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ABSTRACT

The final report presents a quarter-by-quarter analysis of results in a project designed to develop and implement a microcomputer-based management system for resource room teachers of mainstreamed mildlly handicapped secondary students. Information was to consist of updated daily records of instructional activities and of the individual student program in each subject area in both regular and resource classes. Quarterly reports address site development activities, computer systems information, data collection and analysis tasks, and computer software information. Teachers had access to an individualized education program system which enhanced daily lesson planning, and were trained to use two software programs: a reading assessment and progress evaluation program and a math assessment and tutorial program. Among major findings were that teachers were able to record and monitor student academic performances via microcomputers; that teachers readily accepted and used certain non-time consuming software programs; and that a math achievement software program contributed to significant achievement improvement of mildly handicapped middle school students. (CL)

FINAL REPORT

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EVALUATING AND PROVIDING FEEDBACK ON THE EFFECTIVENESS OF INSTRUCTION FOR HANDICAPPED CHILDREN INTEGRATED IN INNER-CITY SECONDARY SCHOOLS

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YEAR ONE

YEAR ONE QUARTER ONE

This project was undertaken to develop, implement and evaluate a systematic data management and information system utilizing microcomputers to provide resource room teachers of mainstreamed mildly handicapped high school pupils with updated daily records of instructional activities and of the individual student program in each subject area in both regular and resource room classrooms. Project activities during the first quarter focused on the identification of variables, the collection of assessment information, the development of measures of classroom effectiveness, development of a data collection system and the development of the microcomputer system.

Identification of Variables

The review of literature regarding the identification of variables which have been shown to be accurate indices of the student the student performance focused on the Academic Learning Time Literature (Denham and Lieberman, 1980; Fisher, Berliner, Filby, Marliave, Cahen, Deshaw and More, 1978; Rieth, Polsgrove and Semmel, 1979; and Rosenshine, 1978), and the Follow Through Literature (Bissel, 1976 and Stallings, 1975). Based upon these reviews, the following variables were chosen for study: Allocation time, engagement time, level of difficulty, and level of success.

Allocation Time was defined as the amount of time during the school day that teachers set aside for instruction in a specific instructional area. This variable was included since Fisher, et. al., 1978, found that the amount of time that teachers allocated to instruction in a specific academic area is positively associated with learning in that area. They indicated further that, all things being equal, the more time allocated to academic content the higher the students' achievement.

In this study, the experimenters decided to interview teachers to obtain data regarding the amount of time allocated per day and per week in each subject matter area. In the resource room, the experimenters decided to record the amount of time allocated for reading and math instruction while in the regular classroom the amount of time allocated for instruction in the various content areas of mathematics, social studies, and science were to be recorded. After the initial data were collected, the resource room teacher was to be responsible for reporting any changes in schedule which would alter the amount of instructional time allocated since he/she is required to maintain communication with regular classroom teachers regarding the instructional program provided to mainstreamed special education students. In addition, the experimenters were to independently monitor the amount of time allocated for instruction. These reliability checks were to be conducted unobtrusively by school and project personnel on allocation times reported.

In the Fisher, et. al. study, Engagement Time was defined as the amount of time the student spent paying attention to the task and actively engaged in a task. These investigators reported that "the proportion of allocated time that students are engaged (in academic activity) is positively associated with learning." Thus one could conclude that students who pay greater attention to a task learn more. These data, however, are prohibitively expensive to collect since they entail the collection of observational data. Consequently, the investigators were to collect data documenting the time that students are actually engaged in seatwork activities and estimates of time spent on reading and discussion activities.

A system was developed to document the actual amount of time that students actively engage in seatwork activities. The system called for recording the amount of time elapsed between teacher's initial instructional assignment and the student's completion of the assignment. This was to be accomplished by providing the student with an assignment sheet (a duplicate of the teacher's lesson plan) which specified the curricular materials and pages assigned. The student was to record the time he/she began each activity and then record the time they completed the instructional assignment. Reliability checks were to be collected systematically to verity the accuracy of the student's self-recording. Reliability procedures were to consist of the teacher, an aide, or another student independently but concurrently recording the time the students began their academic assignments, and recording the time when the student completes the paper which is signitied by placing the paper in a tote tray on the teacher's desk. These data were to be recorded on a daily data sheet by the resource room teacher. The students were to be trained to reliably self-record these data. In the case of students who spend time in the regular classroom, the recording and the reliability procedures were to be implemented to ensure accurate reporting. The time spent on all academic activities in the resource room were to be measured by reviewing worksheets, silent reading activities, reading comprehension activities, language art activities (writing term or theme papers), math seatwork activities (computation, word problems), social studies and science, reading assignments and seatwork. The accuracy of assignment completion was to be monitored.

We also planned to measure the Level of Difficulty of Academic Content. One measure considered was to measure the readability of the academic material assigned to the student and compare and contrast that data with the informal data collected on the student's academic repetoire. Readability was to be calculated using a computer-based readability program originally developed by General Motors Corporation (Walker and Boillot, 1979). The calculation of the readability level of all assigned reading material was to be obtained simply by typing randomly selected samples of it into a TRS 80 computer and activating the Dale-Chall and the GMC program. The machine was to calculate the readability of various passages and makes it available via a computer screen or hard copy. These data could then stored for distribution later to teachers who can compare the readability level of a students' assigned with the student's level of reading as measured by standardized achievement tests. Such a system enables teachers to identify discrepancies in students which would warrant program modification. Data were to be collected by analyzing the texts students were assigned to use in the various content areas.

Success Rate as described by Fisher, et. al. (1975) was a measure of the degree to which students correctly understand the assigned instructional tasks. Three broad levels of success on a task were identified. High success describes situations where the student has a good grasp of the task and only makes occasional careless errors. If a student does not understand the task and makes correct responses at about the chance level, then this situation is labeled low success. Situations that fall between low and high success are defined as medium success. Medium success involves a situation of partial understanding, where the student understands enough to produce some correct responses, but also commits errors due to limitations in his/her understanding of the task. Overall, it was found that the more time the student spent on high success material the higher his/her achievement. The measurement involved recording the accuracy attained on daily academic assignments and comparing the readability level of the academic content material with the students reading repetoire.

Initially, in order to maximize the probability of placing students in the appropriate success level material, the staff relied heavily upon criterion referenced assessment instruments to pinpoint the students academic repetoire. This facilitated accurate assignment of the pupil's academic program; Lovitt (1977) has indicated that by directly and frequently measuring the target skills and by carefully studying the child's response patterns the teacher can learn the breadth and consistency of the problem and discern error patterns. Thus, the teacher will know why the pupil is not behaving as he/she should and can make the appropriate modifications. This variable was measured by collecting data regarding the type, amount and accuracy of work that the pupil completes.

Assessment Data Collection

Assessment data were collected on thirty 10th and 11th grade level students at Arlington High School during the first quarter of the project. The data collected include norm-referenced measures of achievement in reading and mathematics using the Stanford Diagnostic Reading and Math Test and criterion referenced measures using an informal reading inventory and an informal math computation test.

The identification of idiosynchratic pupil scheduling systems employed at Arlington High School, however, resulted in a decision to select twenty additional students from another school. This decision was precipitated by the findings that many of the initial thirty students selected at Arlington High School were placed in academic classes outside of the resource room that were staffed by certified special education teachers. Thus, many students were enrolled in a series of content specific resource rooms, rather than truly integrated into mainstreamed regular classroom settings.

Measures of Classroom Effectiveness

Some of the measures of classroom effectiveness that were initially selected for study have been mentioned in the previous section. Those included teacher allocation plan data, and the permanent academic products that students produce daily, reports of the number of pages assigned, the amount of time spent on reading and recitation assignments, and measures of the type of instruction that is provided to teach various academic concepts. These data were intended to provide a gross analysis of the impact of type of instruction on accuracy of student assignments.

Development of the Data Collection System

The data collection system developed was tied directly to a daily activity form which was completed in part by the teacher and the student (see figures 1 and 2). The sheet provided a recording of the instructional materials being used, the instructional objective, the pages assigned, the length of time the student spent on the task, the number of items assigned and completed and the accuracy of the students answers. Initially, the form was completed by the resource teacher while students were being trained to self-record data. The form was field tested in the resource room before initiating its use in the regular classrooms in order to streamline the recording procedures. Presently, approximately five minutes of teacher time per pupil is required to complete the form. Since most teachers were assigned responsibility for 30 to 40 students, planning and recording time required a total of 90 to 120 minutes per day. The intention was to reduce the time to enable the teacher to complete the instructional planning and monitoring within the planning periods provided during the school day and immediately after the school day terminates. Then the data collection system was to be expanded to the regular classes. Preliminary data suggested that time required to fill out forms is a critical variable in teacher cooperation.

As part of our plan, the data activity forms were to be collected by the data manager once they were completed by the teacher. Although the data were initially recorded manually, a computer program was later developed for excecution, monitoring and

FIGURE 1

DAILY ACTIVITY FORM

Student ______________________ Date ____________

A	TI	MATERIALS	PAGES		TIME		ITEMS		Cor-rect	% Cor-rect
			Begin	End	Begin	End	Assigned	Completed		

SA - Subject Area Code

R - Reading
M - Math
S - Spelling
C - Composition
SS- Social Studies
SC- Science

TI - Type of Instruction

(1) Lecture
(2) Modelling
(3) Prompting
(4) Self-instructional
(5) Discussion
(6) Peer Tutoring
(7) Teacher Tutoring
(8) Teaching Machine

Taken from Year 1 Quarter 1

FIGURE 2

**** Database Management System Time-Probe-Step Daily Activity Coding Sheet

Student: Student Number: School:

Teacher: Teacher Number: IEP Date:

TPS Date	Instr Area	Skill	LRO Name/Number	SRO Name/Number	Perf Type	Time Spent in minutes	Score	Status	Method Type	Ref Test	Material

Instructional Area Codes
(1) Language Arts
(2) Math
(3) Spelling
(4) Composition
(5) Life Skills

Skill Codes
(1) to (10)
See individual instructional area manuscripts for skill numbers.

Method Codes
(1) Lecture
(2) Modelling
(3) Prompting
(4) Self-Instruction
(5) Discussion
(6) Peer Tutoring
(7) Teacher Tutoring
(8) Teaching Machine

Performance Code
(1) NRM
(2) CRM

Status Codes (1) Completed (2) Not Completed

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storage. The ultimate goal was to develop a system allowing the teacher to enter data and subsequently receive a profile of the data as well as an analysis of the readability level of materials to be used subsequently. Thus, the teacher will be informed of the suitability of the reading level compared to the students assessed repertoire. This comparison was to serve as a basis for deciding the appropriateness of the instructional activities.

The computerized form of codified instructional objectives developed later in the project allowed the monitoring of the pupils rate of progress within specifically developed hierarchies of instructional objectives. This system allowed teachers to have access to indices of pupil progress by measuring rate of mastering objectives over time.

Development of the Microcomputer System

As specified in the proposal, data management system activities were divided into two stages of development: The hardware identification and selection stage; and the software design and development stage.

1. Hardware identification and selection. The project identified and selected a Radio Shack TRS-80 Model I microcomputer system for the primary school-based user interface for performing data entry, data summary and analysis, and data retrieval functions. These microcomputer systems are readily available, well documented, maintained through local Radio Shack dealerships, currently purchased by many school systems, and very cost effective. The microcomputer identified for the project was a Level II CPU, dual disk drive, 48K

RAM. The system was designed to be connected through an acoustic-coupled telephone line to a time-sharing computer system for transmitting all student data from each local site to the integrated database. The integrated database was then be available for extensive longitudinal analysis by the project investigators for program evaluation and a more comprehensive analysis of long-range individual student performance.

The time-sharing system identified to store IEP objectives and materials matches were located at the Bloomington Academic Computing Services at Indiana University. This system was accessible through local telephone communications from the Indianapolis school sites. The database system employed was the Scientific Information Retrieval System (SIR) which was designed for interface directly to major statistical computer packages such as SPSS and BMOP storage, EIA communications interface. As many school systems already have TRS-80 Level I or II systems currently in use for mathematics and science classes for instructional purposes. The low-cost expansion of disk drive(s), RAM memory, communication interface, and printer to these systems provided the configuration necessary to perform the data management functions currently under design and development.

2. <u>Data management software design and development.</u> Current efforts on software system design have been directed toward the identification of database structure to be employed for an efficient method of data storage and retrieval. Early in the system design, it was apparent that the problem of data integration across students and classrooms would better be served by establishing a communications network into a large time-sharing computer facility for large file

data storage and longitudinal data analysis. Individual student data analysis was, however, confined to the microcomputer system located at the individual school site. Employing a telephone data communication network allowed periodic transfer of student data into a large integrated database which provided a more efficient method of performing individual and group data analysis procedures.

The individual microcomputer systems installed at the school site provided the primary interface between the teacher (user) and the student information entered, summarized, and retrieved by the teacher. Individual student data was stored and retrieved from individual data diskettes through a conversationally prompted system at each local site as specified.

The student data storage and retrieval system for the local site microcomputers was designed to contain student information on individual diskettes with data analysis and report generation functions directed towards providing the teacher with an efficient system to provide feedback on the effectiveness of instruction on individual handicapped children.

YEAR ONE QUARTER TWO

Site Development Activities

First quarter implementation activities occured at Arlington High School, but due to idiosyncratic scheduling patterns, students spent little time in regular class. Consequently, a second site was added to obtain data that was more representative of mainstream academic settings. Considerable time was spent establishing contacts, gaining administrative approval and developing working relationships with personnel at North Central High School, our second project site. North Central had a total of 3,200 students, about 250 of whom were identified as special education students. Approximately 100 other students are receiving services of remedial reading teachers through Title I and other programs.

Through a series of planning meetings, we identified a coterie of special class resource room teachers, regular teachers, and special project teachers who agreed to participate in the development of our student activity and data monitoring system. Students assigned to resource rooms were selected for inclusion in the project. Resource room teachers, primarily because it is in their current workscope, coordinated the planning and monitoring activities. Student performance information was be submitted to the resource room teacher for compilation and dissemination.

Development Assessment Measures

During the second quarter, instruments were developed to continuously monitor student progress. These monitoring instruments consisted of a series of reading and math probes administered bi-weekly. Reading probes consisted of 100 word passages taken from currently assigned texts or from comparable texts with the same reading level. Initially, students' oral reading of the passages were tape recorded, and the number of words read correctly per minute and the number of errors made per minute were scored and graphed as measures of student progress. In addition, students were asked comprehension questions on the content of the reading passage. These comprehension questions focused primarily on recalling detail, sequencing, and analysis (see Figure 3).

Math probes, which consisted of timed trials on problems similar to those included in the initial math assessment, were administered. The probe results are graphed as the number of digits correct and incorrect per minute. These data were used as additional indices of program effectiveness (see Figure 4).

A revised version of the daily coding sheet was developed (see Figure 5). This sheet included the list of instructional materials that the teacher uses, the instructional level of these materials, the pages assigned, an indication of the amount of time that the student spent on the task, the number of items assigned, the number of items completed and the number of items correct and incorrect. These data are used for calculating percentage and rate, which were indices used to directly monitor pupil performance and to indirectly monitor teacher behaviors.

Development of Data Collection Systems

A major activity during this second quarter was the development,

FIGURE 3

READING POWER 6
Pages 389-390

Does Anyone Live Out There?

When you look up at the stars and study their movements across the heavens for a long time, you cannot help noticing that most of the stars move in a regular and orderly way. Here, in the northern hemisphere, they appear to rotate clockwise around the North Star, called Polaris by astronomers. In fact, their movement around Polaris is so regular that you can measure the seasons on Earth by the positions of the different constellations like the Big Dipper or Orion, the hunter.

Most of the stars move in this orderly manner, but some of them don't. Some, among the brightest stars in the sky, seem to wander about aimlessly.

Reading Power 6 - Does Anyone Live Out There?

1. What word in the story means a group of stars?

2. "Most of the stars move in this orderly manner, but some of them don't." What does the word "some" refer to?

3. What word in the story means without direction or purpose?

4. What is the point around which the stars seem to rotate?

5. What do astronomers call the North Star?

6. Find the sentence that says how you can measure the seasons on Earth.

7. What sentence in the story leads you to believe that not all stars rotate in an orderly manner?

8. What do we notice about most stars?

9. What is an astronomer's job?

10. Which word does not belong?

    a. Big Dipper
    b. Orion
    c. Polaris

NAME________________________________ GRADE________________________ DATE________

ADDITION FACTS ANSWERS 11 - 18

ORIGINATOR: SST

PROBE

																				PROB. DIGIT
8	8	4	7	2	4	6	9	8	8	3	8	8	4	2	4	6	7	9	8	(20)
+5	+3	+8	+6	+9	+7	+6	+9	+8	+9	+8	+5	+3	+7	+9	+9	+8	+7	+3	+7	(40)
6	2	7	7	8	2	5	5	6	7	4	7	8	6	7	8	9	5	9	8	(40)
+5	+9	+9	+6	+3	+9	+8	+9	+7	+7	+8	+5	+5	+9	+4	+7	+7	+6	+3	+9	(80)
9	8	7	4	9	9	8	7	6	8	7	9	8	5	6	6	7	8	8	6	(60)
+2	+8	+4	+9	+8	+9	+8	+6	+8	+5	+5	+4	+6	+8	+7	+9	+7	+9	+4	+6	(120)
9	7	3	4	8	8	9	4	7	9	9	4	9	6	8	7	2	4	8	8	(80)
+4	+6	+9	+7	+3	+9	+8	+9	+7	+2	+7	+9	+5	+8	+6	+7	+9	+7	+3	+5	(160)
8	6	7	8	9	4	7	8	7	3	2	8	7	8	8	4	6	5	8	7	(100)
+3	+8	+5	+8	+4	+8	+7	+5	+6	+9	+9	+7	+4	+5	+3	+7	+5	+7	+5	+9	(200)
8	9	5	9	8	7	6	8	7	4	7	6	5	5	2	8	7	7	2	6	(120)
+9	+3	+6	+7	+7	+4	+9	+5	+5	+8	+7	+7	+9	+8	+9	+3	+6	+9	+9	+5	(240)
8	9	7	6	4	2	4	8	9	3	8	8	9	6	4	2	7	4	8	8	(140)
+7	+3	+7	+8	+9	+9	+7	+3	+5	+8	+9	+8	+9	+6	+7	+9	+6	+8	+3	+5	(280)

FIGURE 4

**** Student Activity Management System Daily Coding Sheet ****

Student Name/Number -

Date -

Class Code	Material Code Name/Level/Page(s)	Instr Method Code	Time Started	Time Stopped	Problems or Pages(s) Assigned	Pages Completed or Problems CORRECT	Problems INCORRECT

Class Codes
(1) Reading
(2) Spelling
(3) Writing
(4) Social Studies
(5) General Science
(6) Math
(7) Biology

Instructional Method Codes

(1) Lecture	(2) Textbook
(3) Worksheet	(4) Workbook
(5) Discussion	(6) Peer Tutoring
(7) Teacher Tutoring	(8) Teaching Machine
(9) Films	(10) TV
(11) Assembly	(12) Instructional Game
(13) Library Work	(14) Lab Work
(15) Composition	

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FIGURE 5

evaluation and modification of the student performance data collection system. This was focused, in particular, on the development of new procedures to allow teachers to record daily student performance information and their revisions of the instructional activities recording sheet directly on the computer to reduce data recording time. Estimates of teacher data entry time indicated that teachers could complete information on this sheet or enter the same data directly on the computer for instruction received in the resource room, depending on the number of entries, at a rate of one to two minutes per pupil. This represented a substantial reduction from the initial ten minutes per student required to enter the data. These prototypical developments and subsequent testing occurred in the resource rooms. Given the cooperation of resource room teachers, we decided to field test the recording sheet in these settings and work the recording process before approaching regular classroom teachers with the system. A major project goal attained during the second quarter was the training of the resource teacher to enter data directly into the microcomputer. Previously, the data were entered by a data manager. Currently, resource room teachers are beginning to do their daily plans directly on the microcomputer, as well as entering the results of the instruction for a particular day at the first site.

The collection process centered around the Student Activity Management System Daily Coding Sheet, which was piloted in November, 1980. Subsequent revisions of the coding sheet were made after teachers had recorded the data for several months. The amount of teacher time required to complete the sheet was a major problem and was reduced substantially, based on teacher feedback. The final version (see Figure 6) allowed the resource teacher, the regular class teacher, the student or a combination of students and teachers to easily complete the form. Flexibility was designed to accomodate the idiosyncratic differences between teachers and their style of entry and the students' ability to reliably provide the data requested on the sheet. A couple of noteworthy breakthroughs that enabled the teachers to save time in monitoring the students' performance were: 1) The elimination of the process of computing the percent correct or rate of student performance for each activity (this is automatically calculated by the computer) and 2) the transfer of student demographic data to the microcomputer from student records kept by the larger on-site computer. The microcomputer software allowed the teacher to retrieve information regarding the student's demograhic profile, daily attendance record, schedule of after-school activities, class schedules, previous test results, placement history, IEP information and much of the information currently incorporated into the cumulative files, such as previous schools attended, attendance patterns, grades and previous psychological and educational assessment results. This system was secured to allow only authorized school personnel to gain access to the student records.

Operationally, the system involved the resource teacher inserting the program diskette and the individual student diskette, and then initiating the program. The teacher then automatically was presented with a summary of the last five days of student activities across all subject matter areas. She/he can then entered a particular day's

FIGURE 6

```
**********************************************************************************
UDENT ACTIVITY MANAGEMENT SYSTEM / DAILY ACTIVITY REPORT

UDENT: John Doe              /  # 1
X: M
RTHDATE:  3/ 3/64
DRESS: 3209 EAST 10TH APT 15A
       BLOOMINGTON IN  47401
----------------------------------------------------------------------------------
ASS: READING / PERIOD:  2  / TEACHER: WATKINS-#224

TE          MATERIAL/LVL/PG(S)        SCORE        TIME METHOD

 2/ 4/81 LENNES       3 21-25        100% /    0 670 WORKBOOK
 2/ 3/81 MERRILL      7 10-35         86% /    0  20 TEXTBOOK
 2/ 2/81 LENNES RDR   6 25-35        100% /    0  12 TEXTBOOK
 2/ 1/81 LENNES RDR   6 12-22        100% /    0  14 TEXTBOOK
----------------------------------------------------------------------------------
ASS: SPELLING / PERIOD:  4  / TEACHER: GLENN-#797

TE          MATERIAL/LVL/PG(S)        SCORE        TIME METHOD

 2/ 2/81 SPELLME      4 10-12        100% /    0  10 WORKBOOK
 2/ 1/81 DR SPELLO    2 1-3           75% /    1   9 WORKBOOK
----------------------------------------------------------------------------------
ASS: WRITING / PERIOD:  1  / TEACHER: FARBY-#343

TE          MATERIAL/LVL/PG(S)        SCORE        TIME METHOD

 2/ 1/81 LETTER       0 0            100% /    0  30 COMPOSITION
----------------------------------------------------------------------------------
ASS: SOCIAL STUDIES / PERIOD:  6  / TEACHER: TARBELL-#2

TE          MATERIAL/LVL/PG(S)        SCORE        TIME METHOD

 NO DAILY ACTIVITIES FOUND <<
----------------------------------------------------------------------------------
ASS: GENERAL SCIENCE / PERIOD:  7  / TEACHER: ERLICK-#101

TE          MATERIAL/LVL/PG(S)        SCORE        TIME METHOD

 NO DAILY ACTIVITIES FOUND <<
----------------------------------------------------------------------------------
ASS: MATH / PERIOD:  3  / TEACHER: SMITH-#444

TE          MATERIAL/LVL/PG(S)        SCORE        TIME METHOD

 NO DAILY ACTIVITIES FOUND <<
----------------------------------------------------------------------------------
ASS: BIOLOGY / PERIOD:  0  / TEACHER:

TE          MATERIAL/LVL/PG(S)        SCORE        TIME METHOD

 NO DAILY ACTIVITIES FOUND <<
**********************************************************************************

** PLEASE NOTE ****
TIVITY DATES MARKED WITH '*' INDICATE THAT THE ACTIVITY WAS COMPLETED.

PORT COMPLETED *
```

activities, specifically listing the materials assigned to the student, the pages, the readability level of the material, the amount of time the student spent on a task, the items assigned, the number correct and the number incorrect. Once student assignments were collected and graded, the information could be coded into the machine and daily summary reports generated. We have found in the initial sets of demonstrations and the prototypical program that there was a considerable degree of variability regarding teacher attention to the information presented on the machine. The data presented in Figures 7 & 8 suggest that at present, teachers have moved students into higher level content without their completing appropriate lower level content.

