing to spend with CAI materials is noticeably longer than with many other instructional materials (Bright, 1983; Jensen, 1982). Bright (1983)

suggests that "the increased involvement, which is precisely increased engaged time, is related to the substantive interaction between the user and the machine" (p. 149).

Math Blaster has been found to possess a high degree of interactivity (Zeller, 1987/1988). Interactivity has been defined by (Jonassen, 1985) as a process where the "learner actively or overtly responds to the information presented by the technology, which in turn adapts to the learner, a process more commonly referred to as feedback" (p. 7).

Learners must process information actively in order to facilitate comprehension and retention (Ausubel, 1960). Therefore, the more learners interact with materials they are trying to learn, the more likely they will comprehend and retain the material (Weller, 1988). Thus, interactivity enhances the learning process through active responding on the part of the learner to the information presented by the technology (feedback).

The process of interactivity, as described above, has been found to be positively correlated with high levels of student engagement (Fisher, et al., 1980). Furthermore, the ratio of student engaged time to allocated time is positively associated with learning (Fisher, et al., 1980). Therefore, it logically follows that a CADP program with a high degree of interactivity

can be effectively utilized to increase the amount of student engaged time and thus contribute toward an overall increase in the rate of successful learning.

A successful remediation of specific academic weaknesses ideally involves mastery of the material in the shortest time period possible. Carnine and Silbert (1979) offer six guidelines to effectively teach remedial readers, which are relevant to remedial math students:

- 1) Provide extra instruction;
- 2) start the extra instruction as soon as any deficit appears;
- 3) use highly trained personnel;
- 4) select a program that teaches essential skills and teaches them well;
- 5) move remedial students through the instructional program as rapidly as possible; and
- 6) motivate the students to achieve. (p. 50)

It appears that time, in the context of increasing the amount of instruction so that mastery is achieved as rapidly as possible, is an important variable to consider when addressing the issue of effective remediation.

Time is also an important consideration as it relates to the concept of "pacing" or the speed in which tasks are presented. Carnine (1976) suggests that lessons presented during a fast-rate condition (5 seconds per task) led to substantially higher attending and correct answers than lessons presented during a slow-rate condition (14 seconds per task). This researcher feels that the fast paced format of Math Blaster, in terms of presentation of math problems and allowable response time, facilitated the rate increases of all subjects



involved in this particular study. The relationship between pace (of presentation) and possible rate increase (higher rate of correct answers) is an especially important consideration for acquisition of math facts. Many educators do not consider that a math fact is mastered if it takes more than a few seconds to respond (Alessi & Trollip, 1985). Therefore, a CADP program that requires a response to be quick in order to be correct has important utility for remediation of students who have not acquired math facts with any degree of fluency.

In spite of the importance of the variable of time as it relates to successful remediation, most computer studies to date have "treated time as an interesting but not theoretically important variable" (Bright, 1983). Since educators obviously consider time to be an important variable in remediation, this researcher feels that use of the computer to provide "equivalent learning in less total student time" is an important, educationally relevant, benefit of CADP which has not been fully addressed by researchers. The results of the present study suggest that a CADP program like Math Blaster can be used to successfully provide a greater amount of instructional time and accelerate the rate of progress of students who are targeted as soon as their deficit appears. This supposition opens the door to further research along this area and points out potential weaknesses of this particular study.

In this study, CADP was introduced as a supplement to the regular instructional and drill and practice activities. No effort was made to compare CADP to other more traditional, less automated drill and practice activities since it was felt that it would be extremely difficult to rule out the possibility of exposure to alternative treatment conditions while not in school.

This issue arose for subject number six who made a dramatic increase in rate from session seven to session nine during baseline condition (see Figure 1). When questioned, subject six stated that her mother had begun working with her at home on addition facts. This led the researcher to question all the other subjects regarding any at-home practice of math facts. It was reported that none of the other subjects received additional practice.

Since this study was not comparing alternative interventions the data for subject six were considered interesting, but not viewed as a serious problem. In fact, the trend of data for this subject provided the opportunity for a microcomparison between at-home drill with mother and CADP with Math Blaster (see Figure 1). Note that after exposure to CADP the rate per minute for subject six increased even more, from 13 problems per minute to 15 problems per minute, never falling below 13.5 problems per minute.

The findings of the present research study suggest some intriguing possibilities for future study such as a

comparison of alternative intervention conditions, like flash card drill and practice and CADP, with engaged time as dependent variable. Another interesting study might involve a comparison of Math Blaster to other CADP programs with similar components of interactivity and rapid pacing with possible dependent variables of rate increase or engaged time.

This study did not involve a detailed examination of possible long-term effects of the CADP intervention. However, a follow-up by the researcher with the classroom teacher revealed that not a single student in the class, including those involved in the study, received less than 80% on an end-of-the-year math achievement test. It would be interesting to follow these students through second grade to see if the CADP rate increase has been maintained.

The aim of this research has been to study the effect of computer assisted drill and practice on the variable of rate correct per minute acquisition of basic addition math facts for students specifically targeted as being deficit in this area. Research findings suggest that the variable of engaged time is important in increasing student success rate (Fisher, et al, 1980). Interpretation of the phenomenon of using the computer to increase the amount of student engaged time, and therefore increase the rate of success (Bright, 1983), opens the door to a multitude of educational possibilities which warrant further investigation in the research area.