Subsequently, the investigators will evaluate the impact of a variety of formats and reporting procedures on teacher behavior. Data will be collected to determine if teachers modified student programs after being informed by the computer print out that the student did not complete or performed poorly on assignments. To aid the teacher in making informed decisions, the daily activity forms and reports will be presented cumulatively with the last daily activity placed at the top of the report form for each class so that the teacher has quick access to the activities and results she or he logs over the last four days. Another facet of the data collection system will involve the development of data collection sheets and graphs for the areas of reading and mathematics. These forms will enable the principal investigators and teachers to have both formal and test data available to them in a tabular summarized form for making project and instructional decisions. These forms will be

FIGURE 7

```
*********************************************************************************
SKILL: STUDY SKILLS
LRO                    SRO                    STATUS      TOTAL  TPS
---                    ---                    ------      -----  ---

FOLOWDIREC 1
                       HOBBYDIRS 1            COMPLETED            1
*********************************************************************************
SKILL: VOCABULARY
LRO                    SRO                    STATUS      TOTAL  TPS
---                    ---                    ------      -----  ---

INCORPSKLS 6
                       DEFINEWORD 7           INCOMPLETE           1

CONTXTMEAN 1
                       COMPSENT 2             COMPLETED            1
*********************************************************************************
SKILL: COMPREHENSION
LRO                    SRO                    STATUS      TOTAL  TPS
---                    ---                    ------      -----  ---

CAUSEFFECT 22
                       IDEUTCAUSE 1           INCOMPLETE           1

INFERENCE 20
                       GENENDING 5            COMPLETED            1

SSFACTOPIN 27
                       COMPLIKDIF 2           COMPLETED            1

GENSUMRIES 37
                       SUMCONTENT 2           COMPLETED            1

IDMAJCONCP 3
                       IDMAINIDEA 2           COMPLETED            1
                       SELMNIDEA 3            COMPLETED            2

SSOLUPROBS 28
                       JUDGESOL 3             COMPLETED            1
*********************************************************************************
SKILL: ENGLISH SKILLS
LRO                    SRO                    STATUS      TOTAL  TPS
---                    ---                    ------      -----  ---

SYHOANHET 13
                       IDDEFHETPR 10          COMPLETED            1
                       IDHOMONYMS 4           INCOMPLETE           1
                       USEHOMSENT 14          COMPLETED            1
                       USEANTSENT 13          COMPLETED            1
                       USESYNSENT 12          COMPLETED            1
                       USEHETPAIR 11          INCOMPLETE           1

RECSPELPAT 9
                       PRONOUNCE 4            COMPLETED            2


[illegible]LE
                       PHONSPELL 3            COMPLETED            2
                       SPELLWORDS 2           COMPLETED            2
                       IDWORDS 1.5            COMPLETED            2
                       IDSILNTLET [illegible] COMPLETED            1
```

LETTERWRIT 3

FIGURE 8

LETTERWRIT 3	FRIENDLET 2	INCOMPLETE		1
SENTENCES 1				
	GENSENTS 6	COMPLETED		1
	IDSENTTYPE 16	COMPLETED		1
	DRAWCONCLU 10	INCOMPLETE		1
	PROOFREAD 8	COMPLETED		2
	NORUNONS 7	COMPLETED		2
	SUMMARIZE 11	COMPLETED		1
	DOTRANSFRM 17	COMPLETED		1

****

SKILL: STUDY SKILLS

LRO	SRO	STATUS	TOTAL	TPS
FOLOWDIREC 1				
	HOBBYDIRS 1	COMPLETED		1

****

SKILL: VOCABULARY

LRO	SRO	STATUS	TOTAL	TPS
CONTXTMEAN 1				
	COMPSENT 2	COMPLETED		1
INCORPSKLS 6				
	DEFINEWORD 7	INCOMPLETE		1

****

SKILL: COMPREHENSION

LRO	SRO	STATUS	TOTAL	TPS
CAUSEFFECT 22				
	IDEUTCAUSE 1	COMPLETED		1
INFERENCE 20				
	GENENDING 5	INCOMPLETE		1
IDMAJCONCP 3				
	IDMAINIDEA 2	COMPLETED		1
SSFACTOPIN 27				
	COMPLIKDIF 2	COMPLETED		1
IDMAJCONCP 17				
	SELMNIDEA 3	COMPLETED		1
SSOLUPROBS 28				
	JUDGESOL 3	COMPLETED		1

****

SKILL: ENGLISH SKILLS

LRO	SRO	STATUS	TOTAL	TPS
SYNOANHET 13				
	IDDEFHETPR 10	COMPLETED		1
	IDHOMONYMS 4	COMPLETED		1
	USEHOMSENT 14	COMPLETED		1
	USEANTSENT 13	COMPLETED		1
	USESYNSENT 12	COMPLETED		1
COMPSUPINF 2				
	MAKESENTS 20	COMPLETED		1
	IDTENSENT 19	COMPLETED		1

updated every two weeks to include the latest reading and mathematics probe information on students. These data will be also available for correlation with the students' daily activity reports.

During this quarter, the readability program was compiled which markedly reduced the amount of time necessary to complete a readability index of instructional materials. This feature reduced the time necessary to complete the readability accross the three formulas from three minutes to one minute.

Description of Data Management System Development

The project data management system configured two separate computer systems linked together through as telephone-based data transmission scheme. Figure 9 schematically illustrates the system currently in place. The on-site microcomputer systems provide the primary interactive user interface at the schools for the daily collection and retrieval of teacher and student data. The centrally located time-sharing computer system provides the facility for storage of all data collected at the various local school sites. The employment of a central data storage facility allows periodic transfer of data collected from each microcomputer site, and permited project access into an integrated database for overall data analysis and summary evaluation requirements. The data communications scheme consisted of a slow-speed (300 baud) telephone transmission system, utilizing dial-up ports into the central time-sharing system.

Local school site microcomputer systems. The primary computer selected for data entry and retrieval for project participants consisted of a Radio Shack TRS-80 microcomputer, configured with dual

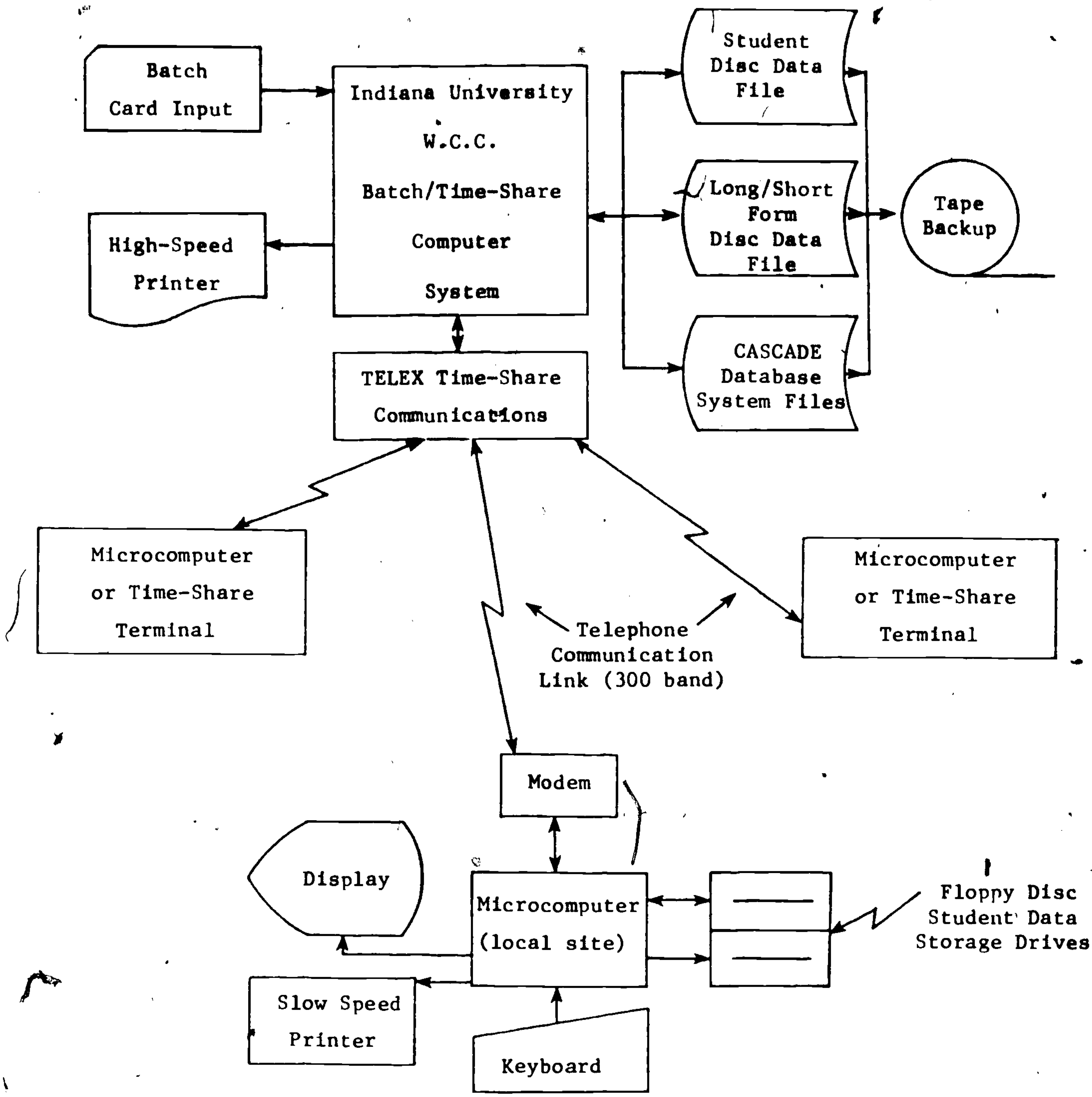


Figure 9. Database Management System

5-1/4" floppy disk drives, minimum of 32K core memory, a serial communications interface, and a slow-speed printer. The selection and implementation of this unit provided the local school sites with an effective, low-cost microcomputer that easily interacted with users for conversational data entry and retrieval. The dual floppy disk system assigned one disk unit for individual student data storage and the other unit for system software programs. The attached printer provided users with optional paper copy reports of all data entry and retrieval functions.

Central site time-sharing computer system. The centralized computer system serving the integrated databased functions was located on the Bloomington campus and consisted of time-sharing CDC 6000 and CYBER 172 computer system. The TELEX time-sharing communications system provided the data transmission facilities.

Data communications link. Communication functions were provided by dial-up telephone ports available through the Indiana University Computer Network (IUCN). This network allowed local telephone calls originating from the Indianapolis area to be routed into the Bloomington central computer facility. The transfer of data to the central system used the TELEX time-sharing protocol.

Software Component Description

Local site microcomputer software. The microcomputer system software can be classified into four overall functions: 1) The Users Daily Activity Entry (DAE) Routines; 2) The Users Summary Report Routines; 3) The Data Communications Routines; and 4) The Software Utility Routines. The software developed to provide these four general functions resides on a system floppy diskette assigned to one of the disk drives. All current software was developed and written in BASIC to provide for interactive access, diskette file management, and data transmission functions. Figure 10 depicts the general procedures for use of the software routines provided at the microcomputer site. The main components of these functions are described below.

DAE routines. The daily activity entry routines provide the user access into the data management system. When the user selects the DAE function, the system interacts with the user through visual prompts displayed on the microcomputer television screen. The DAE routines prompt the user for all function selection and data entry requests. The routine also monitors user entry errors and re-prompts for printer copy log of the entry activity for user reference. Figure 11 is an example of this log which is produced during an interactive data entry session.

The student data diskettes also contained individual demographic files to provide user access to student background information. Student demographic information was also interactivly entered by the user and the software routines provide the user the option of modifying previously entered information. The diskette data file structure was designed for random access record processing which allowed the users to select class codes, identify date of data entry, and enter for storage the variable information into the disk file data records.

Data summary report routines. At any time, the user could access the student data file to retrieve stored information. Figure

STUDENT ACTIVITY MANAGEMENT SYSTEM

SYSTEM USE FLOW CHART

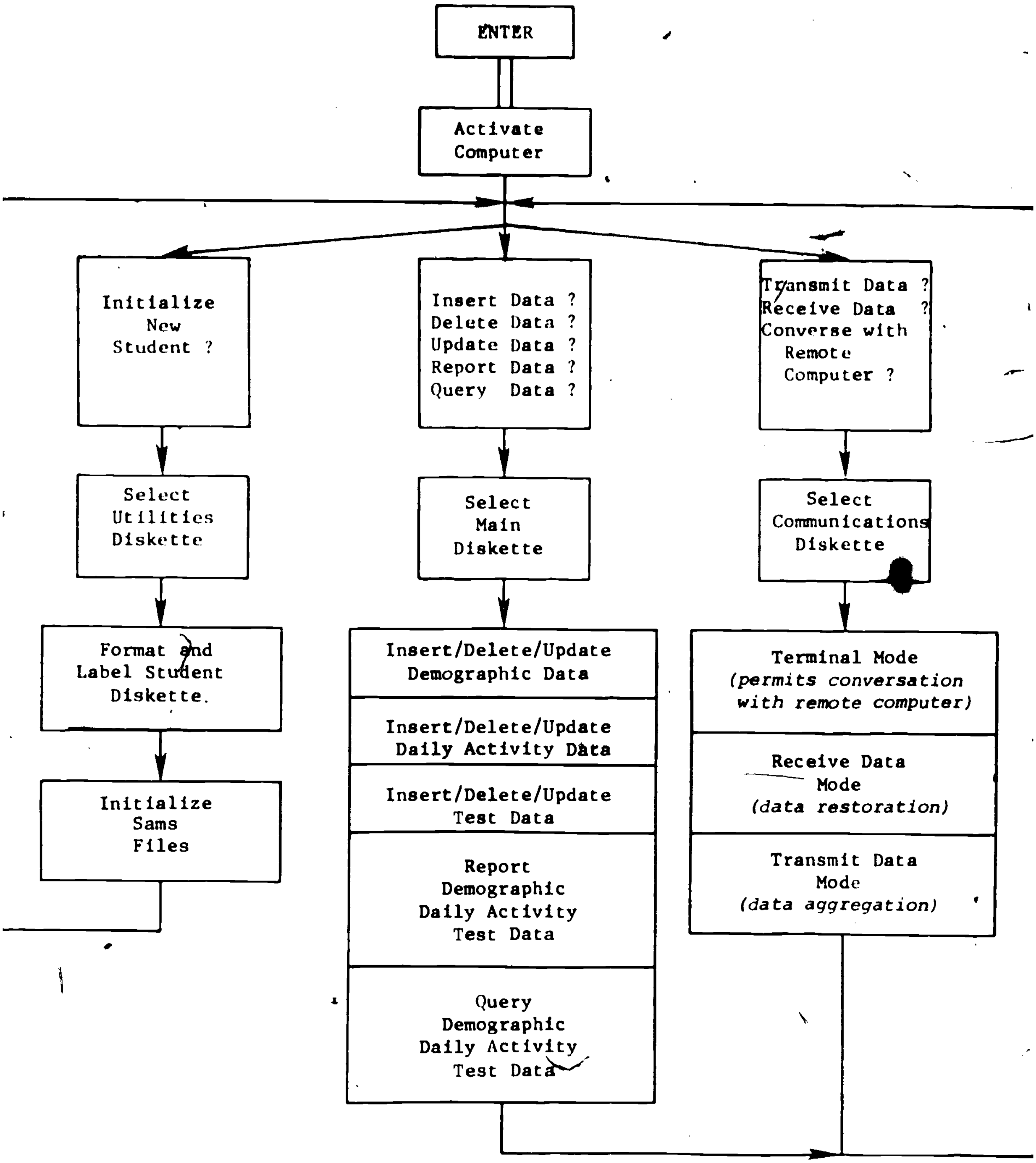


Figure 10

SAMS DAILY ACTIVITY DATA ENTRY MODULE
DAILY ACTIVITY ENTRY LOG

STUDENT: **John Doe** # 1

CLASS: READING / PERIOD: 2 / TEACHER: **Mr. ABC** #[illegible]

	DATE	MATERIALS/LVL/PG(S)			SCORE		TIME	METHOD
*	3/ 2/81	LEARNES	2	25-55	100% /	0.71	14	TEXTBOOK
*	3/ 2/81	LEARNES WKB.	2	4-4	90% /	2.57	7	WORKBOOK
*	3/ 3/81	SILVAROLI	5	21-30	100% /	0.90	10	TEXTBOOK

CLASS: SPELLING / PERIOD: 1 / TEACHER: [illegible] #[illegible]

	DATE	MATERIALS/LVL/PG(S)			SCORE		TIME	METHOD
	3/ 1/81	DR. SPELLO	6	12-20	8[illegible]% /	0.[illegible]	20	TEXTBOOK
*	3/ 1/81	SHEET #1	6	1-1	70% /	7.20	5	WORKSHEET
*	3/ 2/81	SPELLAE	3	10-12	50% /	0.[illegible]	15	WORKBOOK

CLASS: SOCIAL STUDIES / PERIOD: [illegible] / TEACHER: [illegible] #[illegible]

	DATE	MATERIALS/LVL/PG(S)			SCORE		TIME	METHOD
	3/ 1/81	OUR WORLD	7	10-20	80% /	0.[illegible]	11	TEXTBOOK
*	3/ 1/81	PRACTICE	0	0	60% /	0.30	10	PEER TUTOR

CLASS: MATH / PERIOD: 3 / TEACHER: SMITH #[illegible]

	DATE	MATERIALS/LVL/PG(S)			SCORE		TIME	METHOD
*	3/ 1/81	**Bas. Math**	3	1	90% /	1.[illegible]	14	WORKSHEET
*	3/ 2/81	**Bas. Math**	3	1	86% /	1[illegible].00	2	WORKSHEET

FIGURE 11

12 depicts a student report. This sample report contains a full listing of all the data collected on the selected student during the data collection period. Software was developed that allowed users selective inquiry into subsections of the data files.

Data transmission routines. Upon selection by the user, the system executed the data transmission routine to transfer the data to the central time-sharing computer site. When the user established connection to the computer system through the telephone line and acoustic modem, the system established the required communications protocol with the time-sharing system and initiated the data transfer process. The system retrieved the data from the student diskette file structure, reformated the data for transmission, transmited the data, verified the transmission, and prompted users when the process is completed. The system assembled the data into separate blocks and calculated a checksum which was transmitted with the data and checked by the time-sharing system. If the data check sum did not match, the time-sharing system requested a retransmission from the microcomputer and the data transmission process continues.

Microcomputer system utility routines. Various routines were available on the system diskette which performed student disk file initialization and formating tasks when new students are assigned to the program. Copy routines for backing both system and student data diskettes were also present in the utility routines.

Central time-sharing computer software routines. The current software routines developed for the central time-sharing system were grouped into two general functions; the database management system, and the data communications routines. Most of the software

****

STUDENT ACTIVITY MANAGEMENT SYSTEM / DAILY ACTIVITY REPORT

STUDENT: John Doe / # 1
SEX: M
BIRTHDATE: 3/ 3/64
ADDRESS: 3209 EAST 10TH APT 15R
BLOOMINGTON IN 47401

CLASS: READING / PERIOD: 2 / TEACHER: WATKINS-#224

DATE	MATERIAL/LVL/PG(S)			SCORE		TIME	METHOD
* 3/ 3/81	SILVAROLI	5	21-30	100% /	0.90	10	TEXTBOOK
* 3/ 2/81	LENNES WRK	2	4-4	90% /	2.57	7	WORKBOOK
* 3/ 2/81	LENNES	2	25-35	100% /	0.71	14	TEXTBOOK
* 3/ 1/81	LENNES	4	10-25	86% /	0.93	14	TEXTBOOK

CLASS: SPELLING / PERIOD: 4 / TEACHER: GLENN-#797

DATE	MATERIAL/LVL/PG(S)			SCORE		TIME	METHOD
* 3/ 2/81	SPELLME	3	10-12	50% /	0.07	15	WORKBOOK
* 3/ 1/81	SHEET #1	6	1-1	73% /	2.20	5	WORKSHEET
* 3/ 1/81	DR. SPELLO	6	12-20	87% /	0.35	20	TEXTBOOK

CLASS: WRITING / PERIOD: 1 / TEACHER: FARBY-#343

DATE MATERIAL/LVL/PG(S) SCORE TIME METHOD

>> NO DAILY ACTIVITIES FOUND <<

CLASS: SOCIAL STUDIES / PERIOD: 6 / TEACHER: TARBELL-#2

DATE	MATERIAL/LVL/PG(S)			SCORE		TIME	METHOD
* 3/ 1/81	PRACTICE	0	0	60% /	0.30	10	PEER TUTOR
* 3/ 1/81	OUR WORLD	7	10-20	80% /	0.73	11	TEXTBOOK

CLASS: GENERAL SCIENCE / PERIOD: 7 / TEACHER: ERLICK-#101

DATE MATERIAL/LVL/PG(S) SCORE TIME METHOD

>> NO DAILY ACTIVITIES FOUND <<

CLASS: MATH / PERIOD: 3 / TEACHER: SMITH-#444

DATE	MATERIAL/LVL/PG(S)			SCORE		TIME	METHOD
* 3/ 2/81	Basic Math	3	1	86% /	13.00	2	WORKSHEET
* 3/ 1/81	Basic Math	3	1	90% /	1.93	14	WORKSHEET

CLASS: BIOLOGY / PERIOD: 0 / TEACHER:

DATE MATERIAL/LVL/PG(S) SCORE TIME METHOD

>> NO DAILY ACTIVITIES FOUND <<

****

**** PLEASE NOTE ****
ACTIVITY DATES MARKED WITH '*' INDICATE THAT THE ACTIVITY WAS COMPLETE

* REPORT COMPLETED *

FIGURE 12

development at the central computer level focused upon using both existing software utility packages and the time-sharing sytem file control commands.

Database Management System

As indicated earlier, the project employed the Scientific Information Retrieval (SIR) System to serve the database manager function. This system is efficient for storing hierarchical structured data for user retrieval functions based upon a sort/key query request language. The SIR system control language is similar to the SPSS control language and the retrieved data files from database can be accessed by large statistical processing packages, such as the SPSS and BMD. The application of the SIR system as the database manager provided project evaluators with a flexible system for data analysis tasks.

Data communication routines. Data from the local site microcomputer system was received through the time-sharing system file control. When data was transmitted into local data files, a procedure file was called to process it for storage into the SIR system. The procedure file contained a sequence of control commands which executed various routines; these performed checksum verification on transmitted data blocks and format data files for inclusion into the SIR database. The time-sharing system could also be accessed independently from a time-sharing terminal for data file to tape backup procedures and database maintenance functions.

Continuing Data system Development Activities.

The primary development activities at the local sites provide a greater user selection of data entry and retrieval system functions. The DAE routines were expanded to include various options for data deletions, insertions, and replacements. Inclusions of these expanded user functions allowed direct random access into the student data diskettes for user modification at any variable/record location.

The same data file access procedures were developed for inclusion into the data summary report routines. This development permitted the user to employ a prompted query-based subset of the variables stored for any student. This activity was identified through discussions concerning what type of feedback was most important to users. Various formats for data presentation and display were investigated.

Further modification of the data transmission routines were also scheduled. The major development of these routines involved optional communication protocols into different central computer time-sharing systems. The inclusion of different system communication options greatly improved the flexibility of the system to access other "standard" time-sharing systems, which in turn, enhanced the system's disseminability.

Complementing the local site development of different data transmission protocols, an evaluation of other larger central computer systems will also be undertaken to identify basic system development requirements needed for different central system data storage applications. The Indiana University Computer Network currently provides time-sharing access into two other large systems; a DEC-10 System, and a PRIME-750 System. The identification and documentation of the requirements to access these systems will al contribute to the ability to disseminate the system widely w: little additional development time.

YEAR ONE QUARTER THREE

During the third quarter, a number of tasks related to the development, implementation and evaluation of an efficient, systematic microcomputer-based data and information system were completed. These tasks focused primarily in the areas of program and software development.

Program Development Activities

Arlington High School (A.H.S.). The majority of activities at Arlington focused on the collection and storage of individual pupil data and the careful monitoring of teacher program planning and decision making behavior. As in the past, the resource room teacher was responsible for recording a majority of the individual student data, including long and short range objectives, instructional materials used and student assignment accuracy data. The students retained responsibility for recording the amount of time they spent on each assignment.

The most significant change that occurred during the third quarter, however, involved the teacher entering into the microcomputer all pupil performance data collected in her classroom. This indicated that teachers could use microcomputers to enter individual pupil data, to monitor pupil progress, and to plan pupil programs. Exploring the use of the microcomputer as a tool to aid teacher record-keeping and decision-making was a major objective of the project. Daily teacher decisions to be made included: the selection of the long and short range objectives for each daily activity, the instructional materials selected, and the teaching method employed. These decisions were prompted by a newly developed, automatically activated student performance summary program, CITH (Instructional Management System) CIMS, which summarized the student's performance for the previous four days on the pre-specified Long Range Objectives (LRO's) and Short Range Objectives (SRO's).

The investigators continued to systematically monitor the teachers' planning behavior and compared planning data recorded immediately after the teacher began using the computer, with data entered during the first semester by an assistant. Data compared included the average number of skill areas in which the student received instruction, the number of LRO's assigned, the number of SRO's successfully completed and the percentage of SRO's assigned that were completed correctly.

In comparing the data collected by the teacher and entered by the clerk during the first semester with those entered in March, several findings emerged. First, the teacher typically assigned more LRO's during the first semester than in March. Second, and perhaps most importantly, the teacher assigned many more SRO's, and frequently assigned additional SRO's, before the preceding SRO's were successfully completed (see Table 1). Third, the March data demonstrated a substantial reduction in the number of SRO's assigned. In addition, the percent of SRO's successfully completed increased by fourteen percent indicating that the teacher waited for the student to successfully complete one SRO before assigning additional SRO's. These results suggest that having the teacher enter student

TABLE 1

Comparison of Data Entry Behavior of Teacher A in the Months of December and March
(In Averages Across Individual Students)

	No of Skill Areas	LRO's Assigned	SRO's Assigned	SRO's Completed	% SRO's Completed
Oct. - Dec.	2.6	7.6	14.1	10.16	72
March	2.5	6.5	9.2	7.9	86

performance data daily may have encouraged the teacher to attend more closely to skill acquisition data, prompting her to incorporate additional activities into the IEP to enable students to meet their LRO's and SRO's. A newly developed microcomputer software program may have been responsible for this change in teacher performance. For each SRO selected by the teacher, she was required to enter daily permanent product information to update student progress and to specify the criterion for student mastery. As the microcomputer program required students' performance to meet prespecified performance criteria before advancing to the next SRO in the institutional sequence, this may have prompted the teacher to evaluate more closely student progress on SRO's assigned, rather than capriciously assigning SRO's according to a sequence determined by the available instructional materials. Subsequent data analyses reveal more clearly the effects the daily data entry experience had on teacher decision making, in terms of number of materials assigned per SRO, time spent in each SRO, and changes in student performances on weekly student acquisition rates.

An alternative explanation for the changes in teacher planning behavior may indicate that the teacher was perfunctory in reporting the data related to student progress in order to reduce the amount of time spent planning student activities. The fact that the teacher reduced the number of instructional activities required to teach a skill indicates that she may have reduced the amount of individualization of instruction. This, in turn, may have contributed to a regression of student performance. The answer to these and other questions will be provided after the post-testing is completed and the data are analyzed. These data will be reported in the fourth quarter report.

Site Development Activities

North Central High School. After receiving approval from the Special Education Coordinator for the school district for entry into North Central High School (NCHS), the appropriate classrooms and personnel were identified. Personnel were contacted and a planning session was set up with the Special Education Coordinator at North Central High School, the school principal, the District Special Education Coordinator, the resource room teacher and the project staff. At this meeting, the main components of the grant were discussed and a demonstration of the Student Activity Management Sheet (SAMS) was given by the project's computer programmer. As a result of the meeting, the high school principal and the special education resource teachers approved the implementation of the program into the high school. In addition, a meeting was to be scheduled between the project and high school staffs, in which the North Central Special Education Coordinator would explain to the high school staff the purpose of the project and the required role of the teachers in collecting the classroom data.

The meeting was held, and a general discussion was held of the SAMS and the estimated amount of teacher time required to complete the daily activity sheet for mainstreamed students in each of their classes. The consensus of this meeting was that regular class teachers decided not to participate in the project activities because their time was overcommitted and they felt that they did not need additional information regarding student performance.

The teachers did indicate, however, that they would be willing to allow students to record the data and deliver it to the resource room teacher for entry into the microcomputer. Printouts were to be shared with the teachers. To accomodate student data recording procedure, the Student Academic Management System (SAMS) was revised.

The final details of the SAMS form were then completed in a subsequent work session. The Student Activity Management Sheet includes the following information: name of the student, data, week number, classroom subject, period, the attendance (on time, absent or tardy), homework status, the class activity (i.e., book, worksheet, a lecture, discussion,etc.), the pages, problems, or questions assigned, the time the activity started and stopped,the percentage correct on the instructional activity and the grade received, a space for the teacher initial or approval, as well as space for a classmate's initial. Ten students who met the criterion of having at least two academic classes outside of special education were selected to participate in the study. Because this activity amounted to additional work for the students, a reinforcement system was designed.

The next step entailed training the students to complete the SAMS. Student training included a discussion of the SAMS and the student reward system. Questions about the SAMS and how to fill it out were answered and a completed model SAMS was provided for the students for reference. An accounting system was also developed to keep track of students' points. During the first week, the English teacher allowed project staff to meet with the students for five minutes a day, so that any problems that developed with regard to the collection of data could be discussed. The completed SAMS was submitted to the resource teacher at the end of each school day. We found that students could reliably collect and report data concerning their daily activities and that this information was important for resouce room teachers to make educational decisions. The program was not problem free, however. After four weeks, the regular classroom teachers became less willing to allow students time to collect data. They did, however, allow the program to continue. The teachers' waning enthusiasm affected the behavior of several students who periodically neglected to submit their completed SAMS forms and who ultimately dropped out of the study.

These experiences indicated that unless teachers provided students with incentives such as points added to their grades for recording appropriate progress data, they were not reliable recorders. Our experience, based on observation and teacher feedback, suggests that the keys to convincing teachers to use computers for monitoring and planning in a mainstreamed environment may also be in providing supervised opportunities for teachers to use the computers and convincing teachers of the computer's worth as a time saving device to aid planning, report generation, and decision making.

We have tested the effects of supervised practice programs designed to entice teachers to use the microcomputers for program planning and monitoring. Initially, the cooperating resource teacher was reluctant to do her planning at the computer console. After one week of supervised practice using the machine and the newly developed programs, however, she became an enthusiastic advocate of its value for planning and tracking student progress. Based on this promising finding, our future efforts will be directed toward determining the generality of this approach as well as formatively evaluating alternative approaches.

We have found also that teacher usage is related to the extent school systems require teachers to develop daily lesson plans, generate meaningful periodic reports, and use data to make daily decisions regarding the course of instruction with students. Unfortunately, based on observation especially at the secondary level, the individual pupil program development is most frequently merely a perfunctory exercise. Our experiences indicate that in meeting P.L.94-142 compliance requirements teachers currently rarely depend on daily lesson plans or individualized instruction, nor do they use previous data to make educational decisions such as selecting objectives, matching materials to objectives, or remediating instructional difficulties. To counter the resistance to these functions, we developed computer programs that were efficient and required little teacher time.

Computer Systems Development

Student Activity Management System (SAMS) Development. The SAMS project configures two separate computer systems, linked together through a telephone-based data transmission scheme. Figure 13 schematically illustrates the system used. The onsite microcomputer systems provide the primary interactive user interface at the schools for the daily collection and retrieval of teacher and student data.

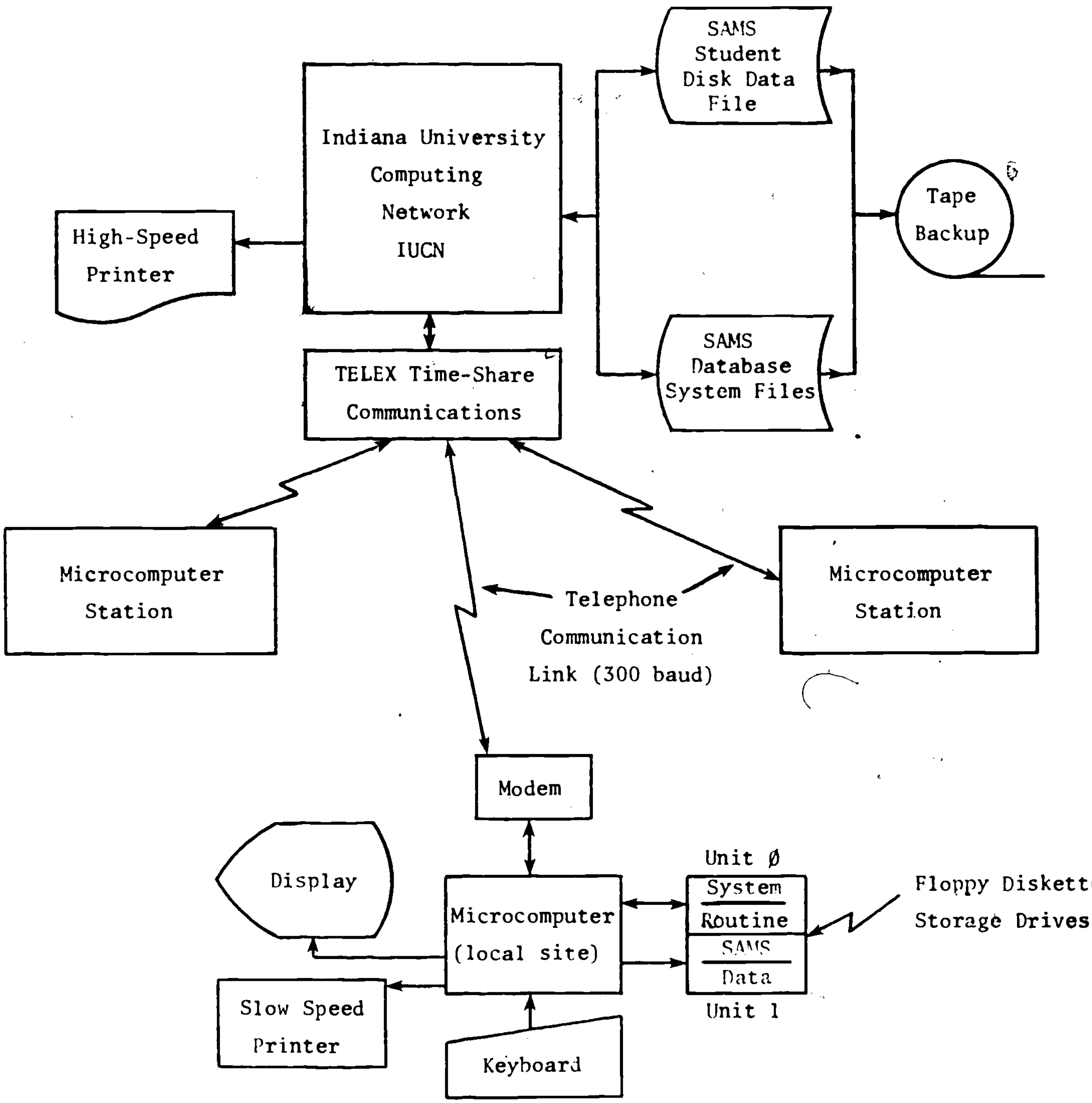


Figure 13. SAMS Database Management System Configuration

The centrally located time-sharing computer system provided the facility for storage of all data collected at the various local school sites. The employment of a central data storage facility allowed periodic transfer of collected data from each microcomputer site, and permitted project access into an integrated database for overall data analysis and summary evaluation requirements. As previously described, the data communications scheme consists of a slow-speed (300 baud) telephone transmission system utilizing dial-up ports into the central time-sharing system. Current communication functions are provided by dial-up telephone ports available through the Indiana University Computer Network (IUCN). This network allows local telephone calls originating from the Indianapolis area to be routed into the Bloomington central computer facility. The transfer of data to the central system uses the TELEX time-sharing protocol.

Software Component Description

Local Site Microcomputer Software. The SAMS microcomputer software can be classified into four overall functions: 1) The database management access routines; 2) The summary report routines; 3) The data communication routines; and 4) The software system utility routines. The software developed to provide these four general functions reside on one of the two floppy diskettes, which are inserted into one of the disk drives. The individual data activity diskettes are inserted into the other disk drive. All software was developed in BASIC and compiled into object code to provide faster execution of the database management and data transmission program functions. The main components of these functions are described below.

SAMS Activity Management Routines (AMR). Activity Management Routines provide the user with an interactive method to enter daily student activity data into the system. When the user selects the AMR functions, the system interacts with the user through visual prompts displayed on the microcomputer television screen. The AMR routines prompt the user for all activity module selections and data entry requests. The system also monitors user data entry errors and re-prompts the user for reentry of corrected data.

Figure 14 shows the initial AMR menu display that is presented to the user at the beginning of a data entry and retrieval session. The eight data access modules currently available in the system are:

1. Student demographic data
2. Student contact data
3. Student activity data
4. Student IRI/IMI data
5. Student SDRT data
6. Student SDMT data
7. Student group points data
8. Teacher schedules/services data

The following sections contain brief descriptions of the AMR modules implemented on the system. Specific information regarding the use and interpretation of the student/teacher activity data presented is discussed elsewhere in this report. Figures 15 through 21 will illustrate formats of user screen displays for data activity entry and examples of printed reports available from the SAMS system.

```
•••••• •••••• •••••••• ••••••
•••••• •••••• •••••••• ••••••
STUDENT ACTIVITY MANAGEMENT SYSTEM
CENTER FOR INNOVATION IN TEACHING THE HANDICAPPED
(C)1980 C.I.T.H. / INDIANA UNIVERSITY
** MAIN SYSTEM DISKETTE **
1 = ACCESS DEMOGRAPHIC DATA
2 = ACCESS CONTACT DATA FOR A STUDENT
3 = ACCESS ACTIVITY DATA FOR A STUDENT
4 = ACCESS IRI/IMI DATA FOR A STUDENT
5 = ACCESS SDRT DATA FOR A STUDENT
6 = ACCESS SDMT DATA FOR A STUDENT
7 = ACCESS POINTS DATA FOR A GROUP
8 = ACCESS TEACHER DATA FOR A TEACHER
PRESS THE KEY FOR THE NUMBER YOU DESIRE,
'H' FOR HELP, OR 'E' TO EXIT
```

FIGURE 14. SAMS AMR User Selection Menu

1. <u>Student Demographic Data.</u> Figure 15 (1-5) illustrates information available from the Demographic Access Module. The menu (15.1) permits the user to select any of six choices related to each individual student data diskette. These are: 1) Standard demographics; 2) School related demographics; 3) Class schedules; 4) Extra-curricular school activities; 5) Extra-curricular non-school activities; and 6) A full printed demographic report.

The user actions for data entry and display control are prompted on the bottom of each display page. The up and down arrows on the keyboard move the arrow pointer to the data item selected for entry or modification. If no data is present for the item, an "a" symbol will be present in the data field to the right of the arrow. An "*" selection allows the user to enter or modify the data item pointed to by the arrow. More than one page of information may be available for each type of demographic record and the user controls page displays through the use of the "<" and ">" characters for "previous" and "next" pages. The "P" character prints the report displayed, and the "E" character returns the user to the main AMR menu.

Similar user control conventions are present in all of the following modules.

2. <u>Student Contact Data.</u> Figure 16 (1-3) illustrates the student information available with regard to teacher to teacher and teacher to parent contacts. The menu (16.1) is the initial user display and Figure 16.2 and 16.3 show the printed reports available. Note that all dated or sequenced information in this and other activity modules are listed in order from the most recently entered information down to the initial entries. User data entry procedures

15.1. Demographic Data Access Menu

```
SAMS DEMOGRAPHIC DATA ACCESS MODULE

1 = ACCESS STANDARD DEMOGRAPHICS
2 = ACCESS SCHOOL DEMOGRAPHICS
3 = ACCESS CLASS SCHEDULE
4 = ACCESS EXTRA-CURRICULAR SCHOOL ACTIVITIES
5 = ACCESS EXTRA-CURRICULAR NON-SCHOOL ACTIVITIES
6 = PRINT ENTIRE DEMOGRAPHIC RECORD
OPTION NUMBER?
(PRESS ONLY THE 'ENTER' KEY TO EXIT)
```

15.2. Standardized Demographics

```
SAMS DEMOGRAPHIC DATA ACCESS MODULE > STANDARD DEMOGRAPHICS
STUDENT NUMBER (1-9999)        -> 1
FIRST NAME (15)                   GREGORY
MIDDLE INITIAL (1)                D
LAST NAME (20)                    SMITH
SEX (M/F)                         M
BIRTHDATE (MM/DD/YY)              05/01/63
STREET ADDRESS (30)               1346 S. EMERSON AVENUE
CITY (15)                         INDIANAPOLIS
STATE (4)                         IN
ZIPCODE (10)                      46224
PARENTS' NAME (25)                MR. GERALD SMITH
PHONE # (AAA-XXX-NNNN)            317-555-8765

USE THE UP/DOWN ARROW KEYS TO MOVE ARROW, '*' TO ENTER ITEM,
'P' TO PRINT, '<'/'>' FOR PREVIOUS/NEXT PAGE, 'E' TO EXIT.
```

15.3. School Demographics

```
SAMS DEMOGRAPHIC DATA ACCESS MODULE > SCHOOL DEMOGRAPHICS
COUNSELOR (25)                 -> MS. MARJORIE TELSON
MAINSTREAMED (Y/N)                Y
HIGH RISK (Y/N)                   N
LEARNING DISABLED (Y/N)           Y
MENTALLY RETARDED (Y/N)           N
EDUCATIONALLY DEPRIVED (Y/N)      N
BASIC (Y/N)                       N
PROGRAM TRACK (15)                VOCATIONAL


USE THE UP/DOWN ARROW KEYS TO MOVE ARROW, '*' TO ENTER ITEM,
'P' TO PRINT, '<'/'>' FOR PREVIOUS/NEXT PAGE, 'E' TO EXIT.
```

Figure I5(1-3). SAMS: Demographic Access Module

15.4. Class Schedule

```
SAMS DEMOGRAPHIC DATA ACCESS MODULE > CLASS SCHEDULE
-> RDNG         1   READING          DARNELL                  234
   ENG          11  ENGLISH B        WILEY                    123
   SOC ST.      5   SOC ST B         BARNSTON                 400
   SCI          4   SCIENCE B        STEEL                    456Y
   MATH         3   MATH C1          MERRYWELL                345
   RES. RM.     10  RESOURCE         STEFFEL                  123E
   STDY HALL    2   STUDY HALL       DURAM                    345
------------------------------------------------------------------------
SAMS CLASS      P.  NAME             TEACHER                  ROOM



USE THE UP/DOWN ARROW KEYS TO MOVE ARROW, '*' TO ENTER ITEM,
'P' TO PRINT, '<'/'>' FOR PREVIOUS/NEXT PAGE, 'E' TO EXIT.
```

15.5. School Activities

```
SAMS DEMOGRAPHIC DATA ACCESS MODULE > SCHOOL ACTIVITIES > PAGE:1
-> FOOTBALL                        3:15PM
   WRESTLING                       4:30-5:15
   @                               @
   @                               @
   @                               @
   @                               @
   @                               @
------------------------------------------------------------------------
ACTIVITY                           TIME



USE THE UP/DOWN ARROW KEYS TO MOVE ARROW, '*' TO ENTER ITEM,
'P' TO PRINT, '<'/'>' FOR PREVIOUS/NEXT PAGE, 'E' TO EXIT.
```

15.6. Non-School Activities

```
SAMS DEMOGRAPHIC DATA ACCESS MODULE > NON-SCHOOL ACTIVITIES
-> ARBY'S JOB                      6:30PM                317-555-690[illegible]
   @                               @                     @
   @                               @                     @
   @                               @                     @
   @                               @                     @
------------------------------------------------------------------------
ACTIVITY                           TIME                  PHONE



USE THE UP/DOWN ARROW KEYS TO MOVE ARROW, '*' TO ENTER ITEM,
'P' TO PRINT, '<'/'>' FOR PREVIOUS/NEXT PAGE, 'E' TO EXIT.
```

Figure 15 (4-6). SAMS: Demographic Access Module

16.1. Contact Data Access Menu

```
SAMS-CONTACT DATA ACCESS MODULE

1 = TEACHER-TO TEACHER CONTACTS
2 = TEACHER TO PARENT CONTACTS
TYPE OF CONTACT?
(PRESS ONLY THE 'ENTER' KEY TO EXIT)
```

16.2. Teacher Contact Report

```
SAMS CONTACT DATA ACCESS MODULE > TEACHER CONTACTS

STUDENT: 1     GREGORY          SMITH

DATE      TIME    FROM        TO          ? OUTCOME

04/15/81  3:00    STEEL       MERRYWELL   C PLAN COORDINATION
04/11/81  2:00    BARNSTON    WILEY       P SOC. ST. VOCABULARY
04/10/81  9:45    DURAM       STEFFEL     C CLASSROOM MANAGEMENT
04/04/81  2:00    DARNELL     STEFFEL     + NOTED LESS TARDINESS
04/02/81  1:00    WILEY       STEFFEL     - DISCUSS LOW TEST SCORE
04/01/81  12:30   STEFFEL     DARNELL     S DISCUSS TARDINESS
04/01/81  10:30   STEFFEL     WILEY       P PLAN ENGLISH CURRIC

* END OF CONTACTS *

PURPOSE CODES: (REFERS TO '?' COLUMN HEADER ABOVE)

'P' = PLANNING
'S' = SOLVE PROBLEM
'C' = CONSULTATION
'+' = ACADEMIC PLUS
'-' = ACADEMIC MINUS
```

16.3. Parent Contact Report

```
SAMS CONTACT DATA ACCESS MODULE > PARENT CONTACTS

STUDENT: 1     GREGORY          SMITH

DATE      TIME    FROM        TO          ? OUTCOME

04/05/81  2:30    STEFFEL     MOTHER      + LESS TARDINESS
04/03/81  2:00    STEFFEL     FATHER      - LOW ENGLISH TEST SCORE
04/01/81  1:30    STEFFEL     MOTHER      S DISCUSS TARDINESS

* END OF CONTACTS *

PURPOSE CODES: (REFERS TO '?' COLUMN HEADER ABOVE)

'P' = PLANNING
'S' = SOLVE PROBLEM
'C' = CONSULTATION
'+' = ACADEMIC PLUS
'-' = ACADEMIC MINUS
```

FIGURE 16 (1-3). SAMS: Student Contact Data Access Module (not shown) are similar to the demographic and activity modules which follow.