APPENDICES

Appendix A  
Examples of Timed Tests Used for  
Data Collection

Name 21 other

Addition Facts: Sums 0-18  
Test 8+

Minutes				
1	2	3	4	5

Score

*Key*

A	$\begin{array}{r} 5 \\ +6 \\ \hline 11 \end{array}$	$\begin{array}{r} 3 \\ +8 \\ \hline 11 \end{array}$	$\begin{array}{r} 0 \\ +4 \\ \hline 4 \end{array}$	$\begin{array}{r} 7 \\ +8 \\ \hline 15 \end{array}$	$\begin{array}{r} 6 \\ +5 \\ \hline 11 \end{array}$	$\begin{array}{r} 9 \\ +1 \\ \hline 10 \end{array}$	$\begin{array}{r} 2 \\ +5 \\ \hline 7 \end{array}$	$\begin{array}{r} 5 \\ +9 \\ \hline 14 \end{array}$	$\begin{array}{r} 7 \\ +4 \\ \hline 11 \end{array}$	$\begin{array}{r} 1 \\ +7 \\ \hline 8 \end{array}$
B	$\begin{array}{r} 1 \\ +8 \\ \hline 9 \end{array}$	$\begin{array}{r} 9 \\ +4 \\ \hline 13 \end{array}$	$\begin{array}{r} 4 \\ +3 \\ \hline 7 \end{array}$	$\begin{array}{r} 1 \\ +6 \\ \hline 7 \end{array}$	$\begin{array}{r} 0 \\ +8 \\ \hline 8 \end{array}$	$\begin{array}{r} 7 \\ +2 \\ \hline 9 \end{array}$	$\begin{array}{r} 5 \\ +4 \\ \hline 9 \end{array}$	$\begin{array}{r} 2 \\ +0 \\ \hline 2 \end{array}$	$\begin{array}{r} 1 \\ +3 \\ \hline 4 \end{array}$	$\begin{array}{r} 9 \\ +0 \\ \hline 9 \end{array}$
C	$\begin{array}{r} 8 \\ +3 \\ \hline 11 \end{array}$	$\begin{array}{r} 2 \\ +7 \\ \hline 9 \end{array}$	$\begin{array}{r} 4 \\ +8 \\ \hline 12 \end{array}$	$\begin{array}{r} 6 \\ +0 \\ \hline 6 \end{array}$	$\begin{array}{r} 3 \\ +2 \\ \hline 5 \end{array}$	$\begin{array}{r} 5 \\ +8 \\ \hline 13 \end{array}$	$\begin{array}{r} 0 \\ +0 \\ \hline 0 \end{array}$	$\begin{array}{r} 6 \\ +8 \\ \hline 14 \end{array}$	$\begin{array}{r} 4 \\ +6 \\ \hline 10 \end{array}$	$\begin{array}{r} 3 \\ +5 \\ \hline 8 \end{array}$
D	$\begin{array}{r} 0 \\ +5 \\ \hline 5 \end{array}$	$\begin{array}{r} 4 \\ +0 \\ \hline 4 \end{array}$	$\begin{array}{r} 1 \\ +4 \\ \hline 5 \end{array}$	$\begin{array}{r} 9 \\ +9 \\ \hline 18 \end{array}$	$\begin{array}{r} 6 \\ +2 \\ \hline 8 \end{array}$	$\begin{array}{r} 3 \\ +0 \\ \hline 3 \end{array}$	$\begin{array}{r} 5 \\ +1 \\ \hline 6 \end{array}$	$\begin{array}{r} 8 \\ +9 \\ \hline 17 \end{array}$	$\begin{array}{r} 2 \\ +4 \\ \hline 6 \end{array}$	$\begin{array}{r} 8 \\ +7 \\ \hline 15 \end{array}$
E	$\begin{array}{r} 7 \\ +6 \\ \hline 13 \end{array}$	$\begin{array}{r} 1 \\ +9 \\ \hline 10 \end{array}$	$\begin{array}{r} 9 \\ +6 \\ \hline 15 \end{array}$	$\begin{array}{r} 5 \\ +3 \\ \hline 8 \end{array}$	$\begin{array}{r} 1 \\ +0 \\ \hline 1 \end{array}$	$\begin{array}{r} 8 \\ +4 \\ \hline 12 \end{array}$	$\begin{array}{r} 2 \\ +2 \\ \hline 4 \end{array}$	$\begin{array}{r} 8 \\ +0 \\ \hline 8 \end{array}$	$\begin{array}{r} 3 \\ +9 \\ \hline 12 \end{array}$	$\begin{array}{r} 0 \\ +9 \\ \hline 9 \end{array}$
F	$\begin{array}{r} 3 \\ +4 \\ \hline 7 \end{array}$	$\begin{array}{r} 7 \\ +9 \\ \hline 16 \end{array}$	$\begin{array}{r} 6 \\ +6 \\ \hline 12 \end{array}$	$\begin{array}{r} 2 \\ +6 \\ \hline 8 \end{array}$	$\begin{array}{r} 7 \\ +3 \\ \hline 10 \end{array}$	$\begin{array}{r} 4 \\ +5 \\ \hline 9 \end{array}$	$\begin{array}{r} 9 \\ +3 \\ \hline 12 \end{array}$	$\begin{array}{r} 6 \\ +4 \\ \hline 10 \end{array}$	$\begin{array}{r} 0 \\ +2 \\ \hline 2 \end{array}$	$\begin{array}{r} 4 \\ +2 \\ \hline 6 \end{array}$
G	$\begin{array}{r} 4 \\ +1 \\ \hline 5 \end{array}$	$\begin{array}{r} 6 \\ +9 \\ \hline 15 \end{array}$	$\begin{array}{r} 0 \\ +1 \\ \hline 1 \end{array}$	$\begin{array}{r} 5 \\ +5 \\ \hline 10 \end{array}$	$\begin{array}{r} 8 \\ +2 \\ \hline 10 \end{array}$	$\begin{array}{r} 2 \\ +9 \\ \hline 11 \end{array}$	$\begin{array}{r} 6 \\ +7 \\ \hline 13 \end{array}$	$\begin{array}{r} 1 \\ +2 \\ \hline 3 \end{array}$	$\begin{array}{r} 5 \\ +7 \\ \hline 12 \end{array}$	$\begin{array}{r} 9 \\ +8 \\ \hline 17 \end{array}$
H	$\begin{array}{r} 5 \\ +2 \\ \hline 7 \end{array}$	$\begin{array}{r} 3 \\ +1 \\ \hline 4 \end{array}$	$\begin{array}{r} 8 \\ +8 \\ \hline 16 \end{array}$	$\begin{array}{r} 4 \\ +9 \\ \hline 13 \end{array}$	$\begin{array}{r} 3 \\ +6 \\ \hline 9 \end{array}$	$\begin{array}{r} 9 \\ +7 \\ \hline 16 \end{array}$	$\begin{array}{r} 2 \\ +3 \\ \hline 5 \end{array}$	$\begin{array}{r} 0 \\ +6 \\ \hline 6 \end{array}$	$\begin{array}{r} 8 \\ +6 \\ \hline 14 \end{array}$	$\begin{array}{r} 5 \\ +0 \\ \hline 5 \end{array}$
I	$\begin{array}{r} 6 \\ +3 \\ \hline 9 \end{array}$	$\begin{array}{r} 1 \\ +1 \\ \hline 2 \end{array}$	$\begin{array}{r} 8 \\ +5 \\ \hline 13 \end{array}$	$\begin{array}{r} 0 \\ +7 \\ \hline 7 \end{array}$	$\begin{array}{r} 9 \\ +5 \\ \hline 14 \end{array}$	$\begin{array}{r} 6 \\ +1 \\ \hline 7 \end{array}$	$\begin{array}{r} 3 \\ +3 \\ \hline 6 \end{array}$	$\begin{array}{r} 4 \\ +7 \\ \hline 11 \end{array}$	$\begin{array}{r} 7 \\ +1 \\ \hline 8 \end{array}$	$\begin{array}{r} 2 \\ +8 \\ \hline 10 \end{array}$
J	$\begin{array}{r} 2 \\ +1 \\ \hline 3 \end{array}$	$\begin{array}{r} 7 \\ +0 \\ \hline 7 \end{array}$	$\begin{array}{r} 3 \\ +7 \\ \hline 10 \end{array}$	$\begin{array}{r} 9 \\ +2 \\ \hline 11 \end{array}$	$\begin{array}{r} 4 \\ +4 \\ \hline 8 \end{array}$	$\begin{array}{r} 0 \\ +3 \\ \hline 3 \end{array}$	$\begin{array}{r} 7 \\ +5 \\ \hline 12 \end{array}$	$\begin{array}{r} 8 \\ +1 \\ \hline 9 \end{array}$	$\begin{array}{r} 1 \\ +5 \\ \hline 6 \end{array}$	$\begin{array}{r} 7 \\ +7 \\ \hline 14 \end{array}$