3. Student Activity Data. Figure 17 (1-3) illustrates the student activity information available. Figure 17.1 is the initial display presented to the user when the student activity module is selected. Upon selection of the class number, Figure 17.2 is displayed to the user and the system prompts for the action desired. This display indicates the last student activity entered and prompts for additions or modifications. Figure 17.3 shows the complete printed report of student activities that may be requested.

4. Student IRI/IMI Data. Figure 18 (1-5) shows the Informal Reading and Math Inventory information available. Figure 18.1 is the initial menu displayed which prompts the user for a selection. Figure 18.2 and 18.3 illustrates the Informal Reading Inventory (IRI) data and Figure 18.4 and 18.5 Informal Math Inventory (IMI) data. Figure 18.2 and 18.4 is the initial display for each of the inventories and Figure 18.3 and 18.5 the printed reports available.

The prompted options shown in Figure 18.2 and 18.4 allow the user to enter new inventory data, control the display, or print out the information contained within the database. The character options available are: the "I" key for inserting new information, the ">" key for displaying the next page of information, the "R" key to reset to the first page, the "P" key to print all information, the "K" key to display the column information keys shown on the bottom of the printed reports (18.3, 18.5), and the "E" key to return to the current module menu.

5. Student SDRT Data. Figure 19 (1-2) shows the information

17.1. Student Class Schedule

```
SAMS ACTIVITY ACCESS MODULE

STUDENT: # 1      GREGORY            SMITH
     CLASS        P. NAME             TEACHER                     ROOM
 1 = RDNG         1   READING         DARNELL                     234
 2 = ENG          11  ENGLISH B       WILEY                       423
 3 = SOC ST.      5   SOC ST B        BARNSTON                    400
 4 = SCI          4   SCIENCE B       STEEL                       456Y
 5 = MATH         3   MATH C1         MERRYWELL                   345
 6 = RES. RM.     10  RESOURCE        STEFFEL                     123B
 7 = STDY HALL    2   STUDY HALL      DURAM                       345
CLASS NUMBER?
(Press ONLY the ENTER key to EXIT)
```

17.2. Selected Class Activity Access Menu

```
SAMS ACTIVITY ACCESS MODULE
STUDENT: # 1      GREGORY            SMITH
     CLASS        P. NAME             TEACHER                 ROOM
 1 = RDNG         1   READING         DARNELL                 234
DATE      ATTENDENCE             HOMEWORK   NUM. OF ACTIVITIES
04/05/81 ON TIME                  YES                2
(ABOVE DATE IS LAST DATE ENTERED)

1 = INSERT ACTIVITIES
2 = DELETE ACTIVITIES
3 = ALTER ACTIVITIES
4 = DISPLAY ACTIVITIES
5 = PRINT ACTIVITIES
OPTION NUMBER?
(Press ONLY the ENTER key to EXIT)
```

Figure 17 (1-2). SAMS: Student Activity Access Module

17.3. Student Class Activity Printed Report

```
SAMS ACTIVITY ACCESS MODULE

STUDENT: #1      GREGORY          SMITH

     CLASS        P. NAME          TEACHER                    ROOM
 1 = RDNG        1  READING        DARNELL                    234

--------------------------------------------------------------------------------
DATE       ATTENDENCE              HOMEWORK  NUM. OF ACTIVITIES
04/05/81 ON TIME                     YES               2

ACTIVITY                      PB.   PE.   PRB   QUE   MIN   %OK   GRADE
SMALL GRP                      34    38     0     0    25    0%   C
OUR WORLD                      29    39     0    10    20   74%   C

--------------------------------------------------------------------------------
DATE       ATTENDENCE              HOMEWORK  NUM. OF ACTIVITIES
04/04/81 ABSENT (EXC.)               NA.               0

ACTIVITY                      PB.   PE.   PRB   QUE   MIN   %OK   GRADE
* NO ACTIVITIES FOUND *

--------------------------------------------------------------------------------
DATE       ATTENDENCE              HOMEWORK  NUM. OF ACTIVITIES
04/03/81 TARDY (UNEXC.)              NO                3

ACTIVITY                      PB.   PE.   PRB   QUE   MIN   %OK   GRADE
D+L WRKBOOK                     2     5    30     0    15   70%   C
WORKSHEET #2                    0     0     0    40    15   78%   C+
ORAL RDING                     12    14     0     0    10    0%   C

--------------------------------------------------------------------------------
DATE       ATTENDENCE              HOMEWORK  NUM. OF ACTIVITIES
04/02/81 ON TIME                     YES               2

ACTIVITY                      PB.   PE.   PRB   QUE   MIN   %OK   GRADE
SPELL IT                       12    15     0    20    10   78%   C+
DISCUSSION                      0     0     0     0    20    0%   A

* END OF ACTIVITIES *

KEY:
UNEXC = UNEXCUSED
EXC = EXCUSED
NA = NOT APPLICABLE
PB = BEGINNING PAGE NUMBER
PE = ENDING PAGE NUMBER
PRB = NUMBER OF PROBLEMS ASSIGNED
QUE = NUMBER OF QUESTIONS ASSIGNED
MIN = ACTIVITY TIME IN MINUTES
%OK = PERCENTAGE CORRECT
P. = CLASS PERIOD
```

17 (3). SAMS: Student Activity Access Module

Figure 18 IRI/IMI Data Access Menu

```
SAMS IRI/IMI DATA ACCESS MODULE

1 = INFORMAL READING INVENTORY (IRI)
2 = INFORMAL MATHMATICS INVENTORY (IMI)
TYPE OF TEST? ?
(PRESS ONLY THE 'ENTER' KEY TO EXIT)
```

18.2 IRI Data Display and Action Menu

```
SAMS IRI/IMI DATA ACCESS MODULE > INFORMAL READING INVENTORY
CODE          DATE       MATERIAL
BIMONTH       04/23/81  STECK
  C   E    T    C%      E%      CR      ER     CC    IOR
 73  27   21   73.0%   27.0%   3.5     1.3    70%   93%
CODE          DATE       MATERIAL
BIMONTH       04/11/81  STECK
  C   E    T    C%      E%      CR      ER     CC    IOR
 65  35   16   65.0%   35.0%   4.1     2.2    67%   91%
CODE          DATE       MATERIAL
PRETEST       03/22/81  STECK
  C   E    T    C%      E%      CR      ER     CC    IOR
 50  50   20   50.0%   50.0%   2.5     2.5    55%   92%
STUDENT: 1      GREGORY            SMITH
'I' TO INSERT TEST, '>' FOR NEXT PAGE, 'R' TO RESET'
'P' TO PRINT, 'K' FOR KEY, 'E' TO EXIT
```

18.3 IRI Printed Data Report

```
MS IRI/IMI DATA ACCESS MODULE > INFORMAL READING INVENTORY

UDENT: 1     GREGORY          SMITH

DE          DATE       MATERIAL      C    E    T     C%       E%      CR     ER     CC    IO

MONTH       04/23/81  STECK         73   27   21    73.0%   27.0%    3.5    1.3    70%   93
MONTH       04/11/81  STECK         65   35   16    65.0%   35.0%    4.1    2.2    67%   91
ETEST       03/22/81  STECK         50   50   20    50.0%   50.0%    2.5    2.5    55%   92

END OF TESTS *

Y:
= NUMBER OF CORRECT RESPONSES
= NUMBER OF ERROR RESPONSES
= TIME IN MINUTES
 = PERCENTAGE CORRECT
 = PERCENTAGE ERROR
 = CORRECT RESPONSES/MINUTE
 = ERROR RESPONSES/MINUTE
 = PERCENTAGE OF COMPREHENSION QUESTIONS CORRECT
R = INTER-OBSERVER RELIABILITY
```


18 (1-3). SAMS: IRI/IMI Data Access Module

18.4 IMI Data Display and Action Menu

```
SAMS IRI/IMI DATA ACCESS MODULE - INFORMAL MATHEMATICS INVENTORY
CODE          DATE     MATERIAL
WEEKLY        04/16/81 STERLING
  C    E    T    C%      E%      CR     ER    CC    IOR
 69   31    5  69.0%   31.0%   13.8    6.2   70%   90%
CODE          DATE     MATERIAL
WEEKLY        04/09/81 STERLING
  C    E    T    C%      E%      CR     ER    CC    IOR
 62   38    5  62.0%   38.0%   12.4    7.6   68%   92%
CODE          DATE     MATERIAL
WEEKLY        04/02/81 STERLING
  C    E    T    C%      E%      CR     ER    CC    IOR
 56   44    5  56.0%   44.0%   11.2    8.8   57%   88%
STUDENT: 1    GREGORY          SMITH
'I' TO INSERT TEST, '>' FOR NEXT PAGE, 'R' TO RESET'
'P' TO PRINT, 'K' FOR KEY, 'E' TO EXIT
```

18.5 IMI Printed Data Report

MS IRI/IMI DATA ACCESS MODULE > INFORMAL MATHEMATICS INVENTORY

UDENT: 1 GREGORY SMITH

DE	DATE	MATERIAL	C	E	T	C%	E%	CR	ER	C	I
EKLY	04/16/81	STERLING	69	31	5	69.0%	31.0%	13.8	6.2	70%	9
EKLY	04/09/81	STERLING	62	38	5	62.0%	38.0%	12.4	7.6	68%	9
EKLY	04/02/81	STERLING	56	44	5	56.0%	44.0%	11.2	8.8	57%	8
ETEST	03/27/81	STERLING	50	50	5	50.0%	50.0%	10.0	10.0	40%	9

END OF TESTS *

Y:
= NUMBER OF CORRECT RESPONSES
= NUMBER OF ERROR RESPONSES
= TIME IN MINUTES
= PERCENTAGE CORRECT
= PERCENTAGE ERROR
= CORRECT RESPONSES/MINUTE
= ERROR RESPONSES/MINUTE
= PERCENTAGE OF COMPREHENSION QUESTIONS CORRECT
R = INTER-OBSERVER RELIABILITY

Figure 18 (4-5). IRI/IMI Data Access Module available for student performance on the Stanford Diagnostic Reading Test (SDRT). Figure 19.1 shows the initial display and the user options available. The user options are similar to the previous IRI/IMI module data entry and control functions. Figure 19.2 is the printed report available.

6. Student SDMT Data. The format of the Stanford Diagnostic Math Test (SDMT) is similar to the SDRT discussed above with the column variable keys changed to reflect the information required to store SDMT data (Figure 19 (1-2)). All user prompted options are the same.

7. Student Group Points Data. Figure 20 (1-2) illustrates the Student Group Points data records available to the user to track student assignment completion activities. Figure 20.1 shows the initial display for the selection of the group point data entry, entering new students, displaying and accessing points, and printing out group information. Figure 20.2 shows a printed report for one group of students across the indicated 10 days.

8. Teacher Schedules/Services Data. Figure 21 (1-2) illustrates the Teacher Schedules and Service information available to users of the system. Figure 21.1 shows the initial display which contains the names of the teachers and their current schedules. Individual teacher instructional services are displayed at the bottom of the screen corresponding to the arrow that points to the teacher name and schedule at the top of the screen. Similar item addition and modification options are employed to the user for keeping teacher schedules and services current and available. Figure 21.2 shows a complete printed report of all the current teacher schedules and

19.1 SDRT Data Display and Action Menu

```
SAMS SDRT DATA ACCESS MODULE    STANFORD DIAGNOSTIC READING TEST
STUDENT: 1       GREGORY              SMITH
CODE             DATE      AUD.  RC.   RC.   RC.   PHON STRU READ
                           VOC.  LIT.  INF.  TOTL  ANAL ANAL RATE
MONTHLY          05/15/81  7.2   6.0   3.0   5.02  6.15 4.9  4.9
MONTHLY          04/15/81  6.9   5.8   2.8   4.97  6.0  4.8  4.79
PRETEST          03/18/81  6.8   5.6   2.5   4.9   6.0  4.6  4.6
* END OF TESTS *




'I' TO INSERT TEST, '>' FOR NEXT PAGE, 'R' TO RESET'
'P' TO PRINT, 'K' FOR KEY, 'E' TO EXIT
```

19.2 SDRT Printed Data Report

```
SAMS SDRT DATA ACCESS MODULE : STANFORD DIAGNOSTIC READING TEST

STUDENT: 1       GREGORY              SMITH

CODE             DATE      AUD.  RC.   RC.   RC.   PHON STRU READ
                           VOC.  LIT.  INF.  TOTL  ANAL ANAL RATE

MONTHLY          05/15/81  7.2   6.0   3.0   5.02  6.15 4.9  4.9
MONTHLY          04/15/81  6.9   5.8   2.8   4.97  6.0  4.8  4.79
PRETEST          03/18/81  6.8   5.6   2.5   4.9   6.0  4.6  4.6

* END OF TESTS *

KEY:
AUD. VOC. = AUDITORY VOCABULARY
RC. LIT. = READING COMPREHENSION - LITERAL
RC. INF. = READING COMPREHENSION - INFERENTIAL
RC. TOTL = READING COMPREHENSION - TOTAL
PHON ANAL = PHONETIC ANALYSIS
STRU ANAL = STRUCTURAL ANALYSIS
READ RATE = READING RATE
```

Figure 19 (1-2). SAMS: SDRT Data Access Module

20.1 SDMT Data Display and Action Menu

SAMS SDMT DATA ACCESS MODULE > STANFORD DIAGNOSTIC MATH TEST
STUDENT: 1 GREGORY SMITH

			BROWN FORM			GREEN FORM
CODE	DATE	NSYS.	COMP.	APPL.	TOTAL	APPL.
MONTHLY	04/12/81	5.3	5.3	4.9	5.15	4.9
PRETEST	03/14/81	5.1	5.3	4.1	4.7	3.9

* END OF TESTS *

'I' TO INSERT TEST, '>' FOR NEXT PAGE, 'R' TO RESET'
'P' TO PRINT, 'K' FOR KEY, 'E' TO EXIT

20.2 SMDT Printed Data Report

SAMS SDMT DATA ACCESS MODULE > STANFORD DIAGNOSTIC MATHEMATICS TEST

STUDENT: 1 GREGORY SMITH

			BROWN FORM			GREEN FORM
CODE	DATE	NSYS.	COMP.	APPL.	TOTAL	APPL.
MONTHLY	04/12/81	5.3	5.3	4.9	5.15	4.9
PRETEST	03/14/81	5.1	5.3	4.1	4.7	3.9

* END OF TESTS *

KEY:
NSYS = NUMBER SYSTEMS
COMP = COMPUTATION
APPL = APPLICATIONS

Figure 20 (1-2). SAMS: SDMT Data Access Module

21.1 Points Access Menu Display

```
SAMS STUDENT POINTS ACCESS MODULE

WHAT GROUP NUMBER (1-5) DO YOU WANT TO ACCESS?
(PRESS ONLY THE 'ENTER' KEY TO EXIT)
```

```
SAMS STUDENT POINTS ACCESS MODULE

GROUP NUMBER 1 HAS 6 STUDENT(S).
THE LAST DAY POINTS WERE ENTERED WAS: 10
1 = ACCESS POINTS
2 = DISPLAY POINTS
3 = PRINT POINTS
4 = ENTER STUDENT(S) INTO GROUP
5 = SELECT STUDENT FOR REWARD
CHOICE NUMBER?
(PRESS ONLY THE 'ENTER' KEY TO EXIT)
```

Figure 21 (1). SAMS: Student Points Data Access Module

21.2 Printed Points Data Report

```
SAMS STUDENT POINTS ACCESS MODULE

GROUP NUMBER: 1 HAS 6 STUDENT(S).

DAYS: 1 TO 10

STUDENT: KAREN COURTNEY
D 1=100         D 2=100         D 3=100         D 4=100         D 5= 90
D 6=100         D 7=100         D 8=100
D 9=100         D10=100
TOTAL POINTS: 990 / 1000 = 99 %
TOTAL 100'S: 9 / 10 = 90 %

STUDENT: MICHAEL FUTCH
D 1=100         D 2=100         D 3=100         D 4=100         D 5=100
D 6=100         D 7=100         D 8=100
D 9=100         D10=100
TOTAL POINTS: 1000 / 1000 = 100 %
TOTAL 100'S: 10 / 10 = 100 %

STUDENT: JIM NYE
D 1=100         D 2=100         D 3=100         D 4=100         D 5=100
D 6=100         D 7=100         D 8=100
D 9=100         D10=100
TOTAL POINTS: 1000 / 1000 = 100 %
TOTAL 100'S: 10 / 10 = 100 %

STUDENT: TONY PATTERSON
D 1=100         D 2=100         D 3= 80         D 4=100         D 5=100
D 6=100         D 7=100         D 8=100
D 9=100         D10=100
TOTAL POINTS: 980 / 1000 = 98 %
TOTAL 100'S: 9 / 10 = 90 %

STUDENT: VERNON SCOTT
D 1= 80         D 2=< >         D 3=< >         D 4=< >         D 5=  0
D 6=  0         D 7=  0         D 8=  0
D 9=  0         D10=  0
TOTAL POINTS: 80 / 1000 = 8 %
TOTAL 100'S: 0 / 10 = 0 %

STUDENT: WENDELL SHORT
D 1=100         D 2=100         D 3=100         D 4=100         D 5=  0
D 6=  0         D 7=  0         D 8=  0
D 9=  0         D10=  0
TOTAL POINTS: 400 / 1000 = 40 %
TOTAL 100'S: 4 / 10 = 40 %


TOTAL GROUP POINTS: 4450 / 6000 = 74.1667 %
TOTAL GROUP 100'S: 42 / 60 = 70 %
```

Figure 21 (2). SAMS: Student Points Data Access Module services contained within the system.

SAMS Data Transmission Routines. Upon selection by the user, the system executes the data transmission routine to transfer the data to the central time-sharing computer site. When the user establishes connection to the computer system through the telephone line and acoustic modem, the system establishes the required communications protocol with the time-sharing system and initiates the data transfer process. The system retrieves the data from the student diskette file structure, reformats the data for transmission, transmits the data, verifies the transmission, and prompts the user when the process is completed. The system assembles the data into separate blocks and calculates a checksum which is transmitted with the data and checked by the time-sharing system. If the data checksum does not match, the time-sharing system requests a retransmission from the microcomputer and the data transmission process continues.

SAMS Microcomputer System Utility Routines. Various routines are available on the system diskette which perform student disk file initialiation and formating tasks when new students are assigned to the program. Copy routines for backing both system and student data diskettes are also present in the utility routines.

Central Time-Sharing Computer Software Routines

The current software routines developed for the central time-sharing system are grouped into two general functions; the database management system, and the data communication routines. Most of the software development at the central computer level has focused upon using both existing software utility packages and the time-sharing system file control commands.

Databased Management System. As indicated earlier, the project is using the Scientific Information Retrieval (SIR) system for the database manager function, which provides an efficient method for storing hierarchical structured data for user retrieval functions, based upon a short-key query request language.

Data Communication Routines. The method employed to receive data from the local-site microcomputer systems is through the time-sharing system file control. When data has been transmitted into local data files, a procedure file is called to process the data for storage into the SIR system. The procedure file contains a sequence of control commands which execute various routines which perform checksum verification on transmitted data blocks and formating data files for inclusion into the SIR database.

Continuing System Development Activities

Local Site Microcomputer Development. The primary focus of development activities at the local sites will continuee to provide a greater user selection of data entry and retrieval system functions. The eight AMR routines were evaluated and modified with respect to data item deletions, insertions, and replacements. Modifications of these user functions increased the efficiency of the random access methods employed to store and retrieve data from student diskette databases. The same data item access procedures also provided expanded user functions for data summary report routines. This modification permitted users to employ a query-based retrieval of a subset of variables stored for any student. The developmental guidelines for this activity will be identified through discussions of what feedback is of most importance to the users. Formats for data presentation and display were continuously evaluated for effectiveness.

Further modifications of the data transmission routines reduced the amount of user interaction by providing optional communication protocols into different central computer time-sharing systems. The inclusion of different system communication options greatly improved the flexibility of the system to access other "standard" time-sharing systems which, in turn enhanced the system's disseminability.

Central Computer Development Activities. Complementing the local site development of different data transmission protocols, an evaluation of other large central computer systems were also undertaken to identify basic system development requirements needed for different central system data storage applications. The Indiana University Computer Network provided time-sharing access into two other large systems; a DEC-10 system, and a PRIME-750 system. The identification and documentation of the riquirements to access these systems also contributed to the ability to disseminate the system widely with little additional development time.