# Addition Facts: Sums 0-18 Test 9+

Name \_\_\_\_\_

Minutes				
1	2	3	4	5

Score

Key

A	$\begin{array}{r} 9 \\ +5 \\ \hline 14 \end{array}$	$\begin{array}{r} 5 \\ +2 \\ \hline 7 \end{array}$	$\begin{array}{r} 2 \\ +8 \\ \hline 10 \end{array}$	$\begin{array}{r} 1 \\ +6 \\ \hline 7 \end{array}$	$\begin{array}{r} 8 \\ +4 \\ \hline 12 \end{array}$	$\begin{array}{r} 3 \\ +9 \\ \hline 12 \end{array}$	$\begin{array}{r} 0 \\ +2 \\ \hline 2 \end{array}$	$\begin{array}{r} 8 \\ +9 \\ \hline 17 \end{array}$	$\begin{array}{r} 6 \\ +6 \\ \hline 12 \end{array}$	$\begin{array}{r} 7 \\ +9 \\ \hline 16 \end{array}$
B	$\begin{array}{r} 8 \\ +5 \\ \hline 13 \end{array}$	$\begin{array}{r} 0 \\ +4 \\ \hline 4 \end{array}$	$\begin{array}{r} 7 \\ +6 \\ \hline 13 \end{array}$	$\begin{array}{r} 6 \\ +2 \\ \hline 8 \end{array}$	$\begin{array}{r} 3 \\ +2 \\ \hline 5 \end{array}$	$\begin{array}{r} 8 \\ +7 \\ \hline 15 \end{array}$	$\begin{array}{r} 4 \\ +6 \\ \hline 10 \end{array}$	$\begin{array}{r} 2 \\ +1 \\ \hline 3 \end{array}$	$\begin{array}{r} 5 \\ +8 \\ \hline 13 \end{array}$	$\begin{array}{r} 1 \\ +0 \\ \hline 1 \end{array}$
C	$\begin{array}{r} 4 \\ +2 \\ \hline 6 \end{array}$	$\begin{array}{r} 6 \\ +7 \\ \hline 13 \end{array}$	$\begin{array}{r} 2 \\ +5 \\ \hline 7 \end{array}$	$\begin{array}{r} 8 \\ +1 \\ \hline 9 \end{array}$	$\begin{array}{r} 3 \\ +5 \\ \hline 8 \end{array}$	$\begin{array}{r} 0 \\ +3 \\ \hline 3 \end{array}$	$\begin{array}{r} 7 \\ +0 \\ \hline 7 \end{array}$	$\begin{array}{r} 9 \\ +2 \\ \hline 11 \end{array}$	$\begin{array}{r} 3 \\ +7 \\ \hline 10 \end{array}$	$\begin{array}{r} 1 \\ +8 \\ \hline 9 \end{array}$
D	$\begin{array}{r} 9 \\ +8 \\ \hline 17 \end{array}$	$\begin{array}{r} 4 \\ +7 \\ \hline 11 \end{array}$	$\begin{array}{r} 3 \\ +1 \\ \hline 4 \end{array}$	$\begin{array}{r} 0 \\ +9 \\ \hline 9 \end{array}$	$\begin{array}{r} 5 \\ +7 \\ \hline 12 \end{array}$	$\begin{array}{r} 1 \\ +5 \\ \hline 6 \end{array}$	$\begin{array}{r} 7 \\ +3 \\ \hline 10 \end{array}$	$\begin{array}{r} 2 \\ +7 \\ \hline 9 \end{array}$	$\begin{array}{r} 5 \\ +0 \\ \hline 5 \end{array}$	$\begin{array}{r} 6 \\ +5 \\ \hline 11 \end{array}$
E	$\begin{array}{r} 5 \\ +3 \\ \hline 8 \end{array}$	$\begin{array}{r} 0 \\ +1 \\ \hline 1 \end{array}$	$\begin{array}{r} 4 \\ +5 \\ \hline 9 \end{array}$	$\begin{array}{r} 3 \\ +8 \\ \hline 11 \end{array}$	$\begin{array}{r} 4 \\ +1 \\ \hline 5 \end{array}$	$\begin{array}{r} 2 \\ +0 \\ \hline 2 \end{array}$	$\begin{array}{r} 6 \\ +1 \\ \hline 7 \end{array}$	$\begin{array}{r} 8 \\ +3 \\ \hline 11 \end{array}$	$\begin{array}{r} 7 \\ +8 \\ \hline 15 \end{array}$	$\begin{array}{r} 2 \\ +4 \\ \hline 6 \end{array}$
F	$\begin{array}{r} 1 \\ +7 \\ \hline 8 \end{array}$	$\begin{array}{r} 5 \\ +9 \\ \hline 14 \end{array}$	$\begin{array}{r} 9 \\ +9 \\ \hline 18 \end{array}$	$\begin{array}{r} 1 \\ +2 \\ \hline 3 \end{array}$	$\begin{array}{r} 9 \\ +7 \\ \hline 16 \end{array}$	$\begin{array}{r} 5 \\ +6 \\ \hline 11 \end{array}$	$\begin{array}{r} 3 \\ +4 \\ \hline 7 \end{array}$	$\begin{array}{r} 4 \\ +4 \\ \hline 8 \end{array}$	$\begin{array}{r} 0 \\ +7 \\ \hline 7 \end{array}$	$\begin{array}{r} 1 \\ +1 \\ \hline 2 \end{array}$
G	$\begin{array}{r} 7 \\ +4 \\ \hline 11 \end{array}$	$\begin{array}{r} 2 \\ +3 \\ \hline 5 \end{array}$	$\begin{array}{r} 5 \\ +1 \\ \hline 6 \end{array}$	$\begin{array}{r} 4 \\ +9 \\ \hline 13 \end{array}$	$\begin{array}{r} 3 \\ +0 \\ \hline 3 \end{array}$	$\begin{array}{r} 6 \\ +4 \\ \hline 10 \end{array}$	$\begin{array}{r} 0 \\ +0 \\ \hline 0 \end{array}$	$\begin{array}{r} 7 \\ +5 \\ \hline 12 \end{array}$	$\begin{array}{r} 6 \\ +9 \\ \hline 15 \end{array}$	$\begin{array}{r} 8 \\ +6 \\ \hline 14 \end{array}$
H	$\begin{array}{r} 3 \\ +6 \\ \hline 9 \end{array}$	$\begin{array}{r} 4 \\ +3 \\ \hline 7 \end{array}$	$\begin{array}{r} 0 \\ +8 \\ \hline 8 \end{array}$	$\begin{array}{r} 7 \\ +7 \\ \hline 14 \end{array}$	$\begin{array}{r} 9 \\ +1 \\ \hline 10 \end{array}$	$\begin{array}{r} 4 \\ +0 \\ \hline 4 \end{array}$	$\begin{array}{r} 2 \\ +6 \\ \hline 8 \end{array}$	$\begin{array}{r} 6 \\ +0 \\ \hline 6 \end{array}$	$\begin{array}{r} 1 \\ +4 \\ \hline 5 \end{array}$	$\begin{array}{r} 7 \\ +2 \\ \hline 9 \end{array}$
I	$\begin{array}{r} 5 \\ +5 \\ \hline 10 \end{array}$	$\begin{array}{r} 1 \\ +3 \\ \hline 4 \end{array}$	$\begin{array}{r} 9 \\ +4 \\ \hline 13 \end{array}$	$\begin{array}{r} 1 \\ +9 \\ \hline 10 \end{array}$	$\begin{array}{r} 0 \\ +6 \\ \hline 6 \end{array}$	$\begin{array}{r} 9 \\ +3 \\ \hline 12 \end{array}$	$\begin{array}{r} 8 \\ +2 \\ \hline 10 \end{array}$	$\begin{array}{r} 3 \\ +3 \\ \hline 6 \end{array}$	$\begin{array}{r} 9 \\ +6 \\ \hline 15 \end{array}$	$\begin{array}{r} 5 \\ +4 \\ \hline 9 \end{array}$
J	$\begin{array}{r} 6 \\ +3 \\ \hline 9 \end{array}$	$\begin{array}{r} 8 \\ +0 \\ \hline 8 \end{array}$	$\begin{array}{r} 2 \\ +9 \\ \hline 11 \end{array}$	$\begin{array}{r} 7 \\ +1 \\ \hline 8 \end{array}$	$\begin{array}{r} 6 \\ +8 \\ \hline 14 \end{array}$	$\begin{array}{r} 2 \\ +2 \\ \hline 4 \end{array}$	$\begin{array}{r} 8 \\ +8 \\ \hline 16 \end{array}$	$\begin{array}{r} 0 \\ +5 \\ \hline 5 \end{array}$	$\begin{array}{r} 4 \\ +8 \\ \hline 12 \end{array}$	$\begin{array}{r} 9 \\ +0 \\ \hline 9 \end{array}$