YEAR ONE QUARTER FOUR

During this quarter, project activities concentrated on the collection of student performance and post-test achievement data at the High School Sites In Indianapolis and Washington Township. In addition, the Student Activity Management System (SAMS) software was developed.

The post tests for Year One were administered during the first week of May, 1981. Tests administered included the Standard Diagnostic Reading Test, Standard Diagnostic Math Test, Informal Math Inventory and Informal Reading Inventory. In addition, the SAMS system was used to collect information related to student demographics and school related-activities. The data were collected by the teachers and entered by a data entry clerk.

The protypical version of the SAMS system was completed and field tested at North Central High School. The experimental version of the system was designed to monitor student academic performance including the amount of time allocated for instruction, the amount of time that a student spent working on assigned tasks and the accuracy with which the students completed their tasks. These data were collected both in resource rooms and in the regular classroom. The teacher specifically recorded the time that they allocated in their lesson plans for reading, math, science and social studies instruction. The engagement time involved the student recording the amount of time that elapsed between the time when he/she was assigned an assignment and the time when the student completes the assignment. These were collected by students using a self-recording system which was developed and field tested by the research team. Teachers and the researchers intermittently recorded reliability regarding the accuracy of the students recording. In all cases, the reliability recorded was 100%. Data were recorded regarding the number of pages assigned to the student the number of problems assigned and the accuracy of the students peformance. The authors readily acknowledge that this system is only an approximation of the measures used in collecting one facet of ALT data; however, given the prohibitive expense of collecting observational data, the authors believe these data will closely approximate the ALT data, but with a greatly reduced cost thus increasing the likelihood that schools will implement the system.

EVALUATION: YEAR ONE

Arlington High School Program

SDRT results. Students enrolled in the predominantly learning disabilities resource room at Arlington High School demonstrated uniform growth across all sub-tests of the standardized reading test. These results, depicted in Figure 22 and summarized in Table 2, and t-test comparisons of pretest results versus posttest results (N=14) all reveal statistically significant gains at the .01 level and beyond. In regard to specific subtests on the SDRT, Arlington students improved one grade level equivalent (GLE) on the average in auditory vocabulary, approximately 2.7 GLE's (from 5.8 to 8.5) in literal comprehension, 2.2 GLE's in inferential comprehension (from 5.8 to 8.0), approximately 2 GLE's in total comprehension (from 6.2 to 8.2). In the areas of language usage, students demonstrated a 3 GLE increase (from 5.0 to 9.0) in phonetic analysis and a 2 GLE improvement (from 7.0 to 9.0) in structural analysis. Average achievement in reading rate across students proved insignificant. Overall,the results demonstrate the outstanding effects of the teacher and instructional program.

Informal Reading Inventory Results. Results from the Pre-Post Informal reading test indicate that students (N=14) in the A.H.S. resource room improved slightly in their reading skills in terms of correct words per minute and errors per minute. The most significant results are more apparent, however, in an 11% increase in reading comprehension scores. These results appear in Table 3.

SDMT results. The data from the standardized mathematics test

Figure 22

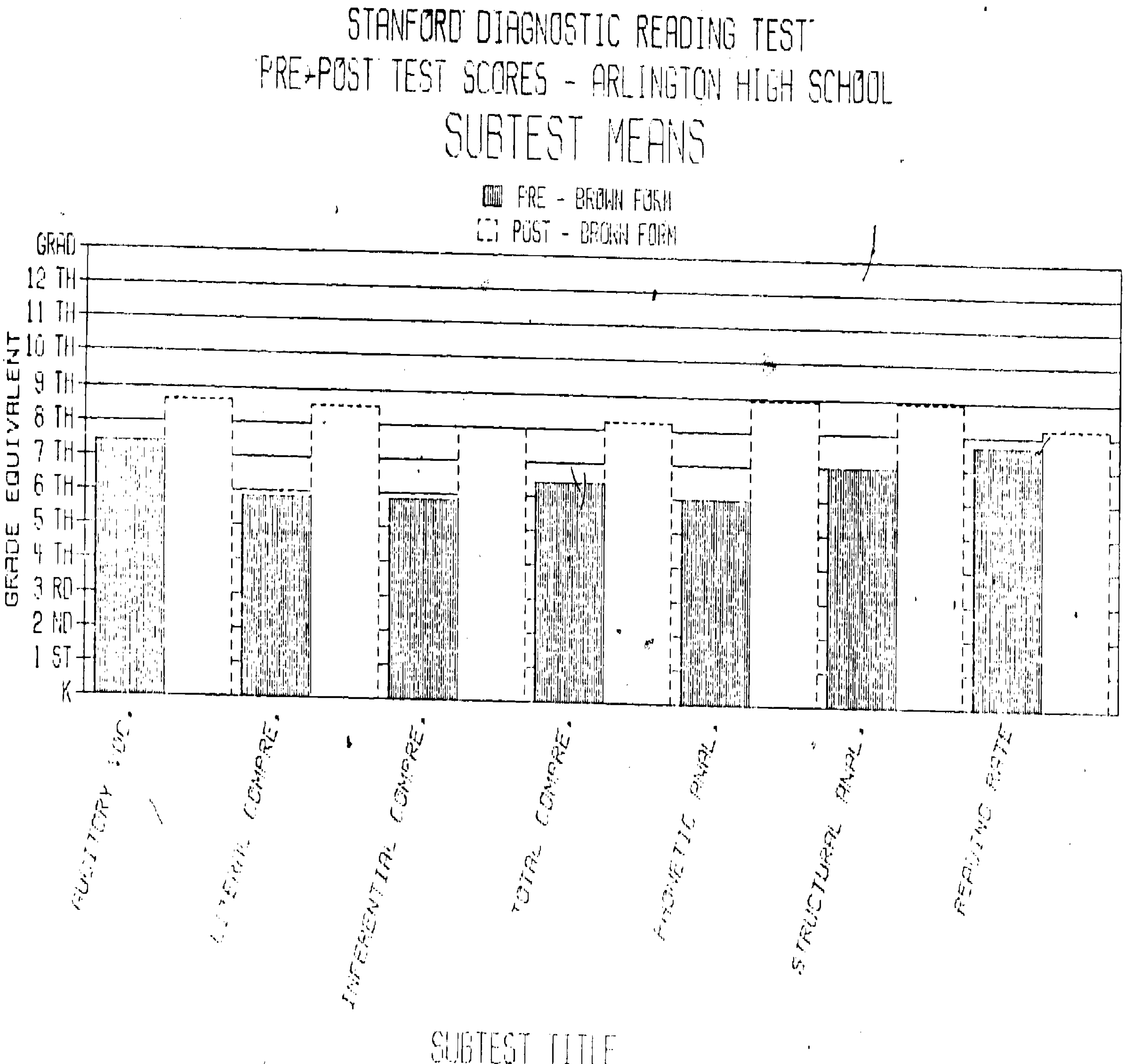

STANFØRD DIAGNOSTIC READING TEST
PRE+PØST TEST SCORES - ARLINGTON HIGH SCHØØL
SUBTEST MEANS
PRE - BRØWN FORM
POST - BRØWN FORM
GRADE EQUIVALENT
GRAD
12 TH
11 TH
10 TH
9 TH
8 TH
7 TH
6 TH
5 TH
4 TH
3 RD
2 ND
1 ST
K
AUDITORY VOC.
LITERAL COMPRE.
INFERENTIAL COMPRE.
TOTAL COMPRE.
PHONETIC ANAL.
STRUCTURAL ANAL.
READING RATE
SUBTEST TITLE

TABLE 2

GROWTH IN READING SKILLS, ARLINGTON STUDENTS (LD)

FOR THE 1980-1981 SCHOOL YEAR

STANFORD DIAGNOSTIC READING TEST (SDRT) RESULTS

	AUD. VOCAB.	LITERAL COMP.	INFERENTIAL COMP.	TOTAL COMP.	PHONETIC ANALYSIS	STRUCTURAL ANALYSIS	RATE
PRETEST	7.4	5.7	5.8	6.4	6.0	7.0	7.7
POSTTEST	8.6	8.5	8.0	8.2	8.9	8.9	8.2

TABLE 3

ARLINGTON HIGH SCHOOL

INFORMAL READING INVENTORY RESULTS

1980-1981

	Correct Words Per Minute	Errors Per Minute	Percent Comprehension
Pretest	98.5	5.9	70
Posttest	104.9	4.2	81

appear in Table 4 and graphically in Figure 23. Analysis of differences between the pretest and posttests using t-test comparisons indicate highly significant gains across all subtests of the SDMT. Subtest results reveal that students averaged over 3 GLE gain (from 5.0 to 8.1) in the number systems and numeration subtests. In the area of applications, students averaged over a 4 GLE gain during the academic year (from 5.0 to 9.5). Total score gains registered approximately a 3 GLE improvment from pre to posttesting (from 5.8 to 8.8) for students receiving basic math instruction in the Arlington High School resource room program.

Informal Math Inventory Results. Data displayed in Table 5 related to students' growth in 13 subskills in math indicate that Arlington High School students improved their computational skill in all sub areas of basic Arithmetic. On easier skills, students showed gains approximately 20 digits correct per minute whereas skills involving short-term memory (eg. "borrowing" or "canceling") students did not increase their speed at calculating digits to a significant degree.

Overall results from both the standardized mathematics measure and informal math measures indicate that the students receiving math instruction made outstanding gains during the academic year. The average academic growth observed ranged between 3 and 4 GLE's. Moreover, students' grade level of functioning at the end of the year averaged between 8.0 and 9.0 indicating that these students could probably compete favorably with students enrolled in regular mathematics courses. These results indicate that despite long periods of academic fallowness secondary students classified as

TABLE 4

GROWTH IN MATH SKILLS, ARLINGTON, 10 STUDENTS

FOR THE SPRING SEMESTER 1980

STANFORD DIAGNOSTIC MATH TEST (SDMT) RESULTS

	NUMERATION	COMPUTATION	APPLICATIONS	TOTAL SCORES
PRETEST	5.1	6.4	5.2	5.7
POSTTEST	8.2	9.2	9.5	8.9

Figure 23

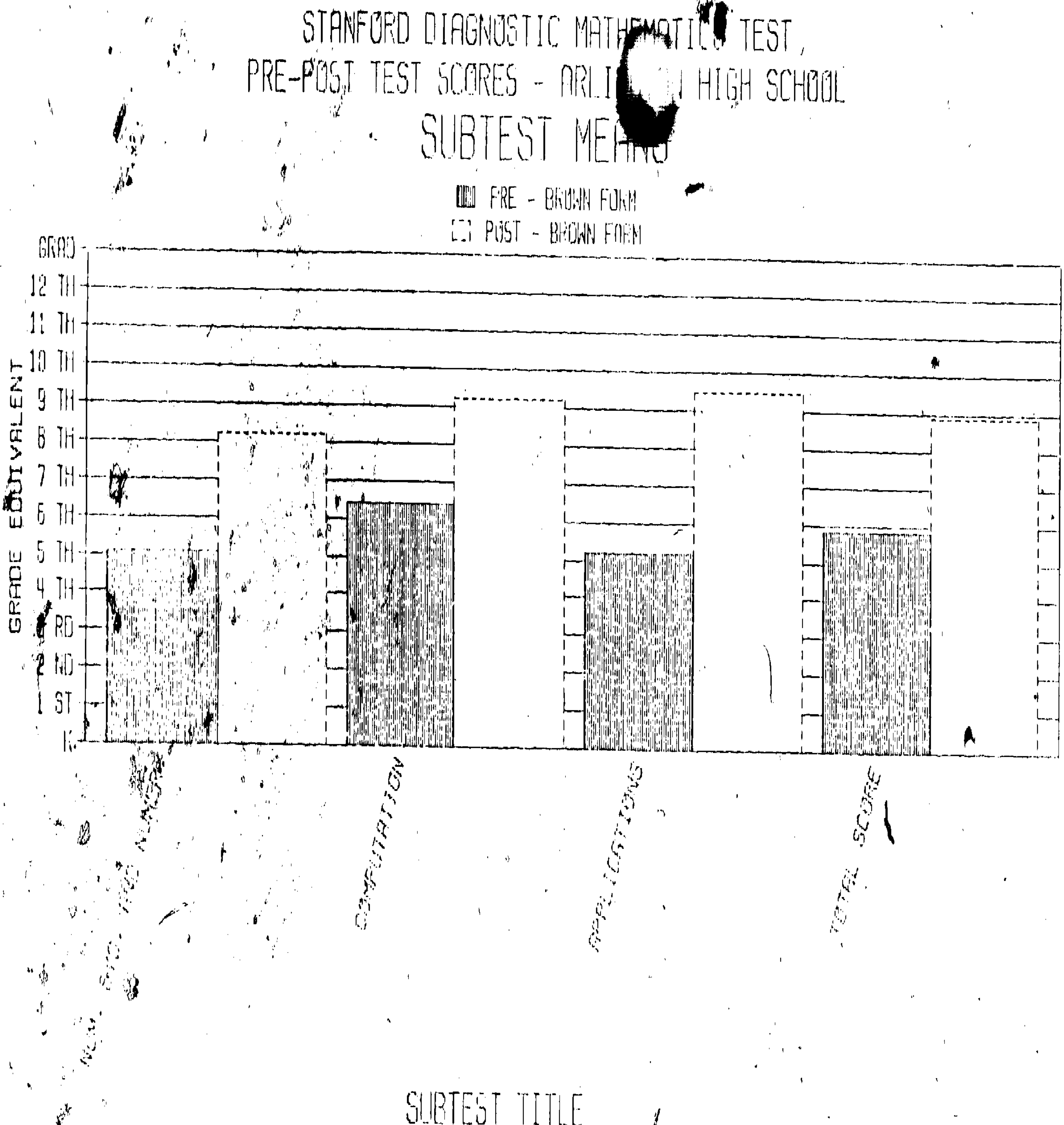

STANFORD DIAGNOSTIC MATH TEST
PRE-POST TEST SCORES
HIGH SCHOOL
SUBTEST ME
PRE - BROWN FORM
POST - BROWN FORM
GRADE EQUIVALENT
12 TH
11 TH
10 TH
9 TH
8 TH
7 TH
6 TH
5 TH
4 TH
3 RD
2 ND
1 ST
COMPUTATION
APPLICATIONS
TOTAL SCORE
SUBTEST TITLE

TABLE 5

STERLING INFORMAL MATH INVENTORY RESULTS

AVERAGE CORRECT DIGITS PER MINUTE

Arlington High School 1980-1981

	ADD 0-10	ADD 11-18	ADD DD W/O CARRY	ADD DD W/CARRY	SUBT 0-9	SUBT 10-18	SUBT DD W/O BORROW	SUBT DD W/BORROW	MULT 0-81	MULT SX W/O CARRY	MULT SX DD W/CARRY	MULT DD W/CARRY	DIVISION 0-81
retest	52	47	35	22	32	22	27	12	41	36	20	19	19
osttest	78	65	45	20	55	35	37	16	62	52	28	27	34

learning disabled and emotionally disturbed, given proper instruction and motivation, can not only learn at the same rate as their academic peers, but actually achieve at higher rates than commonly thought.

Shortridge High School Program

SDRT results. Students in the Shortridge High School unfortunately showed very little improvement in achievement reading over the course of the 1980-1981 school year. However, data presented in Table 6 and Figure 24 reveal that, on the average, students did not regress in achievement over the year. The only significant improvement in average performance appears to be in the area phonetic analysis in which the students improved approximately 1.5 GLE's (from 2.5 to 4.0). It should be noted, however, that despite the lack of statistical significance, the average gain scores exceeded all of the previous gain scores attained by the students enrolled in the program. Thus, despite the lack of significance, the students' achievement growth was greater than it had been in previous years.

Informal reading inventory results. The data appearing in Table 7 indicate that the students enrolled in the Shortridge program showed an average gain in rate of words read correctly of approximately 14 words/minute. Error rate, however, increased from an average of three words per minute to five. Comprehension remained at around the 90% over the 1980-1981 academic year. These results may indicate teacher emphasis on oral reading accuracy, word recognition, and word analysis training. They are corroborated by a slight increase noted in SDRT post test increasing reading rate.

TABLE 6

GROWTH IN READING SKILLS, SHORTRIDGE STUDENTS (LD)

FOR THE 1980-1981 SCHOOL YEAR

STANFORD DIAGNOSTIC READING TEST (SDRT) RESULTS

	AUD. VOCAB.	LITERAL COMP.	INFERENTIAL COMP.	TOTAL COMP.	PHONETIC ANALYSIS	STRUCTURAL ANALYSIS	R
PRETEST	4.1	2.4	2.6	3.5	2.4	3.0	2
POSTTEST	4.2	2.2	2.2	3.2	4.0	3.5	2

Figure 24

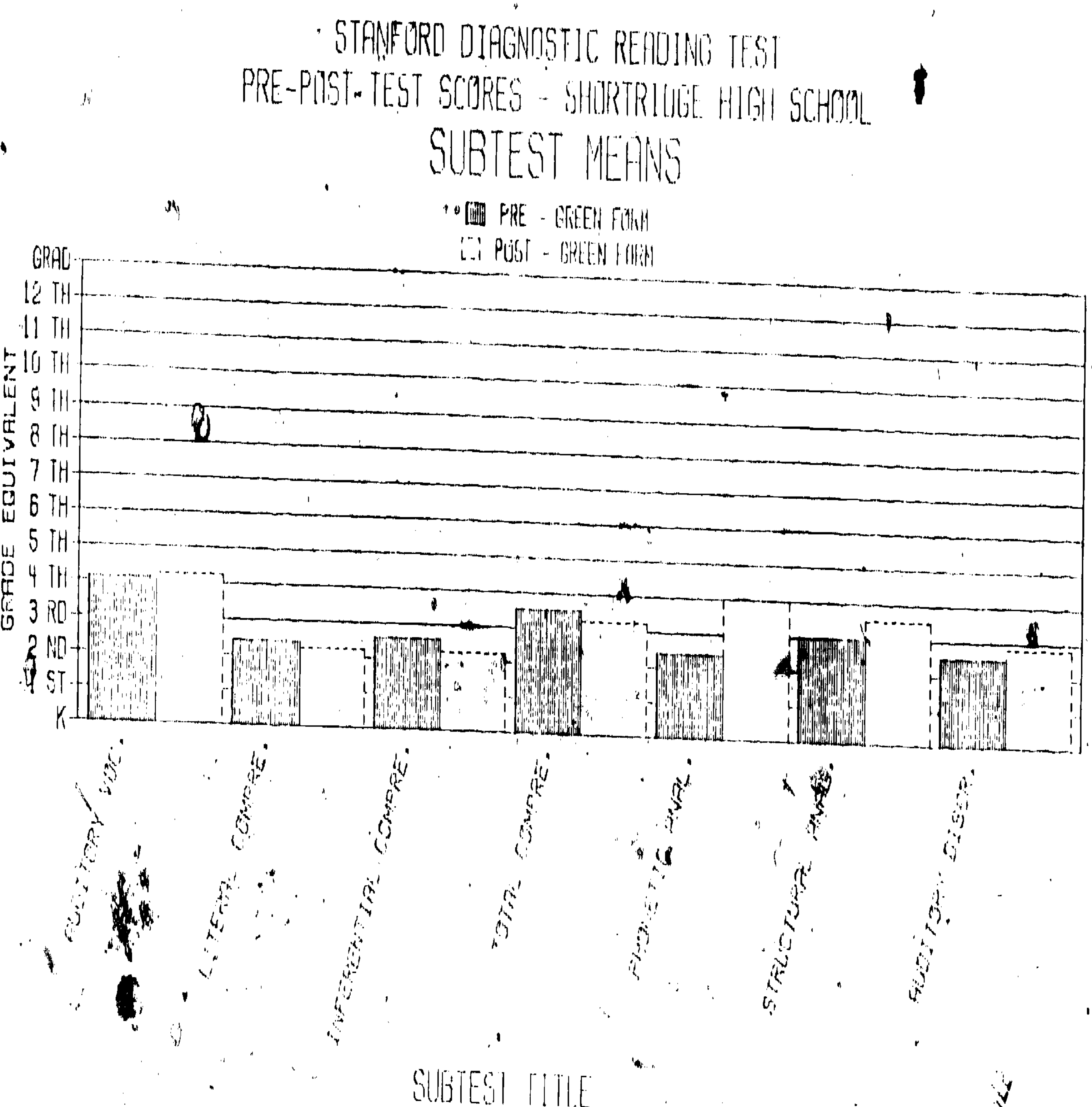

STANFORD DIAGNOSTIC READING TEST
PRE-POST-TEST SCORES - SHORTRIDGE HIGH SCHOOL
SUBTEST MEANS
PRE - GREEN FORM
POST - GREEN FORM
GRADE EQUIVALENT
GRAD
12 TH
11 TH
10 TH
9 TH
8 TH
7 TH
6 TH
5 TH
4 TH
3 RD
2 ND
1 ST
K
LITERAL COMPRE.
INFERENTIAL COMPRE.
TOTAL COMPRE.
STRUCTURAL ANAL.
SUBTEST TITLE

TABLE 7

SHORTRIDGE HIGH SCHOOL

INFORMAL READING INVENTORY RESULTS

	CORRECT WORDS /MINUTE	ERRORS/ MINUTE	PERCENT COMPREHENSION
PRETEST	56	3	91
POSTTEST	70	5	92

SDMT results. Analysis of pre-test compared with post-test results on the SDMT depicted in Table 8 and Figure 25 reveal that students enrolled in the Shortridge High School mathematics program showed virtually no improvement in mathematics achievement during the 1980-1981 school year. Students continued to function between the 3rd and 4th gradelevel equivalent on Number systems and Numeration, Applications, and Total Score subjects. They remained stabilized, for the most part, at approximately 4.0 GLE in Computational skills over the course of the year.

Informal mathematics inventory results. Student gains in correct digits per minute across the thirteen skill levels tapped by the IMI measure enrolled in the Shortridge program are shown in Table 9. Compared with results found on the SDMT, students in the Shortridge program showed some improvement in their ability to rapidly calculate in basic math areas. Students gained in all but one math sub skill and showed impressive improvement especially at lower sub skill levels. In the skill area of multiplication without carrying, they made an impressive 27 digits per minute gain.