Addition Facts: Sums 0-18  
Test 10 +

Name \_\_\_\_\_

Minutes				
1	2	3	4	5

Score

*Key*

A

$\begin{array}{r} 4 \\ +8 \\ \hline 12 \end{array}$	$\begin{array}{r} 2 \\ +7 \\ \hline 9 \end{array}$	$\begin{array}{r} 9 \\ +4 \\ \hline 13 \end{array}$	$\begin{array}{r} 6 \\ +2 \\ \hline 8 \end{array}$	$\begin{array}{r} 1 \\ +1 \\ \hline 2 \end{array}$	$\begin{array}{r} 7 \\ +8 \\ \hline 15 \end{array}$	$\begin{array}{r} 5 \\ +2 \\ \hline 7 \end{array}$	$\begin{array}{r} 8 \\ +1 \\ \hline 9 \end{array}$	$\begin{array}{r} 6 \\ +8 \\ \hline 14 \end{array}$	$\begin{array}{r} 2 \\ +2 \\ \hline 4 \end{array}$
---	--	---	--	--	---	--	--	---	--

B

$\begin{array}{r} 3 \\ +9 \\ \hline 12 \end{array}$	$\begin{array}{r} 8 \\ +7 \\ \hline 15 \end{array}$	$\begin{array}{r} 4 \\ +5 \\ \hline 9 \end{array}$	$\begin{array}{r} 1 \\ +6 \\ \hline 7 \end{array}$	$\begin{array}{r} 8 \\ +4 \\ \hline 12 \end{array}$	$\begin{array}{r} 6 \\ +5 \\ \hline 11 \end{array}$	$\begin{array}{r} 0 \\ +0 \\ \hline 0 \end{array}$	$\begin{array}{r} 9 \\ +1 \\ \hline 10 \end{array}$	$\begin{array}{r} 3 \\ +1 \\ \hline 4 \end{array}$	$\begin{array}{r} 5 \\ +6 \\ \hline 11 \end{array}$
---	---	--	--	---	---	--	---	--	---

C

$\begin{array}{r} 0 \\ +2 \\ \hline 2 \end{array}$	$\begin{array}{r} 4 \\ +1 \\ \hline 5 \end{array}$	$\begin{array}{r} 7 \\ +4 \\ \hline 11 \end{array}$	$\begin{array}{r} 8 \\ +0 \\ \hline 8 \end{array}$	$\begin{array}{r} 5 \\ +3 \\ \hline 8 \end{array}$	$\begin{array}{r} 2 \\ +1 \\ \hline 3 \end{array}$	$\begin{array}{r} 7 \\ +0 \\ \hline 7 \end{array}$	$\begin{array}{r} 3 \\ +7 \\ \hline 10 \end{array}$	$\begin{array}{r} 1 \\ +3 \\ \hline 4 \end{array}$	$\begin{array}{r} 0 \\ +5 \\ \hline 5 \end{array}$
--	--	---	--	--	--	--	---	--	--

D

$\begin{array}{r} 5 \\ +1 \\ \hline 6 \end{array}$	$\begin{array}{r} 9 \\ +9 \\ \hline 18 \end{array}$	$\begin{array}{r} 3 \\ +3 \\ \hline 6 \end{array}$	$\begin{array}{r} 0 \\ +9 \\ \hline 9 \end{array}$	$\begin{array}{r} 9 \\ +8 \\ \hline 17 \end{array}$	$\begin{array}{r} 4 \\ +3 \\ \hline 7 \end{array}$	$\begin{array}{r} 6 \\ +1 \\ \hline 7 \end{array}$	$\begin{array}{r} 1 \\ +0 \\ \hline 1 \end{array}$	$\begin{array}{r} 4 \\ +7 \\ \hline 11 \end{array}$	$\begin{array}{r} 2 \\ +5 \\ \hline 7 \end{array}$
--	---	--	--	---	--	--	--	---	--

E

$\begin{array}{r} 1 \\ +2 \\ \hline 3 \end{array}$	$\begin{array}{r} 7 \\ +1 \\ \hline 8 \end{array}$	$\begin{array}{r} 2 \\ +4 \\ \hline 6 \end{array}$	$\begin{array}{r} 5 \\ +5 \\ \hline 10 \end{array}$	$\begin{array}{r} 0 \\ +3 \\ \hline 3 \end{array}$	$\begin{array}{r} 7 \\ +9 \\ \hline 16 \end{array}$	$\begin{array}{r} 4 \\ +0 \\ \hline 4 \end{array}$	$\begin{array}{r} 6 \\ +7 \\ \hline 13 \end{array}$	$\begin{array}{r} 2 \\ +9 \\ \hline 11 \end{array}$	$\begin{array}{r} 8 \\ +6 \\ \hline 14 \end{array}$
--	--	--	---	--	---	--	---	---	---

F

$\begin{array}{r} 6 \\ +4 \\ \hline 10 \end{array}$	$\begin{array}{r} 0 \\ +7 \\ \hline 7 \end{array}$	$\begin{array}{r} 9 \\ +2 \\ \hline 11 \end{array}$	$\begin{array}{r} 5 \\ +8 \\ \hline 13 \end{array}$	$\begin{array}{r} 3 \\ +6 \\ \hline 9 \end{array}$	$\begin{array}{r} 1 \\ +8 \\ \hline 9 \end{array}$	$\begin{array}{r} 9 \\ +6 \\ \hline 15 \end{array}$	$\begin{array}{r} 2 \\ +0 \\ \hline 2 \end{array}$	$\begin{array}{r} 3 \\ +4 \\ \hline 7 \end{array}$	$\begin{array}{r} 7 \\ +6 \\ \hline 13 \end{array}$
---	--	---	---	--	--	---	--	--	---

G

$\begin{array}{r} 2 \\ +8 \\ \hline 10 \end{array}$	$\begin{array}{r} 9 \\ +7 \\ \hline 16 \end{array}$	$\begin{array}{r} 4 \\ +6 \\ \hline 10 \end{array}$	$\begin{array}{r} 8 \\ +9 \\ \hline 17 \end{array}$	$\begin{array}{r} 3 \\ +0 \\ \hline 3 \end{array}$	$\begin{array}{r} 7 \\ +3 \\ \hline 10 \end{array}$	$\begin{array}{r} 5 \\ +0 \\ \hline 5 \end{array}$	$\begin{array}{r} 9 \\ +3 \\ \hline 12 \end{array}$	$\begin{array}{r} 0 \\ +6 \\ \hline 6 \end{array}$	$\begin{array}{r} 3 \\ +8 \\ \hline 11 \end{array}$
---	---	---	---	--	---	--	---	--	---

H

$\begin{array}{r} 5 \\ +9 \\ \hline 14 \end{array}$	$\begin{array}{r} 8 \\ +3 \\ \hline 11 \end{array}$	$\begin{array}{r} 0 \\ +1 \\ \hline 1 \end{array}$	$\begin{array}{r} 6 \\ +6 \\ \hline 12 \end{array}$	$\begin{array}{r} 4 \\ +2 \\ \hline 6 \end{array}$	$\begin{array}{r} 1 \\ +5 \\ \hline 6 \end{array}$	$\begin{array}{r} 9 \\ +0 \\ \hline 9 \end{array}$	$\begin{array}{r} 2 \\ +3 \\ \hline 5 \end{array}$	$\begin{array}{r} 4 \\ +4 \\ \hline 8 \end{array}$	$\begin{array}{r} 9 \\ +5 \\ \hline 14 \end{array}$
---	---	--	---	--	--	--	--	--	---

I

$\begin{array}{r} 3 \\ +5 \\ \hline 8 \end{array}$	$\begin{array}{r} 7 \\ +5 \\ \hline 12 \end{array}$	$\begin{array}{r} 8 \\ +8 \\ \hline 16 \end{array}$	$\begin{array}{r} 1 \\ +9 \\ \hline 10 \end{array}$	$\begin{array}{r} 7 \\ +7 \\ \hline 14 \end{array}$	$\begin{array}{r} 0 \\ +8 \\ \hline 8 \end{array}$	$\begin{array}{r} 6 \\ +9 \\ \hline 15 \end{array}$	$\begin{array}{r} 8 \\ +5 \\ \hline 13 \end{array}$	$\begin{array}{r} 5 \\ +4 \\ \hline 9 \end{array}$	$\begin{array}{r} 3 \\ +2 \\ \hline 5 \end{array}$
--	---	---	---	---	--	---	---	--	--