Summary of Shortridge Evaluation

Students enrolled in the program at Shortridge High School demonstrated some growth in language arts or mathematics as indicated by both standardized and informal test results. These results are disappointingly at variance with those observed at the Arlington site. One problem encountered at this site involved the lower general achievement and intelligence levels of students compared to those enrolled at the Arlington program. In addition, the teacher

TABLE 8

GROWTH IN MATH SKILLS, SHORTRIDGE, 10 STUDENTS

FOR THE SPRING SEMESTER 1980

STANFORD DIAGNOSTIC MATH TEST (SDMT RESULTS)

	NUMERATION	COMPUTATION	APPLICATIONS	TOTAL SCORES
PRETEST	3.6	4.8	3.8	3.8
POSTTEST	3.7	4.5	3.8	4.0

Figure 25

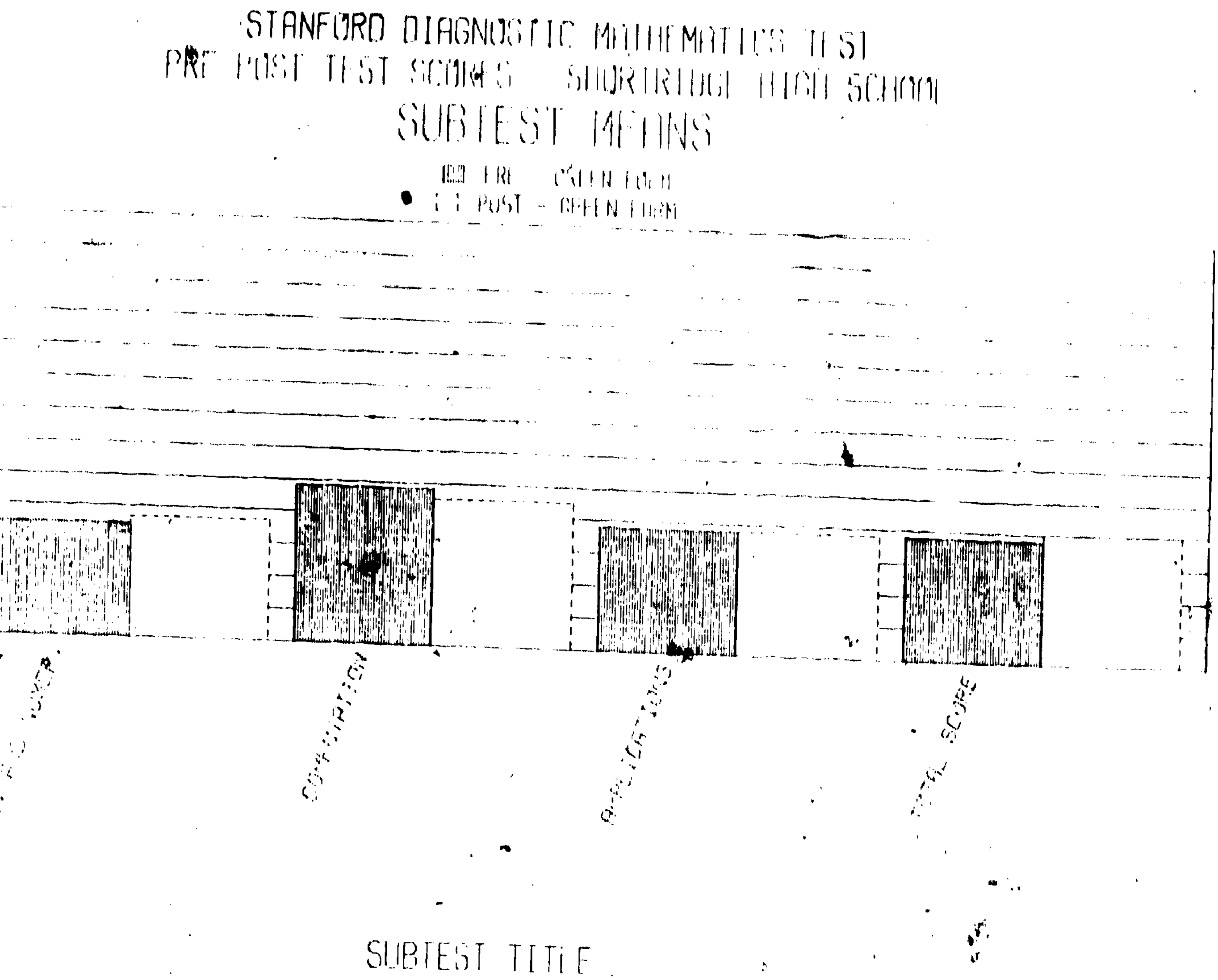

STANFORD DIAGNOSTIC MATHEMATICS TEST
PRE POST TEST SCORES SHORTRIDGE HIGH SCHOOL
SUBTEST MEANS
PRE - GREEN FORM
POST - GREEN FORM
COMPUTATION
APPLICATIONS
TOTAL SCORE
SUBTEST TITLE

TABLE 9

INFORMAL MATH INVENTORY RESULTS

AVERAGE CORRECT DIGITS PER MINUTE

Shortridge High School 1980-1981

	ADD 0-10	ADD 11-18	ADD DD W/O CARRY	ADD DD W/CARRY	SUBT 0-9	SUBT 10-18	SUBT DD W/O BORROW	SUBT DD W/BORROW	MULT 0-81	MULT SX W/O CARRY	MULT SX DD W/CARRY	MULT DD W/CARRY	DIVISION 0-81
etest	32/4	22/9	20/1	16/0	22/1	8/2	18/3	6/6	20/5	23/8	11/5	9/8	13/2
sttest	42/5	36/1	33/1	16/4	34/2	15/3	26/2	9/4	29/6	50/7	16/11	18/15	12/5

assigned to this classroom was only in her second teaching year. When one compares the data taken from Arlington, students in the initial stages of the project, however, there does not appear to be a large discrepancy in achievement levels between the results observed between the two sites. Thus, the results may indicate the differing experience levels of the two teachers. As the level of sophistication of project procedure may be overwhelming to inexperienced teachers, a caveat in the use of these procedures may be that is in inappropriate for implementation by teachers with limited experience. It may be that important element in the successful implementation of this or any project concerns the skill and motivation of the teacher, the type of training received, as well as dedication to following procedures to be implemented in a model program.

The IMI data for Arlington High School indicated that the average student increased their rate of calculating.

1.) Add facts 0-10 increased by 20 correct digits per minute.

2.) Add facts 11-18 increased by 7 correct digits per minute.

3.) Subtraction facts 0-9 increased by 8 correct digits per minute.

4.) Subtraction facts 10-18 increased by 3 correct digits per minute.

5.) Multiplication facts 0-81 incrased by 11 correct digits per minute.

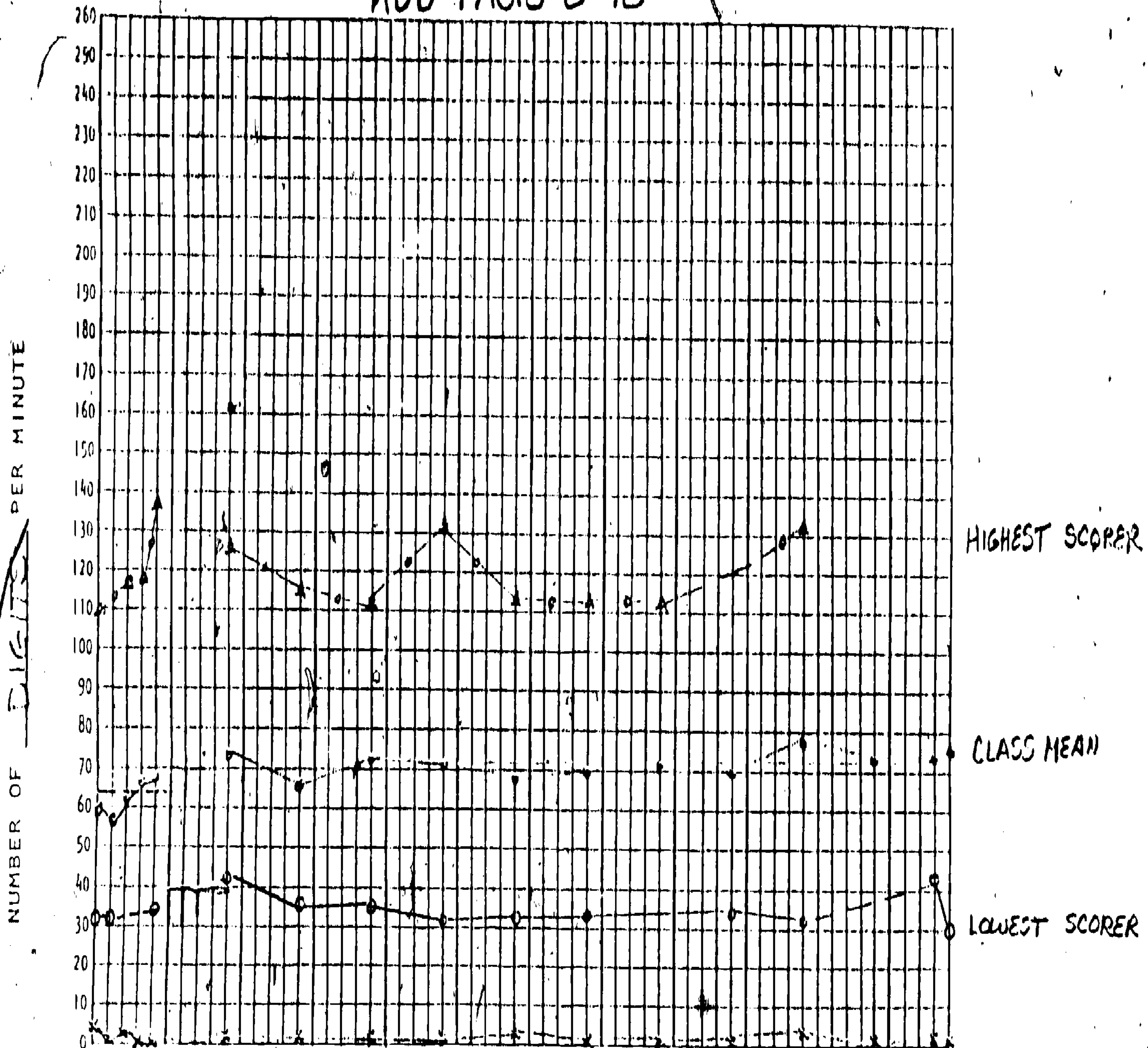
6.) Division facts 0-81 increased by 7 correct digits per minute.

Overall, the data indicates that the students gradually increased their proficiency in the four mathematical operations. The greatest proficiency was attained in the area of addition followed by multiplication, division, and finally subtraction.

NAME ______ SCHOOL Arlington (class) TEACHER #1

GRADE ______ AGE ______ SUBJECT NIE

ADD FACTS 0-10



DAYS M M M M M M M M M M M M

DATE 1/30/81 2/6 2/13 2/20 2/27 3/6 3/13 3/20 3/27 4/10 4/24 5/1-5/8

WEEK 1 2 3 4 5 6 7 8 9 10 11 12

Mean Class SCORE(S) 60/4 72/1 65/1 72/1 71/1 69/2 70/1 71/1 70/1 76/3 74/1 75/2-77/1

58/1

[illegible]

67/1

68/1

$\bar{M}$ = 63/2 $\bar{M}$ = 72/1

--- Average Mean

Corrects

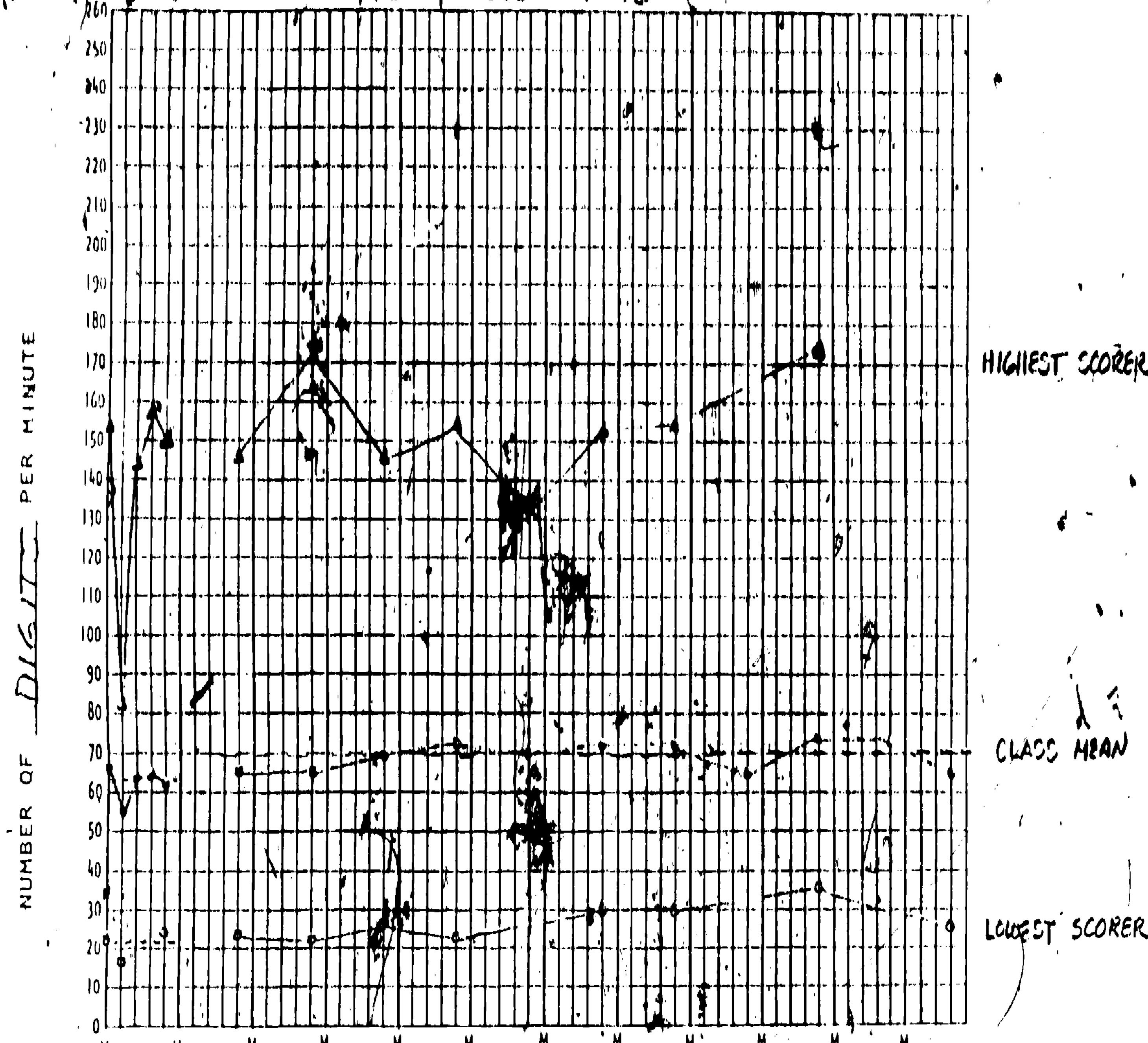
Errors

Corrects

NAME ______ SCHOOL Arlington (Class) TEACHER ______

GRADE ______ AGE ______ SUBJECT NIE

ADD FACTS - 11-18



DATE	1/30/81	2/6	2/13	2/20	2/27	3/6	3/13	3/20	3/27	4/10	4/24	5/1-5/8	
WEEK	1	2	3	4	5	6	7	8	9	10	11	12	
MEAN CLASS SCORE(S)	67/1	66/1	66/1	71/1	73/1	70/1	73/1	72/1	66/1	71/2	73/1	68/2	$\bar{M}$ = 70/1
	56/1												
	71/1												
	66/1												
	67/2												

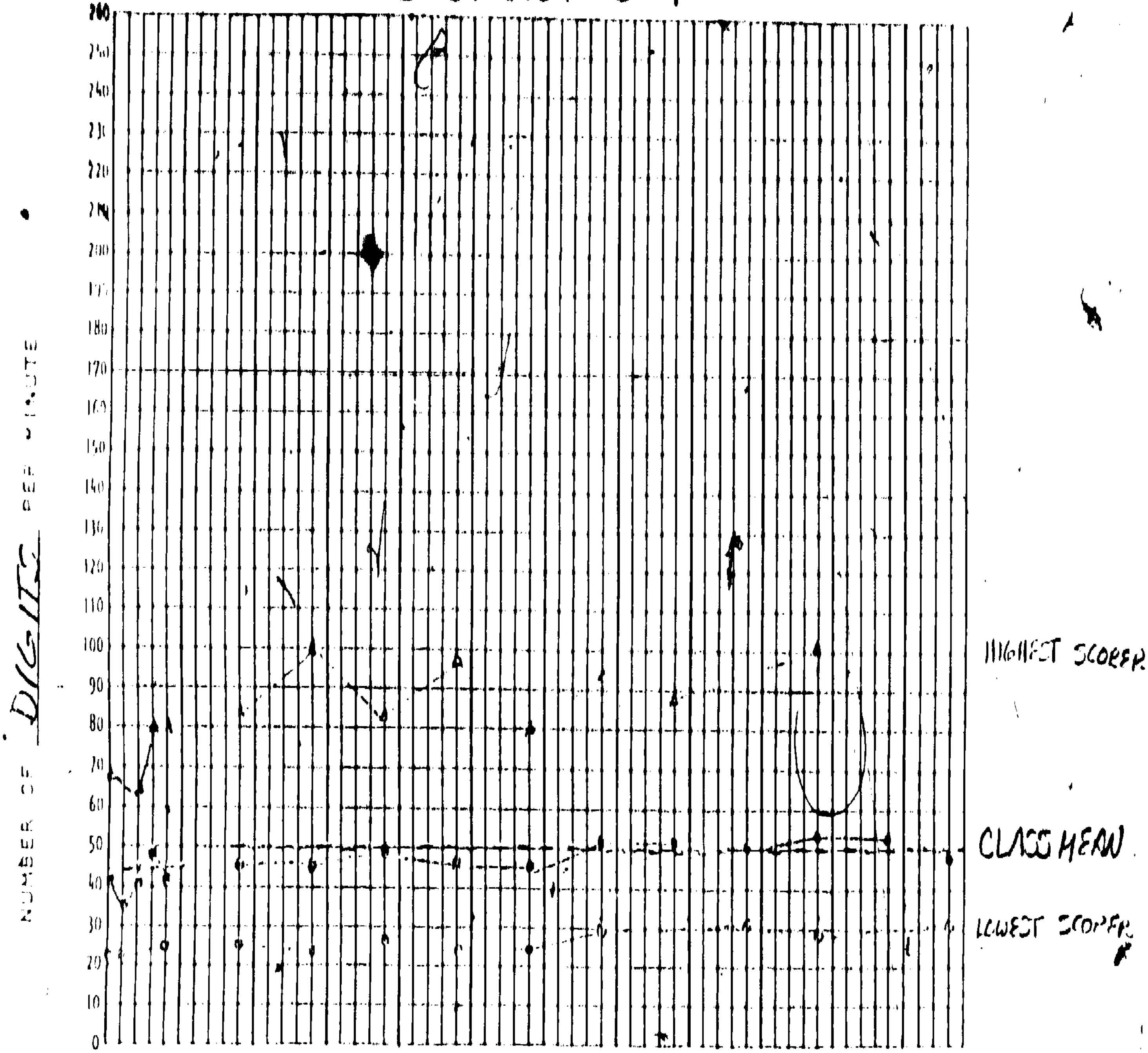
$\bar{M}$ = 63/1

CLASS MEAN GAIN 7/1

NAME ______ SCHOOL Arlington (Class) TEACHER #1

GRADE ______ AGE ______ SUBJECT NIE

SUBTRACT 0-9



DAYS	M	M	M	M	M	M	M	M	M	M	M	M
DATE	1/30	2/6	2/13	2/20	2/27	3/6	3/13	3/20	3/27	4/10	4/24	5/1
WEEK	1	2	3	4	5	6	7	8	9	10	11	12
MEAN CLASS SCORE(S)	41/1	46/1	46/1	50/1	47/1	46/1	52/1	52/1	51/1	52/2	53/1	47/1
	36/1											
	41/1											
	42/1											
	42/1											