J

$\begin{array}{r} 5 \\ +7 \\ \hline 12 \end{array}$	$\begin{array}{r} 1 \\ +4 \\ \hline 5 \end{array}$	$\begin{array}{r} 8 \\ +2 \\ \hline 10 \end{array}$	$\begin{array}{r} 4 \\ +9 \\ \hline 13 \end{array}$	$\begin{array}{r} 2 \\ +6 \\ \hline 8 \end{array}$	$\begin{array}{r} 6 \\ +0 \\ \hline 6 \end{array}$	$\begin{array}{r} 7 \\ +2 \\ \hline 9 \end{array}$	$\begin{array}{r} 0 \\ +4 \\ \hline 4 \end{array}$	$\begin{array}{r} 1 \\ +7 \\ \hline 8 \end{array}$	$\begin{array}{r} 6 \\ +3 \\ \hline 9 \end{array}$
---	--	---	---	--	--	--	--	--	--

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**Addition Facts: Sums 0-18**  
**Test 11 +**

Name \_\_\_\_\_

Minutes

Score

*Key*

1	2	3	4	5
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A	$\begin{array}{r} 5 \\ +4 \\ \hline 9 \end{array}$	$\begin{array}{r} 2 \\ +3 \\ \hline 5 \end{array}$	$\begin{array}{r} 6 \\ +7 \\ \hline 13 \end{array}$	$\begin{array}{r} 7 \\ +2 \\ \hline 9 \end{array}$	$\begin{array}{r} 5 \\ +9 \\ \hline 14 \end{array}$	$\begin{array}{r} 0 \\ +7 \\ \hline 7 \end{array}$	$\begin{array}{r} 9 \\ +5 \\ \hline 14 \end{array}$	$\begin{array}{r} 3 \\ +6 \\ \hline 9 \end{array}$	$\begin{array}{r} 1 \\ +6 \\ \hline 7 \end{array}$	$\begin{array}{r} 4 \\ +8 \\ \hline 12 \end{array}$
B	$\begin{array}{r} 4 \\ +7 \\ \hline 11 \end{array}$	$\begin{array}{r} 6 \\ +3 \\ \hline 9 \end{array}$	$\begin{array}{r} 1 \\ +0 \\ \hline 1 \end{array}$	$\begin{array}{r} 4 \\ +2 \\ \hline 6 \end{array}$	$\begin{array}{r} 9 \\ +0 \\ \hline 9 \end{array}$	$\begin{array}{r} 5 \\ +3 \\ \hline 8 \end{array}$	$\begin{array}{r} 0 \\ +2 \\ \hline 2 \end{array}$	$\begin{array}{r} 3 \\ +2 \\ \hline 5 \end{array}$	$\begin{array}{r} 9 \\ +4 \\ \hline 13 \end{array}$	$\begin{array}{r} 2 \\ +5 \\ \hline 7 \end{array}$
C	$\begin{array}{r} 3 \\ +4 \\ \hline 7 \end{array}$	$\begin{array}{r} 7 \\ +9 \\ \hline 16 \end{array}$	$\begin{array}{r} 5 \\ +1 \\ \hline 6 \end{array}$	$\begin{array}{r} 6 \\ +0 \\ \hline 6 \end{array}$	$\begin{array}{r} 1 \\ +9 \\ \hline 10 \end{array}$	$\begin{array}{r} 8 \\ +2 \\ \hline 10 \end{array}$	$\begin{array}{r} 4 \\ +6 \\ \hline 10 \end{array}$	$\begin{array}{r} 1 \\ +1 \\ \hline 2 \end{array}$	$\begin{array}{r} 0 \\ +4 \\ \hline 4 \end{array}$	$\begin{array}{r} 7 \\ +7 \\ \hline 14 \end{array}$
D	$\begin{array}{r} 9 \\ +9 \\ \hline 18 \end{array}$	$\begin{array}{r} 3 \\ +7 \\ \hline 10 \end{array}$	$\begin{array}{r} 0 \\ +8 \\ \hline 8 \end{array}$	$\begin{array}{r} 6 \\ +6 \\ \hline 12 \end{array}$	$\begin{array}{r} 9 \\ +8 \\ \hline 17 \end{array}$	$\begin{array}{r} 3 \\ +0 \\ \hline 3 \end{array}$	$\begin{array}{r} 1 \\ +3 \\ \hline 4 \end{array}$	$\begin{array}{r} 7 \\ +1 \\ \hline 8 \end{array}$	$\begin{array}{r} 6 \\ +2 \\ \hline 8 \end{array}$	$\begin{array}{r} 8 \\ +9 \\ \hline 17 \end{array}$