311 = 50/1

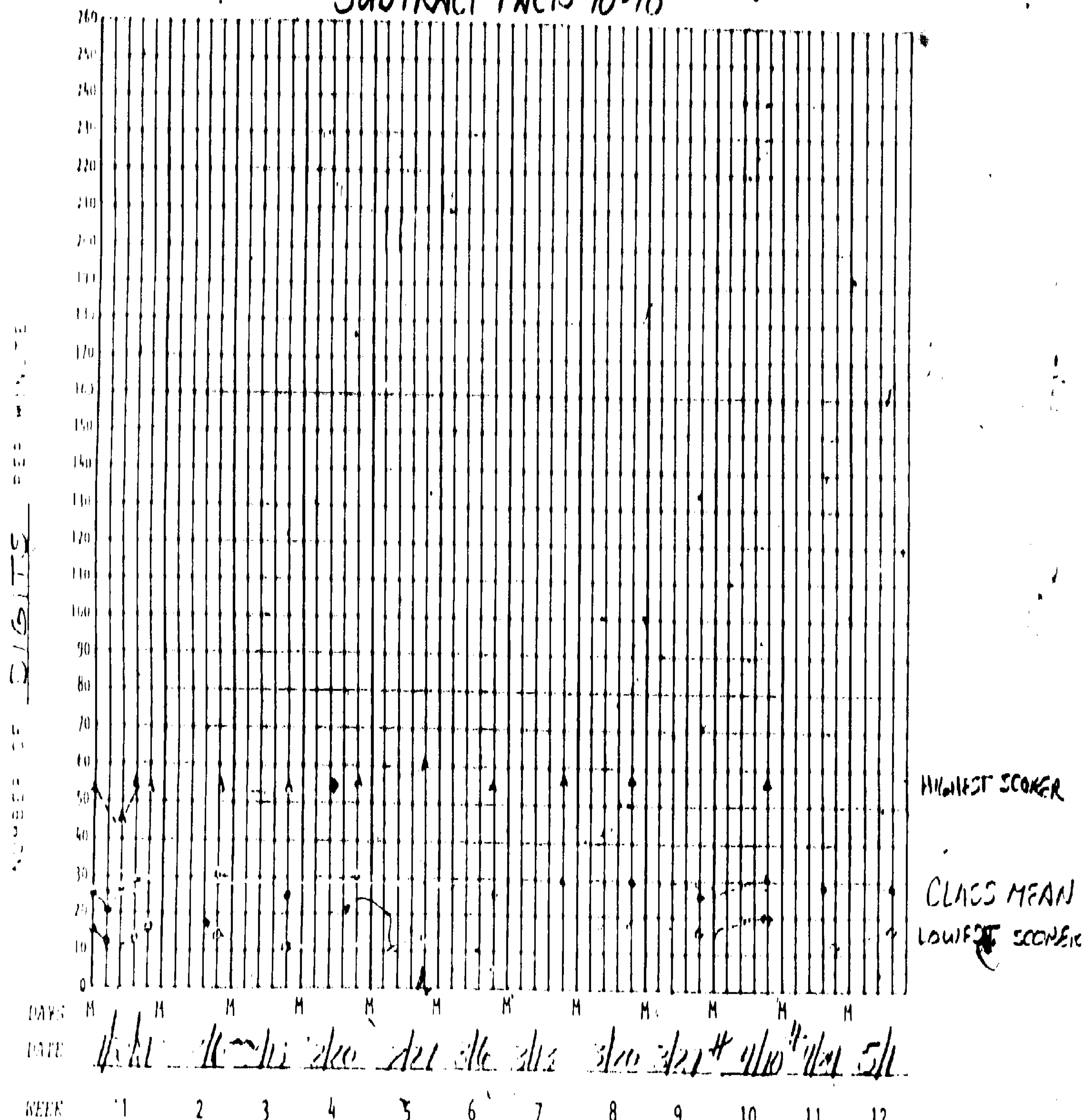
105 M̄ = 42/1

BEST COPY AVAILABLE

NAME ______ SCHOOL Arlington (Chse) TEACHER #1

GRADE ______ AGE ______ SUBJECT NIE

SUBTRACT FACTS 10-18



MEAN CLASS SCORE(S) 26/1 31/1 26/1 31/1 23/1 21/1 26/1 30/1 27/1 31/1 26/1 29/2 $\bar{X}$/1 = 29/2

27/1

21/1

29/1

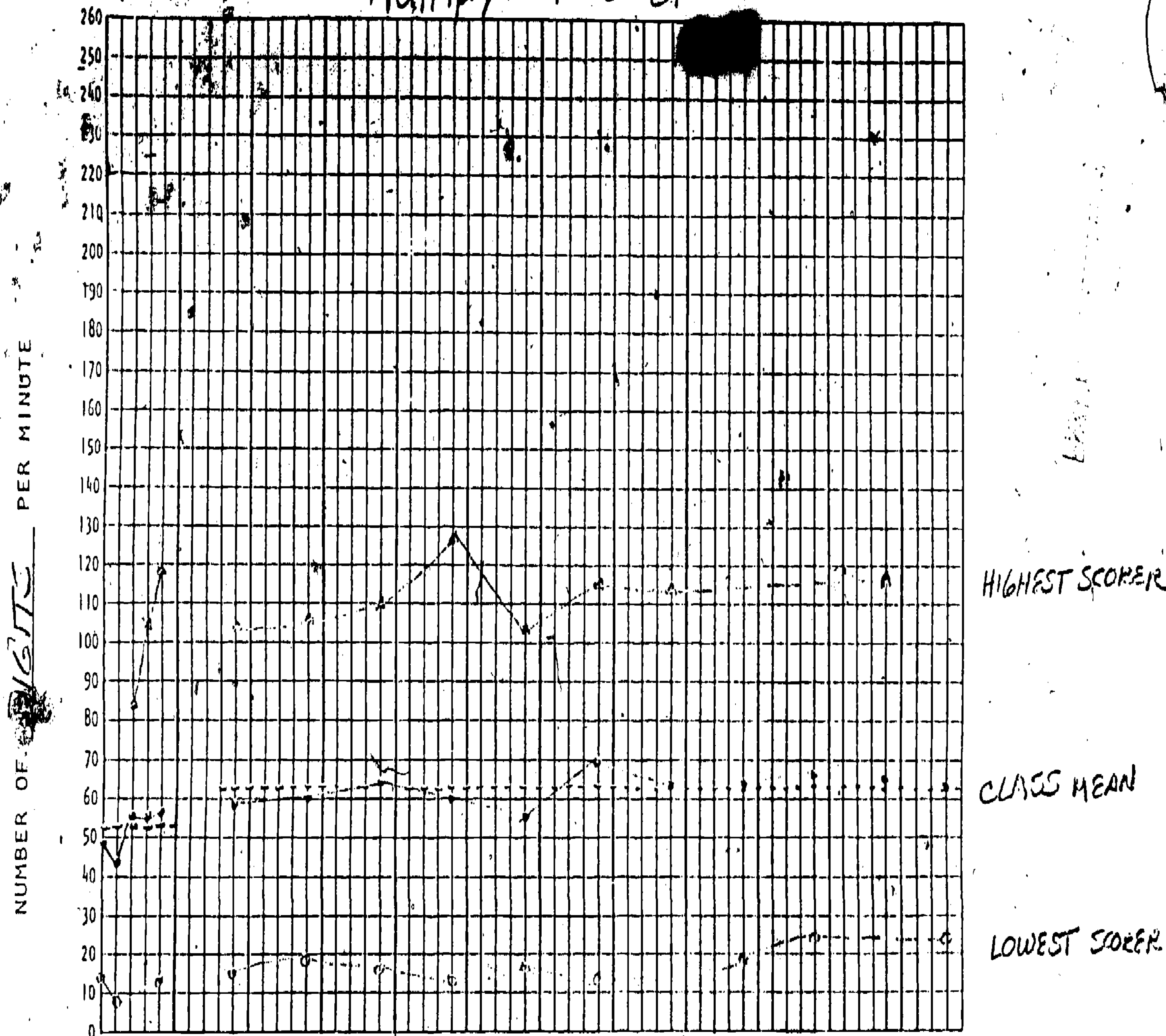
29/1

$\bar{M}$ = 26/1

NAME ____________ SCHOOL Arlington (Class) TEACHER #1

GRADE ____________ AGE ____________ SUBJECT NIE

Multiply Facts 0-81



DAYS	M	M	M	M	M	M	M	M	M	M	M	M
DATE	1/30/81	2/6	2/13	2/20	2/27	3/6	3/13	3/20	3/27	4/10	4/21	5/1
WEEK	1	2	3	4	5	6	7	8	9	10	11	12
MEAN CLASS SCORE(S)	49/7	59/3	61/4	65/3	61/4	57/3	70/1	61/3	64/4	67/5	66/2	61/3
	44/7											
	56/2											
	56/3											
	57/2											

} $\bar{M}$ = 63/3

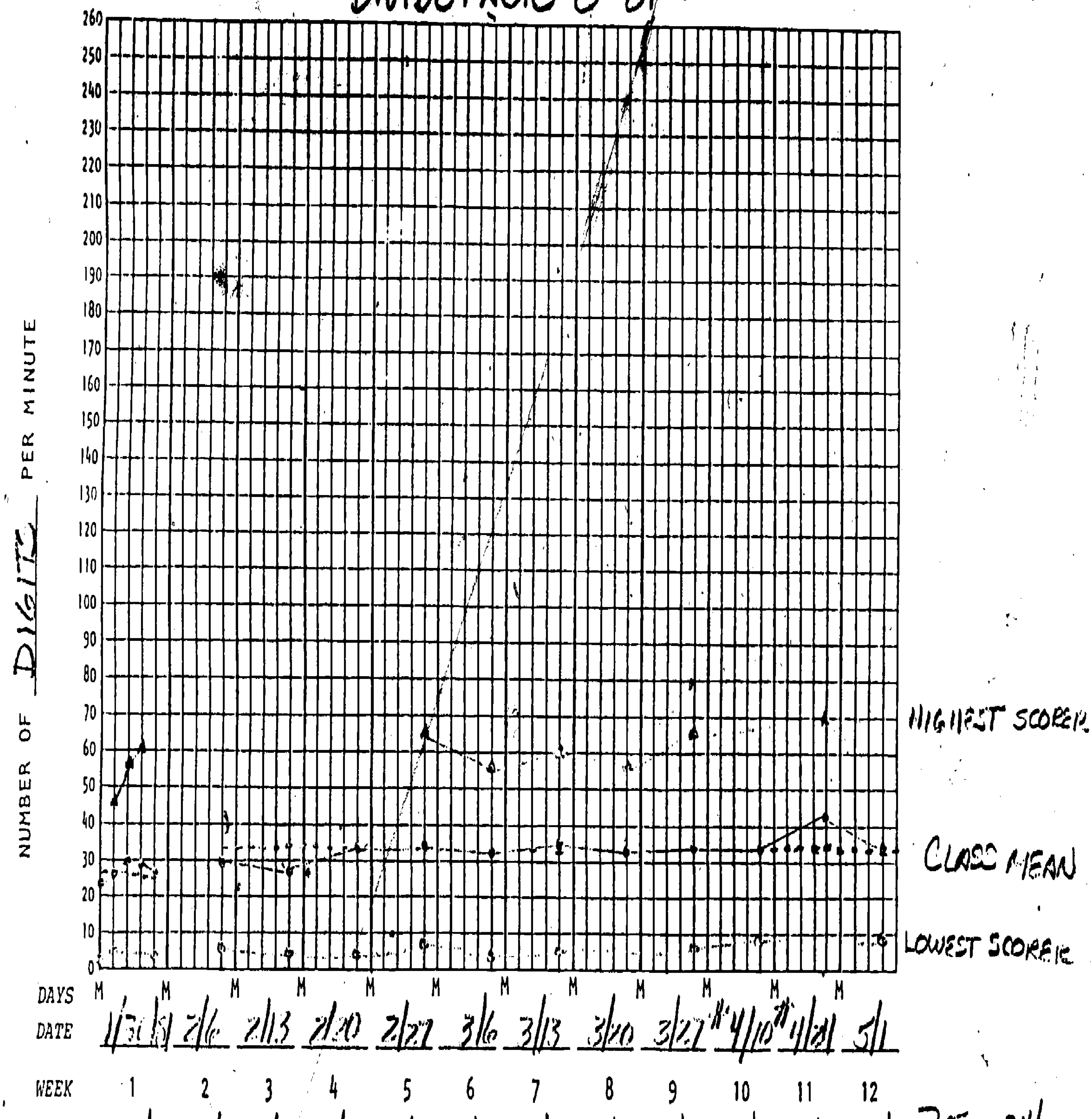
$\bar{M}$ = 52/3

Class Mean Gain = 11/0

NAME ______ SCHOOL Arlington (Class) TEACHER #1

GRADE ______ AGE ______ SUBJECT NIE

DIVIDE FACTS 0-81



MEAN CLASS SCORE(S) 27/2 30/2 28/2 31/2 35/2 32/2 34/2 33/2 31/3 31/3 41/1 34/3 3 $\bar{M}$ = 34/2

21/2

30/3

29/2

25/2

$\bar{M}$ = 27/2

Summary of 1980-81 NIE Data

1. Test-Retest Reliability of IMI Data

Test-retest reliability using a simple correlation procedure was performed on each of the 13 subtests of the IMI.

Three testing days were used at the beginning of the Fall 1980 semester. Reliability was calculated using all three of the possible presentations of this data: 1-2, 1-3, and 2-3.

Data for this is reported in three parts:

Figure 26 Both Schools (N=24)
Figure 27 Arlington High School (N=18)
Figure 28 Shortridge High School (N=5 or 6)

Overall, the reliability of the subtests is well within acceptable limits with a high degree of similarity between the three different comparisants. The between school results is an entirely different story though.

TEST COMPARISON

Sub Skill	1st - 2nd	1st - 3rd	2nd - 3rd
Addition - 0-10	.70 **	.29	.23
Addition -11-18	.85 **	.88 **	.81**
Addition Double digit without carry	.78 **	.85 **	.85**
Addition Double digit with carry	.73 **	.80 **	.78**
Subtraction - 0-9	.84 **	.69 **	.86**
Subtraction -10-18	.65 **	.80 **	.81**
Subtraction Double digit without borrow	.64 **	.63 **	.83**
Subtraction Double digit with borrow	.75 **	.77 **	.83**
Multiplication - 0-81	.92 **	.95 **	.93**
Multiplication single x double without carry	.83 **	.84 **	.81**
Multiplication single x double with carry	.85 **	.87 **	.89**
Multiplication double x double	.78 **	.73 **	.76**
Division- 0-81	.73 **	.87 **	.83**

Figure 26

Simple correlations of test-retest data on IMI. Fall 1980
School = Arlington and Shortridge (N=24)
Measure = digits per min. correct
** is significance to .01 level

TEST COMPARISON

Sub Skill	1st - 2nd	1st - 3rd	2nd - 3rd
Addition - 0-10	.77 **	.19	.00
Addition -11-18	.85 **	.90 **	.79 **
Addition Double digit without carry	.77 **	.82 **	.83 **
Addition Double digit with carry	.71 **	.86 **	.74 **
Subtraction - 0-9	.85 **	.74 **	.85 **
Subtraction -10-18	.55 **	.75 **	.74 **
Subtraction Double digit without borrow	.58 **	.56 **	.75 **
Subtraction Double digit with borrow	.47 *	.48 *	.70 **
Multiplication - 0-81	.89 **	.95 **	.92 **
Multiplication single x double without carry	.81 **	.77 **	.81 **
Multiplication single x double with carry	.82 **	.80 **	.85 **
Multiplication double x double	.75 **	.64 **	.72 **
Division- 0-81	.81 **	.90 **	.73 **

Figure 27

Simple correlations of test-retest data
on IMI. Fall 1980
School = Arlington (N=18 or 19)
Measure = digits per min. correct
** is significance to .01 level
* is significance to .05 level

Sub Skill	1st - 2nd	1st - 3rd	2nd - 3rd
Addition - 0-10	-.41	.07	.14
Addition -11-18	.48	.87 *	.80 *
Addition Double digit without carry	.16	.70	.20
Addition Double digit with carry	.15	-.24	.88 *
Subtraction - 0-9	.76	.28	.74
Subtraction -10-18	.77	.76	.88 *
Subtraction Double digit without borrow	.28	.47	.87 *
Subtraction Double digit with borrow	.97 **	.98 **	.97 **
Multiplication - 0-81	.62	.84 *	.74
Multiplication single x double without carry	.04	.48	-.02
Multiplication single x double with carry	.36	.96 **	.57
Multiplication double x double	.80 *	.99 **	.81 *
Division- 0-81	.96 **	.99 **	.98 **

Figure 28-

Simple correlations of test-retest data
on IMI. Fall 1980
School = Shortridge (N=5)
Measure = digits per min. correct
** is significance to .01 level
* is significance to .05 level

Overall, the results indicate that the Informal Math Inventory used was highly reliable. The data collected at Arlington High School had particularly high coefficients, while the Shortridge test-retest reliability data were frequently insignificant. The discrepancy of the Shortridge data, coupled with anectodal reports of student ability during some of the testing sessions prompted the researchers to question the validity of the Shortridge IMI data.

2. Correlation of IMI with SDMT Subtests & Total

Correlations of IMI Digits per minute correct (average of 3 days testing) with SDMT subtests were computed.

Since there was part pre and post data for both of these measures, computations were made for:

data---preIMI--preSDMT
postIMI--postSDMT

Data is reported in:
Figure 29 Arlington pre data
Figure 30 Arlington post data

IMI SUBTESTS	SDMT SUB TESTS				
	Number Systems (Brown)	Computation (Brown)	Application (Brown)	Total Score (Brown)	Application (Green)
Addition 0-10	.37	.44*	.07	.28	.26
Addition 11-18	.48*	.26	.18	.28	.44**
Addition double without carry	.05	-.02	-.23	-.11	.29
Addition double with carry	.29	.25	-.00	.16	.29
Subtraction 0-9	.31	.48*	.08	.29	.44*
Subtraction 10-18	.44*	.27	.15	.27	.26
Subtraction double without borrow	.36	.27	.11	.24	.47*
Subtraction double with borrow	.28	.24	.17	.24	.08
Multiplication 0-81	.24	.48*	.05	.30	.16
Multiplication single x double without carry	-.09	.12	-.35	-.21	.22
Multiplication single x double with carry	.55**	.44*	.23	.43*	.27
Multiplication double x double with carry	.46*	.42*	.32	.41*	.35
Division 0-81	.41*	.60**	.22	.48*	.36

Figure 29

Correlation of IMI with SMDT (PRE data)
School = Arlington
Measure = IMI - average DMPC
SDMT - grade equiv. score
** is significance to .01 level
* is significance to .05 level

IMI SUBTESTS	SDMT SUB TESTS				
	Number Systems (Brown)	Computation (Brown)	Application (Brown)	Total Score (Brown)	Application (Green)
Addition 0-10	.57**	.08	.40*	.40*	.50*
Addition 11-18	.50*	.20	.38	.38	.42*
Addition double without carry	.29	-.07	.21	.12	.27
Addition double with carry	.41*	.11	.30	.30	.36
Subtraction 0-9	.32	.21	.23	.24	.31
Subtraction 10-18	.40*	.35	.16	.34	.40*
Subtraction double without borrow	.24	.17	.05	.16	.16
Subtraction double with borrow	.31	.30	.30	.26	.40*
Multiplication 0-81	.49*	.23	.38	.44	.40*
Multiplication single x double without carry	.50*	-.13	.41*	.24	.41*
Multiplication single x double with carry	.37	.28	.26	.34	.16
Multiplication double x double with carry	.35	.16	.40*	.28	.16
Division 0-81	.34	.43*	.37	.47*	.39*

Figure 30

Correlation of IMI with SMDT (PRE data)
School = Arlington
Measure = IMI - average DMPC
SDMT - grade equiv. score
** is significance to .01 level
* is significance to .05 level

5. Correlations of IMI Averages with SDMT Subtests & Total

Correlations of IMI Digits per minute correct (average of 3 days testing) with SDMT subtests.

Each of the areas of +, -, x, and ÷ were averaged within each child for a composit average of the subtests in total and within each math area.

Figure 31 pre data
Figure 32 post data

Only Arlington High School was used. There was not enough data available from Shortridge High School.

IMI SUB-TEST AVERAGES	SDMT SUB TESTS				
	Number Systems (Brown)	Computation (Brown)	Application (Brown)	Total Score (Brown)	Application (Green)
Addition	.29	.03	.10	.16	.29
Subtraction	.31	.08	.12	.20	.31
Multiplication	.28	.10	.09	.20	.26
Division	.41*	.60 **	.22	.48 *	.36
Total	.30	.08	.11	.20	.29

Figure 31
Correlation of IMI subtest averages with SDMT (PRE data)
** is significance to .01 level
* is significance to .05 level

IMI SUB-TEST AVERAGES	SDMT SUB TESTS				
	Number Systems (Brown)	Computation (Brown)	Application (Brown)	Total Score (Brown)	Application (Green)
Addition	.43	.15	.21	.26	.26
Subtraction	.36	.23	.13	.23	.21
Multiplication	.48**	.23	.31	.34	.23
Division	.34	.43*	.37	.47*	.39*
Total	.44*	.21	.23	.29	.25

Figure 32
Correlation of IMI subtest averages with SDMT (PRE data)
** is significance to .01 level
* is significance to .05 level

The correlation of the subtests of the informal math inventory with the subtests of the Stanford Diagnostic Math Test vary widely. They range from six significant correlations between the computation subtest and the various subtests of the IMI to no sifnificant correlations between the applications subtest and the various subtests of the IMI. Overall, the results are predictable since the IMI provides a very fine grain assessment of student computational skills. It only follows that the strongest correlation should be with the computation subtest. An anlaysis of the computation subtest indicates that the preponderance of problems on the Brown Level were multiplication and division thus explaining the many significant correlations with comparable subtests on the IMI. On the other hand, there were very few addition and subtraction problems, so with a small sample and a reasonably high probability of student errors, the liklihood of obtaining lower order correlations increased drastically.

3. <u>Test-Retest Reliability of IRI</u>

Test-retest reliability using a sample correlation procedure was performed on each of the 4 measures taken on the IRI.

Three testing days were used at the beginning of the Fall 1980 semester. Reliability was calculated using all three presentations of this data: 1-3, 2-3, and 1-3.

Data for this is reported in:

Figure 33 Both Schools
Figure 34 Arlington High School
Figure 35 Shortridge High School

SUB SKILL MEASURE	TEST COMPARISON		
	1st-2nd	1st-3rd	2nd-3rd
CORRECT PERCENTAGE	.68**	.79 **	.70**
CORRECT RATE	.93**	.82 **	.85**
ERROR RATE	.88**	.95 **	.87**
COMPREHENSION QUESTIONS PERCENT CORRECT	.46**	.56 **	.45*

Figure 33
Simple correlations of test-retest data on IRI. Fall 1980
School = Both
** is significance to .01 level
* is significance to .05 level

SUB SKILL MEASURE	TEST COMPARISON		
	1st-2nd	1st-3rd	2nd-3rd
CORRECT PERCENTAGE	.84**	.79**	.80**
CORRECT RATE	.93**	.84**	.91**
ERROR RATE	.96**	.96**	.95**
COMPREHENSION QUESTIONS PERCENT CORRECT	.07	.27	.15

Figure 34
Simple correlations of test-retest data on IRI. Fall 1980
School = Arlington (N=14)
** is significance to .01 level

SUB SKILL MEASURE	TEST COMPARISON		
	1st-2nd	1st-3rd	2nd-3rd
CORRECT PERCENTAGE	.48	.77*	-.11
CORRECT RATE	.89**	.92**	.63
ERROR RATE	.00	.64	-.17
COMPREHENSION QUESTIONS PERCENT CORRECT	.39	.65	.62

Figure 35
Simple correlations of test-retest data on IRI. Fall 1980
School = Shortridge
** is significance to .01 level
* is significance to .05 level

The test-retest reliability of the informal reading inventory was significant. The data for Arlington and Shortridge mirrored the informal math data since the Arlington scores other than in the area of reading comprehension were all correlated at the .05 level of significance. The Shortridge data were inconsistent, consequently they were suspect.

4. Correlation of IRI and SDRT-Subsets & Total

Correlations of IRI measures (average of 3 days testing) with SDRT subtests and totals were computed.

Arlington and Shortridge used different SDRT forms for their measurements:

Arlington = Brown Level A
Shortridge = green Level B

Pre IRI and pre SDRT tests were correlated as well as post IRI and post SDRT.