E	$\begin{array}{r} 0 \\ +0 \\ \hline 0 \end{array}$	$\begin{array}{r} 4 \\ +3 \\ \hline 7 \end{array}$	$\begin{array}{r} 7 \\ +3 \\ \hline 10 \end{array}$	$\begin{array}{r} 1 \\ +7 \\ \hline 8 \end{array}$	$\begin{array}{r} 9 \\ +3 \\ \hline 12 \end{array}$	$\begin{array}{r} 2 \\ +4 \\ \hline 6 \end{array}$	$\begin{array}{r} 8 \\ +6 \\ \hline 14 \end{array}$	$\begin{array}{r} 4 \\ +5 \\ \hline 9 \end{array}$	$\begin{array}{r} 2 \\ +1 \\ \hline 3 \end{array}$	$\begin{array}{r} 5 \\ +8 \\ \hline 13 \end{array}$
F	$\begin{array}{r} 2 \\ +7 \\ \hline 9 \end{array}$	$\begin{array}{r} 8 \\ +0 \\ \hline 8 \end{array}$	$\begin{array}{r} 3 \\ +3 \\ \hline 6 \end{array}$	$\begin{array}{r} 8 \\ +8 \\ \hline 16 \end{array}$	$\begin{array}{r} 0 \\ +5 \\ \hline 5 \end{array}$	$\begin{array}{r} 5 \\ +2 \\ \hline 7 \end{array}$	$\begin{array}{r} 4 \\ +1 \\ \hline 5 \end{array}$	$\begin{array}{r} 7 \\ +6 \\ \hline 13 \end{array}$	$\begin{array}{r} 2 \\ +9 \\ \hline 11 \end{array}$	$\begin{array}{r} 8 \\ +4 \\ \hline 12 \end{array}$
G	$\begin{array}{r} 5 \\ +5 \\ \hline 10 \end{array}$	$\begin{array}{r} 2 \\ +2 \\ \hline 4 \end{array}$	$\begin{array}{r} 7 \\ +0 \\ \hline 7 \end{array}$	$\begin{array}{r} 1 \\ +5 \\ \hline 6 \end{array}$	$\begin{array}{r} 6 \\ +5 \\ \hline 11 \end{array}$	$\begin{array}{r} 3 \\ +8 \\ \hline 11 \end{array}$	$\begin{array}{r} 9 \\ +7 \\ \hline 16 \end{array}$	$\begin{array}{r} 0 \\ +1 \\ \hline 1 \end{array}$	$\begin{array}{r} 5 \\ +7 \\ \hline 12 \end{array}$	$\begin{array}{r} 9 \\ +2 \\ \hline 11 \end{array}$
H	$\begin{array}{r} 7 \\ +8 \\ \hline 15 \end{array}$	$\begin{array}{r} 3 \\ +1 \\ \hline 4 \end{array}$	$\begin{array}{r} 6 \\ +8 \\ \hline 14 \end{array}$	$\begin{array}{r} 4 \\ +0 \\ \hline 4 \end{array}$	$\begin{array}{r} 1 \\ +8 \\ \hline 9 \end{array}$	$\begin{array}{r} 8 \\ +3 \\ \hline 11 \end{array}$	$\begin{array}{r} 0 \\ +9 \\ \hline 9 \end{array}$	$\begin{array}{r} 6 \\ +9 \\ \hline 15 \end{array}$	$\begin{array}{r} 2 \\ +8 \\ \hline 10 \end{array}$	$\begin{array}{r} 8 \\ +7 \\ \hline 15 \end{array}$
I	$\begin{array}{r} 6 \\ +1 \\ \hline 7 \end{array}$	$\begin{array}{r} 0 \\ +3 \\ \hline 3 \end{array}$	$\begin{array}{r} 4 \\ +4 \\ \hline 8 \end{array}$	$\begin{array}{r} 3 \\ +5 \\ \hline 8 \end{array}$	$\begin{array}{r} 5 \\ +0 \\ \hline 5 \end{array}$	$\begin{array}{r} 7 \\ +5 \\ \hline 12 \end{array}$	$\begin{array}{r} 9 \\ +1 \\ \hline 10 \end{array}$	$\begin{array}{r} 2 \\ +0 \\ \hline 2 \end{array}$	$\begin{array}{r} 8 \\ +5 \\ \hline 13 \end{array}$	$\begin{array}{r} 1 \\ +2 \\ \hline 3 \end{array}$
J	$\begin{array}{r} 1 \\ +4 \\ \hline 5 \end{array}$	$\begin{array}{r} 9 \\ +6 \\ \hline 15 \end{array}$	$\begin{array}{r} 3 \\ +9 \\ \hline 12 \end{array}$	$\begin{array}{r} 5 \\ +6 \\ \hline 11 \end{array}$	$\begin{array}{r} 4 \\ +9 \\ \hline 13 \end{array}$	$\begin{array}{r} 0 \\ +6 \\ \hline 6 \end{array}$	$\begin{array}{r} 6 \\ +4 \\ \hline 10 \end{array}$	$\begin{array}{r} 7 \\ +4 \\ \hline 11 \end{array}$	$\begin{array}{r} 2 \\ +6 \\ \hline 8 \end{array}$	$\begin{array}{r} 8 \\ +1 \\ \hline 9 \end{array}$

Addition Facts: Sums 0-18  
Test 12+

Name \_\_\_\_\_

Minutes				
1	2	3	4	5

Score

*Key*

A	$\begin{array}{r} 4 \\ +4 \\ \hline 8 \end{array}$	$\begin{array}{r} 0 \\ +2 \\ \hline 2 \end{array}$	$\begin{array}{r} 7 \\ +3 \\ \hline 10 \end{array}$	$\begin{array}{r} 9 \\ +2 \\ \hline 11 \end{array}$	$\begin{array}{r} 2 \\ +9 \\ \hline 11 \end{array}$	$\begin{array}{r} 7 \\ +8 \\ \hline 15 \end{array}$	$\begin{array}{r} 5 \\ +9 \\ \hline 14 \end{array}$	$\begin{array}{r} 1 \\ +8 \\ \hline 9 \end{array}$	$\begin{array}{r} 8 \\ +3 \\ \hline 11 \end{array}$	$\begin{array}{r} 5 \\ +2 \\ \hline 7 \end{array}$
B	$\begin{array}{r} 9 \\ +6 \\ \hline 15 \end{array}$	$\begin{array}{r} 4 \\ +9 \\ \hline 13 \end{array}$	$\begin{array}{r} 1 \\ +5 \\ \hline 6 \end{array}$	$\begin{array}{r} 9 \\ +9 \\ \hline 18 \end{array}$	$\begin{array}{r} 7 \\ +1 \\ \hline 8 \end{array}$	$\begin{array}{r} 3 \\ +5 \\ \hline 8 \end{array}$	$\begin{array}{r} 9 \\ +0 \\ \hline 9 \end{array}$	$\begin{array}{r} 2 \\ +1 \\ \hline 3 \end{array}$	$\begin{array}{r} 4 \\ +6 \\ \hline 10 \end{array}$	$\begin{array}{r} 0 \\ +6 \\ \hline 6 \end{array}$
C	$\begin{array}{r} 6 \\ +1 \\ \hline 7 \end{array}$	$\begin{array}{r} 2 \\ +2 \\ \hline 4 \end{array}$	$\begin{array}{r} 5 \\ +0 \\ \hline 5 \end{array}$	$\begin{array}{r} 6 \\ +6 \\ \hline 12 \end{array}$	$\begin{array}{r} 3 \\ +7 \\ \hline 10 \end{array}$	$\begin{array}{r} 0 \\ +4 \\ \hline 4 \end{array}$	$\begin{array}{r} 8 \\ +5 \\ \hline 13 \end{array}$	$\begin{array}{r} 6 \\ +8 \\ \hline 14 \end{array}$	$\begin{array}{r} 2 \\ +5 \\ \hline 7 \end{array}$	$\begin{array}{r} 4 \\ +3 \\ \hline 7 \end{array}$
D	$\begin{array}{r} 4 \\ +7 \\ \hline 11 \end{array}$	$\begin{array}{r} 9 \\ +8 \\ \hline 17 \end{array}$	$\begin{array}{r} 1 \\ +0 \\ \hline 1 \end{array}$	$\begin{array}{r} 5 \\ +3 \\ \hline 8 \end{array}$	$\begin{array}{r} 8 \\ +9 \\ \hline 17 \end{array}$	$\begin{array}{r} 4 \\ +1 \\ \hline 5 \end{array}$	$\begin{array}{r} 3 \\ +0 \\ \hline 3 \end{array}$	$\begin{array}{r} 7 \\ +5 \\ \hline 12 \end{array}$	$\begin{array}{r} 0 \\ +1 \\ \hline 1 \end{array}$	$\begin{array}{r} 7 \\ +9 \\ \hline 16 \end{array}$
E	$\begin{array}{r} 1 \\ +7 \\ \hline 8 \end{array}$	$\begin{array}{r} 5 \\ +6 \\ \hline 11 \end{array}$	$\begin{array}{r} 2 \\ +4 \\ \hline 6 \end{array}$	$\begin{array}{r} 8 \\ +7 \\ \hline 15 \end{array}$	$\begin{array}{r} 0 \\ +9 \\ \hline 9 \end{array}$	$\begin{array}{r} 5 \\ +8 \\ \hline 13 \end{array}$	$\begin{array}{r} 6 \\ +0 \\ \hline 6 \end{array}$	$\begin{array}{r} 1 \\ +2 \\ \hline 3 \end{array}$	$\begin{array}{r} 6 \\ +3 \\ \hline 9 \end{array}$	$\begin{array}{r} 2 \\ +8 \\ \hline 10 \end{array}$
F	$\begin{array}{r} 2 \\ +7 \\ \hline 9 \end{array}$	$\begin{array}{r} 8 \\ +4 \\ \hline 12 \end{array}$	$\begin{array}{r} 3 \\ +2 \\ \hline 5 \end{array}$	$\begin{array}{r} 0 \\ +5 \\ \hline 5 \end{array}$	$\begin{array}{r} 9 \\ +4 \\ \hline 13 \end{array}$	$\begin{array}{r} 8 \\ +0 \\ \hline 8 \end{array}$	$\begin{array}{r} 1 \\ +6 \\ \hline 7 \end{array}$	$\begin{array}{r} 9 \\ +5 \\ \hline 14 \end{array}$	$\begin{array}{r} 4 \\ +8 \\ \hline 12 \end{array}$	$\begin{array}{r} 5 \\ +5 \\ \hline 10 \end{array}$
G	$\begin{array}{r} 6 \\ +7 \\ \hline 13 \end{array}$	$\begin{array}{r} 7 \\ +4 \\ \hline 11 \end{array}$	$\begin{array}{r} 2 \\ +0 \\ \hline 2 \end{array}$	$\begin{array}{r} 8 \\ +2 \\ \hline 10 \end{array}$	$\begin{array}{r} 1 \\ +4 \\ \hline 5 \end{array}$	$\begin{array}{r} 6 \\ +5 \\ \hline 11 \end{array}$	$\begin{array}{r} 3 \\ +6 \\ \hline 9 \end{array}$	$\begin{array}{r} 5 \\ +1 \\ \hline 6 \end{array}$	$\begin{array}{r} 0 \\ +8 \\ \hline 8 \end{array}$	$\begin{array}{r} 3 \\ +1 \\ \hline 4 \end{array}$
H	$\begin{array}{r} 0 \\ +3 \\ \hline 3 \end{array}$	$\begin{array}{r} 4 \\ +5 \\ \hline 9 \end{array}$	$\begin{array}{r} 7 \\ +2 \\ \hline 9 \end{array}$	$\begin{array}{r} 3 \\ +4 \\ \hline 7 \end{array}$	$\begin{array}{r} 9 \\ +1 \\ \hline 10 \end{array}$	$\begin{array}{r} 7 \\ +6 \\ \hline 13 \end{array}$	$\begin{array}{r} 2 \\ +3 \\ \hline 5 \end{array}$	$\begin{array}{r} 1 \\ +1 \\ \hline 2 \end{array}$	$\begin{array}{r} 7 \\ +0 \\ \hline 7 \end{array}$	$\begin{array}{r} 3 \\ +9 \\ \hline 12 \end{array}$
I	$\begin{array}{r} 5 \\ +4 \\ \hline 9 \end{array}$	$\begin{array}{r} 6 \\ +2 \\ \hline 8 \end{array}$	$\begin{array}{r} 4 \\ +0 \\ \hline 4 \end{array}$	$\begin{array}{r} 1 \\ +9 \\ \hline 10 \end{array}$	$\begin{array}{r} 9 \\ +7 \\ \hline 16 \end{array}$	$\begin{array}{r} 0 \\ +0 \\ \hline 0 \end{array}$	$\begin{array}{r} 9 \\ +3 \\ \hline 12 \end{array}$	$\begin{array}{r} 6 \\ +9 \\ \hline 15 \end{array}$	$\begin{array}{r} 7 \\ +7 \\ \hline 14 \end{array}$	$\begin{array}{r} 4 \\ +2 \\ \hline 6 \end{array}$
J	$\begin{array}{r} 1 \\ +3 \\ \hline 4 \end{array}$	$\begin{array}{r} 8 \\ +1 \\ \hline 9 \end{array}$	$\begin{array}{r} 0 \\ +7 \\ \hline 7 \end{array}$	$\begin{array}{r} 8 \\ +8 \\ \hline 16 \end{array}$	$\begin{array}{r} 3 \\ +8 \\ \hline 11 \end{array}$	$\begin{array}{r} 6 \\ +4 \\ \hline 10 \end{array}$	$\begin{array}{r} 5 \\ +7 \\ \hline 12 \end{array}$	$\begin{array}{r} 3 \\ +3 \\ \hline 6 \end{array}$	$\begin{array}{r} 2 \\ +6 \\ \hline 8 \end{array}$	$\begin{array}{r} 8 \\ +6 \\ \hline 14 \end{array}$

Carson Dellosa Publ. CD 0924

Appendix B  
Approval Letter From the Human Subjects  
Institutional Review Board

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WESTERN MICHIGAN UNIVERSITY

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TO: Paula Frandsen  
FROM: Ellen Page-Robin, Chair *EP-R*  
RE: Research Protocol  
DATE: March 31, 1989

This letter will serve as confirmation that your research protocol, "Computer assisted drill and practice as an instructional aid to increasing rate of acquisition of addition math facts," has been approved as exempt by the HSIRB.

If you have any further questions, please contact me at 387-2647.

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