Figure 36 Arlington pre data
Figure 37 Arlington post data
Figure 38 Shortridge pre data
Figure 39 Shortridge post data

SDRT SUBTESTS	IRI SUBJECT MEASURES		
	CORRECT RATE	ERROR RATE	READING COMPREHENSION
AUDITORY VOCABULARY	.03	.21	-.01
READING COMPREHENSION LITERAL	.34	-.23	.26
INFERENTIAL	.39	-.14	.22
TOTAL	.41	-.25	.28
PHONETIC ANALYSIS	-.05	-.26	-.18
STRUCTURAL ANALYSIS	-.03	-.45*	-.33
AUDITORY DESCRIMINATION	.30	-.20	.24

Figure 36
Correlation of IRI with SDRT (PRE data)
FORM = Brown Level A
SCHOOL = Arlington (N=14)
Measure = SDRT = grade level
* is significance to .05 level

SDRT SUBTESTS	IRI SUBJECT MEASURES		
	CORRECT RATE	ERROR RATE	READING COMPREHENSION
AUDITORY VOCABULARY	.15	.28	.06
READING COMPREHENSION LITERAL	.19	-.36	.06
INFERENTIAL	.17	-.17	.12
TOTAL	.06	-.44	.14
PHONETIC ANALYSIS	.29	.17	-.14
STRUCTURAL ANALYSIS	.20	-.46*	-.27
AUDITORY DESCRIMINATION	.50*	.90**	-.22

Figure 37
Correlation of IRI with SDRT (PRE data)
FORM = Brown Level A
SCHOOL = Arlington (N=14)
Measure = SDRT = grade level
** is significance to .01 level
* is significance to .05 level

SDRT SUBTESTS	IRI SUBJECT MEASURES		
	CORRECT RATE	ERROR RATE	READING COMPREHENSION
AUDITORY VOCABULARY	.18	-.37	.29
READING COMPREHENSION LITERAL	.45	-.74*	.89**
INFERENTIAL	.42	-.59	.78**
TOTAL	.51	-.29	.56
PHONETIC ANALYSIS	-.01	-.19	.37
STRUCTURAL ANALYSIS	.55	-.38	.43
AUDITORY DESCRIMINATION	-.11	-.16	.10

Figure 38
Correlation of IRI with SDRT (PRE data)
FORM = Green Level B
SCHOOL = Shortridge (N=8)
Measure = SDRT = grade level
** is significance to .01 level
* is significance to .05 level

SDRT SUBTESTS	IRI SUBJECT MEASURES		
	CORRECT RATE	ERROR RATE	READING COMPREHENSION
AUDITORY VOCABULARY	-.28	-.40	.24
READING COMPREHENSION LITERAL	.34	-.52	.64*
INFERENTIAL	.61*	-.74*	.82**
TOTAL	.51	-.60*	.71*
PHONETIC ANALYSIS	.22	-.25	.32
STRUCTURAL ANALYSIS	.55	-.58	.69*
AUDITORY DESCRIMINATION	-.38	-.27	.21

Figure 39
Correlation of IRI with SDRT (PRE data)
FORM = Green Level B
SCHOOL = Shortridge (N=8)
Measure = SDRT = grade level
** is significance to .01 level
* is significance to .05 level

The correlations between the scores attained on the Informal Reading Inventory (IRI) and the subtests of the Stanford Diagnostic Reading Test (SDRT) were largely non-significant (see previous figures). They suggested that the tests were not related and that they were measuring different behaviors. In this case, low order correlations were expected for the correct rate and error rate subtests since there are no comparable subtests on the SDRT. The data also indicate, however, that the comprehension subtests of the two instruments are measuring different behaviors thus suggesting that great care must be exercised in selecting the content for the comprehension items of the IRI since they do not appear to be measuring behaviors that are typically taught in most major textbooks and sampled on the SDRT.

The pre-post test comparison of the scores attained by the students at North Central High School indicated that the students grew almost two years on the literal comprehension subtest of the SDMT while they regressed slightly on the inferential comprehension subtest. Even after examining the student daily programs, we are unable to explain the discrepancy. When interviewed, the teacher indicated that the instructional program focused more on literal rather than inferential comprehension since the students were more deficient in that area at the beginning of the school year. The progress in this area was impressive and highlighted the effectiveness of the instructional program that included systematic on-going assessment and databased instructional development that allowed frequent opportunities for the students to read (see Tables 10 and 11).

TABLE 10

NORTH CENTRAL

SAMS SDRT DATA SUMMARY '80-'81

		SDRT PRE	SDRT POST	GAIN SCORE
Student 1:	Lit. Comp.	7.3	12.3	5.0
	Inf. Comp.	12.0	12.0	0.0
	Total Comp.	10.0	12.0	2.0
Student 2:	Lit. Comp.	4.6	6.4	1.8
	Inf. Comp.	5.2	5.4	0.2
	Total Comp.	4.8	5.9	1.1
Student 3:	Lit Comp.	2.7	5.6	2.9
	Inf. Comp.	4.1	5.1	1.0
	Total Comp.	3.4	5.1	1.7
Student 4:	Lit. Comp.	9.0	9.5	0.5
	Inf. Comp.	7.7	8.0	0.3
	Total Comp.	8.3	8.8	0.5
Student 5:	Lit. Comp.	2.8	3.5	0.7
	Inf. Comp.	3.5	1.3	-2.2
	Total Comp.	2.6	3.0	0.4
Student 6:	Lit. Comp.	4.6	5.6	1.0
	Inf. Comp.	4.4	3.3	-1.1
	Total Comp.	5.6	4.6	-1.0
Student 7:	Lit. Comp.	4.8	7.6	2.8
	Inf. Comp.	7.0	8.5	1.5
	Total Comp.	5.7	8.2	2.5
Student 8:	Lit. Comp.	5.3	5.8	0.5
	Inf. Comp.	5.5	5.4	-0.1
	Total Comp.	5.3	5.6	0.3

TABLE 11

SAMS SDRT DATA SUMMARY '80-'81

		SDRT PRE	SDRT POST	GAIN SCORE
All Students: (MEAN)	Lit. Comp.	5.14	7.04	1.90
	Inf. Comp.	6.18	6.13	-0.05
	Total Comp.	5.71	6.65	0.94

YEAR TWO

YEAR TWO QUARTER ONE

The activities during the first quarter of the second project year focused primarily on extending the research begun during year one with a new group of teachers and developing additional computer software to facilitate teacher use of microcomputers for assessing and monitoring daily pupil performance. Specific activities entailed selecting three secondary school teachers, enlisting their cooperation, and collecting baseline measures of their use of assessment, monitoring and program-planning strategies. Following the collection of baseline data, the teachers were trained to use microcomputers and software provided by the investigators to assess and to monitor student academic performance and to use these data to plan individual student programs. In addition, the content, quantity, and quality of the teachers communications with regular classroom teachers was also evaluated and additional computer software was developed.

The research activities for year two occurred in the Monroe County School Corporation (MCCSC). Officials from the MCCSC school system volunteered to serve as a research site based upon positive information that they obtained from Indianapolis School System officials concerning the grant activities. Given the proximity of the MCCSC, the system's commitment to require teachers to periodically record student academic progress, and the fact that mildly handicapped students were typically integrated into regular classes for a portion of the day, the decision was made to include the Monroe County System in the project. This decision also was influenced by the opportunity to work with an additional school system in developing classroom compter utilization programs.

As an outgrowth of year one activities, the two school systems that served as year one sites, -- the Indianapolis Public Schools and Washington Township Schools -- both adopted versions of the prototypical student monitoring systems developed and evaluated during this period. Primarily as a result of the success of the current project, the Indianapolis Public Schools invested over $80,000 in local funds to purchase microcomputers for secondary special education classrooms and to train all secondary special education teachers to use modified versions of the instructional management systems that were pilot tested during year one of this project. The Washington Township Schools, on the other hand, primarily because they were not purchasing microcomputers implemented paper and pencil versions of a student activity management system (SAMS) that were developed and evaluated during the first year of the project.

The focus of the project during the second year of the project became one of exploring methods that affected teacher utilization of microcomputer software for making treament-based program decisions for learning and behavior disorders. Major project activities during this period concentrated on ways to modify previously developed software to meet existing needs in field application and to evaluate the effects of these efforts on teacher behavior, atitudes, and student achievement.

The project objectives during the second year were:

1. To develop a computerized data based student performance

information system.

2. To provide Special Education teachers appropriate instruction in the use of microcomputer technology for instructing children with learning and behavior problems and to use data to make and alter program decisions.

3. To determine the frequency with which teachers use the system to monitor student performance.

4. To determine the relationship between the frequency with which teachers monitored pupil performance and actual pupil performance.

5. To determine the impact of the access to computer.software upon the frequency with which the teachers consulted recorded pupil performance data before making educational plans for individual students.

ACTIVITIES

The strategy of the project during the second year primarily involved instigating a concentrated study to determine if access to microcomputer technology, appropriate training and ongoing consultation would motivate teachers to use the power of the microcomputer to systematically collect continuous data on student performance student performance, and to use these data for modifying the student instructional programs. To accomplish this goal, we conducted an intense study of three secondary classrooms; one junior high school classroom (Edgewood) located in a rural community was a self-contained classroom for learning disabled children. A second classroom (Dyer) was a resource room for children with learning and behavior disorders set in a lower socio-economic class suburban junior high school. The third class selected for study was a resource room program located in a large suburban high school. The three teachers of these classrooms were selected on the basis of ther interest in learning to use computers, recommendations of the MCCSC Special Education Administration, location and configuration. After the initial introduction to the project goals and familiarization with procedures, teachers were each given a microcomputer (TRS-80, Model I or Model III) and a small printer for use in their classrooms once the three teachers were selected and their level of computer literacy was informally assessed. While teachers were enthusiastic to learn about microcomputers, none could operate the microcomputers or knew very little about the machine's capabilities. All three teachers verbalized anxiety about using the machines and reported concern about "ruining or hurting them." Consequently, the first activity initiated consisted of an inservice training program to acquaint the teachers with the operation of the microcomputer and its potential application in the classroom. Training consisted of a combination of lecture, demonstration, and an extensive amount of hands-on experience. Teachers were required to independently operate the microcomputer and a preselected piece of software prior to concluding their training. All three teachers attained the criterion. After training, each teacher was initially provided with a microcomputer and a printer for their classroom. They also were given a math computation assessment and remediation software program for use with their students. They later received training in and access to the CIMS and SAMS information management program utilized during the latter part of Year One.

Initially, all students enrolled in the target teachers classroom were assessed using the same battery of tests used during year one. This consisted of a criterion referenced math computation battery, an informal reading inventory, and the Stanford Diagnostic Reading and Math Tests. Consistent with Year One activities, individual student profiles of SDRT and SDMT results were prepared for each student and this information was shared with the teacher. During the same period, each teacher was asked to keep a log of the math and reading IEP activities and materials that they employed for meeting each IEP objective with the students. These data served as a means of documenting the degree to which teachers planned and monitored their instructional activities and allowed the project staff to prepare activities. A computerized list of materials used by teachers for entering in the data-based IEP System.

Unknown to the teachers, the investigators had developed software that would log the frequency and duration with which the teacher used the program. Thus, one set of dependent measures were collected using an unobstrusive program which enabled the investigators to monitor the frequency with which the teacher consulted records of student performance that were automatically prepared by the computer.

Computer Software Development.

Computer software development activities during this quarter consisted of modifying the Cith Mathematics Remediation System (CMMRS) and the development of a prototypical computerized readability system. The CMMRS is a computerized individualized math assessment and remediation program. The program was designed to measure student performance on fourteen subskills within each of four math skill areas; addition, subtraction, multiplication and division.

Problem configurations within each of the four areas being tested were held constant across applications. The configurations are as follows:

Addition Subskills

20% single digit + single digit

20% " " + double digit with no carrying

20% " " + double digit with carrying

20% double digit + double digit with no carrying

20% " " + " " with carrying

Subtraction Subskills

20% single digit - single digit

20% " " - " " with no borrowing

20% double digit - " " " "

20% " " - double digit " "

20% " " - " " with borrowing

Multiplication Subskills

33% single digit x single digit

33% " " x " " with no carrying

33% " " x " " with carrying

Division subskills

100% simple division using a random selection of reciprocals 1-9.

Once the student completed the assessment, the teacher was provided with a report summarizing the student's performance. The reports are available for viewing on the computer screen or as a printed copy in graphic or tabular form. The contents of the report include a listing of: correct digits per minute, error digits per minute, percent of problems correct, number of problems correct per minute and number of problems attempted per minute. In addition, error profiles are available upon teacher request.

The second phase of the CMMRS program involves providing students with remediation in a particular math subskill. It consists of two distinct sets of subroutines. The first, Probe Program, consists of an assessment program designed to assess students on 120 mathematical subskills involving identification of the actual digits which the students are encountering trouble. The assessment probe ascertains through an error pattern analysis if specific math skill weaknesses exist and information on identified weaknesses are then transmitted to program remediate for specfic skill drill and practice. Program probe assesses one concept area at a time through one minute long tests generated from a random sampling of problems representing all specific skills within the content area being tested.

After the one minute test is completed the Probe Program compares student performance against teacher set criterion standards inherent in the Software Program to determine whether the student passed or failed. Whether a student passes or fails a particular skill is determined by both the rate at which he produces correct digits as well as pure percentage of problems correct. These parameters can be manually set by the teacher for each student and adjusted as needed to maximize student motivation and to maintain interest. If the program determines via an analysis of past performance data whether the student has passed two probe tests consecutively, he/she is advanced to the next level. The program activates (branches) a remediation program that provides him/her with intensive practice on that particular skill. After the minute of intime drill on that particular subskill, the program administers another probe to assess competence, student performance information was then recorded on the student's permanent probe history file and the INFO file.

Failure to attain the criterion for passing a probe is usually due either to the student's failure to complete enough problems and/or excessive number of errors. If the student failed because s/he worked too slowly Probe records the reason for the failure as a speed deficit on the permanent student record and readministers the same numbered probe. On the other hand, if the student failed to complete a prespecified percentage of problems or his/her error rate fell below criterion standards, Probe will isolate the dominant pattern of errors based on the problem configuration totals and initiate program Remediate. Probe records the reason for failure on the permanent student record which is made available to the student's teacher.

After the student completes Program Probe and fails to meet criterion for passing, Probe initiates the remediation program. This program provides the student with drill and practice work on specific math skills weaknesses identified in the Probe Progam. The assessed skill weakness information identified in "Probe" is passed to "Remediate" via data files by student performance kept by the machine. Program Remediate obtains the target skill number from Info and then sets the problem generation parameters accordingly. "Remediate" provides a one minute drill and practice session in which all problems presented to the student are representative of the problem configuration deficit area identified in "Probe". After the one minure drill and practice session is completed, "Probe" compares student performance against the performance criterion. If the student passes, "Remediate" writes a permanent record of the student's performance and initiates program "Probe" to readminister the same probe number that the student failed earlier. If the student does not meet criterion standards set, "Remediate" will write a permanent student record of performance and reinitialze itself to administer another one minute drill and practice session. The number of trials is unlimited. The student will receive one minute drill and practice sessions on the one specific skill deficit until criterion is reached.

This program was modified during the first quarter in order to meet the programming needs of the participating teachers. This entailed modifying the program menu and installing some options to accomodate the assessment and reporting specifications of the teachers involved. All of the teachers involved used this system as a supplement to their own math teaching system. This represented an appropriate application since the program was developed with this objective in mind. The program was initially implemented during this quarter as it was the easiest program for the teachers to use, having just been introduced to using the computer. This program was designed to model assessment, monitor and report functions which we expected the teachers to apply to the other pupil program planning activites.

During this quarter, priliminary development was begun on a computerized readability system. We initially specified in our grant application that we planned to use the GMC readability system but, after extensive review, we found that the program was inadequate for the immediate daily needs of classroom teacher. The large program required access to a mainframe computer and it was deemed more efficient in the long run to develop the software for a microcomputer based readability program. Thus, preliminary development was begun during this quarter. Initially, we reviewed the available readability formulas and, after very careful review, we decided to develop software to calculate three formulas: Dale-Chall, Harris-Jacobsen and the Spache. These formulas were selected first, because they were judged by experts,commenting in professional journals, as being the best available and second, they enabled us to ascertain the readability of a broad range of passages with difficulty levels from kindergarten to senior high school. Finally, we decided to use a menu driven program that would not require a high degree of computer literacy on behalf of users and one that would complete the requisite calculations quickly.

Once completed, the program was given to the teachers for field testing, and we collected data on the microcomputer to determine how many readability checks the teachers currently complete. The intent was to provide teachers with a tool that can be used to analyze the difficulty of reading passages so that student assignments in both regular and special education classes are consomant with the students' identified reading level.

YEAR TWO QUARTER TWO

During the second quarter of the project we began a series of teacher inservice workshops to provide teachers with skills in the use of microcomputer technology and integration of these into their teaching routines. In addition we extended the development of the computer software and continued our data collection and analysis activiies initiated during the first quarter.

Teacher Training

The three teachers selected to participate in the study were provided instruction, through a series of workshops scheduled in our computer lab, in the use of microcomputers and methods in which this technology could be integrated into actual practice in the special education classroom. Teachers were taught how to operate and care for the machines, simple machine operations, use of instructional software, use of microcomputer records for planing instruction and for evaluating effects, and procedures for entering and retrieving demographic and IEP information related to individual students for collecting repeated assessment information. In addition, they were shown how to document students' progress on the machine and to translate records on student progress into instructional plans.

Teachers were given access to several in-house microcomputer software packages--the CITH Math Remediation System (CMMRS), the CITH Readability Index System (CRIS), and the CITH Instructional Management System--for use in instucting students. These packages were under development as ongoing projects by the CITH staff and the project provided an instructional alternative for teachers to use in their classrooms as well as an opportunity to formatively evaluate and refine these programs by heeding the teachers' sugestions for revision. Teachers also were provided intensive instruction and support in the use of these software packages.

In a series of inservice workshops scheduled over the first semester of the school year, teachers were provided with the rationale and procedures for using software previously developed to aid in assessment, instruction, and decision-making. In relation to the CMMRS, they were taught how to set various criteria controlling the branching capabilities and feedback (correct digits per minute, percentage correct, goals, feedback statements) as a means of individualizing instruction for each student; they were taught how to read the student records and advised how to translate the CMMRS records and SDMT results to identify and provide intensive instruction needed in math subskill areas for their students.

Project teachers were also given instruction in the rationale and necessity of running readability indexes on reading material assigned to students and training in use of a computerized program for calculating these. To further facilitate the teachers' utilization of microcomputer technology for assessment and planning, IEP's of all students assigned to each teacher were first translated into behaviorally stated objectives according to the format specified by Mager (1963) and entered into the computer. Teachers were given intensive training in the rationale and use of these records and encouraged to use these for planning daily objectives, assigning materials, and for evaluating their student's progress. All teachers readily agreed upon the value of using and maintaining this record.

In addition, clearance from the MCCSC special education administration was obtained to substitute the computer-generated IEP results, SDMT and SDRT results, and CMMRS record as the teacher's year-end case conference report.

Finally, supportive consultation from the CITH staff was scheduled on a weekly basis and made available to teachers as needed each weekday during working hours; teachers made liberal use of these services not only to correct their misunderstandings but, to extend their knowledge regarding use of microcomputer technology. A close rapport developed between the CITH staff and project techers. In short, every effort was bent toward providing adequate training, aid, and clearing procedural "underbrush" to facilitate the teacher's use of the microcompter for the purposes outlined in the original proposal.

COMPUTER SOFTWARE DEVELOPMENT

The CITH Readability Index System (CRIS) was completed during the initial portion of this quarter. This software program enables teachers to type 100 word sections of reading passages into the computer and then analyze the readability level of the passage using either the Dale-Chall, Harris-Jacobsen or Spache readability formulas within two minutes of the time that the passage was entered. The formula can be preselected by the teacher before the passage is entered into the computer. The formula, selected in part, is determined by the teachers' estimate of the readability level of the passage. If a passage is estimated to be below third grade level the Spache formula is used, since it is the only formula that could accurately assess readability in this range. Above third-grade level, the teachers can select either the Dale-Chall or the Harris-Jacoasen formulas. The software was similar to other software developed in that it was menu-driven and did not assume that the teachers were "computer literate". Initially, after turning on the machine, the teachers are presented with a menu (see Figure 40). They simply have to select one of the options and follow the carefully sequenced instructions. In the event that they want to enter a passage, they simply select that option and proceed to enter the passage. Once the passage is entered, they then select the edit option as a means of checking the accuracy of their typing. With this option, teachers are able to correct misspellings and insure that no words are omitted or incorrectly ordered. Once this step is completed, the teacher has the option either to enter additional passages or to simply process the single passage. As mentioned previously, the processing takes approximately two minutes to complete. For examples of the completed profiles provided to the teachers, readers are referred to figures 41, 42, and 43.

Following the completion and field testing of the CRIS program, it has become one of the most frequently used programs. One special education teacher has analyzed a sizeable number of passages from texts that they were using and has been besieged with requests from regular classroom teachers to analyze passages from textbooks that were being assigned to the mildly handicapped students in regular classes.

The CITH Information Management System (CIMS) has been detailed in earlier reports. Briefly, this software program consists of five

FIGURE 40

C R I S

C.I.T.H. Readability Index System

Version 3.0

(C)1982 C.I.T.H. / Indiana University

```
<1> CREATE Passage(s)
<2> DELETE Passage(s)
<3> EDIT Passage(s)
<4> DISPLAY Passage(s)
<5> PRINT Passage(s)
<6> PROCESS Passage(s)
<7> EXIT
Press the <KEY> for the COMMAND you desire:
```

FIGURE 41

SPACHE PROFILE

****

C.I.T.H. Readability Index System / (c)1982 GJH/RDE/C.I.T.H.

Passage: BFABI009

****

Words in Passage - FOUND - on the SPACHE (STONE) Word List

WHAT	DO	YOU	WANT
FOR	YOUR	BIRTHDAY	FATHER
I	WANT	AN	AIRPLANE
SAID	ARE	YOU	SURE
HER	FATHER	I	HAD
BEEN	ABOUT	A	DOLL
OR	WOULD	YOU	LIKE
OR	A	PRETTY	NO
I	WANT	AN	AIRPLANE
I	RIDE	A	TO
A	CITY	I	FLY
INTO	THE	AIR	ON
A	DISH	I	FLY
UP	INTO	THE	SKY
ON	A	DOLL	I
WANT	AN	AIRPLANE	FATHER
AND	MOTHER	WENT	TO
THE	STORE	MOTHER	SAY
A	PRETTY	RED	SHE
SAID	WOULD	LOVE	THAT
FATHER	SAW	A	BEAUTIFUL
DOLL			

****

Words in Passage - NOT FOUND - on the SPACHE (STONE) Word List

LUPE'S	ASKED	LUPE	ASKED
THINKING	DISHES	PURSE	LUPE
ANSWERED	CANNOT	PURSE	FARAWAY
CANNOT	CANNOT	LUPE'S	LUPE'S
PURSE	LUPE	PURSE	LUPE'S

****

Statistics

Number of Words Sampled from Passage = 105
Number of Sentences Sampled from Passage = 15
Average Sentence Length = 7 Words
Number of UNIQUE Words NOT ON the SPACHE (STONE) Word List = 20
Number of FAMILIAR Words ON the SPACHE (STONE) Word List = 85

SPACHE Index Grade Level = 3.4641

FIGURE 42

HARRIS-JACOBSON PROFILE

****
C.I.T.H. Readability Index System / (c)1982 GJH/RDE/C.I.T.H.

Passage: BFABI009

****
Words in Passage - FOUND - on the HARRIS-JACOBSON Word List

ASKED	AN	AIRPLANE	ARE
ASKED	ABOUT	A	A
AN	AIRPLANE	ANSWERED	A
A	AIR	A	A
AN	AIRPLANE	AND	A
A	BIRTHDAY	BEEN	BEAUTIFUL
CANNOT	CITY	CANNOT	CANNOT
DO	DOLL	DISHES	DISH
DOLL	DOLL	FOR	FATHER
FATHER	FLY	FLY	FATHER
FATHER	HER	HAD	I
I	I	I	I
INTO	I	INTO	I
LIKE	LUPE	LUPE'S	LUPE'S
LUPE	LOVE	LUPE'S	MOTHER
MOTHER	NO	OR	OR
ON	ON	PRETTY	PURSE
PRETTY	PURSE	PURSE	RIDE
RED	SAID	SURE	STORE
SAY	SHE	SAID	SAW
THINKING	TO	THE	THE
TO	THE	THAT	UP
WHAT	WANT	WANT	WOULD
WANT	WANT	WENT	WOULD
YOU	YOUR	YOU	YOU

****
Words in Passage - NOT FOUND - on the HARRIS-JACOBSON Word List

FARAWAY	LUPE'S	LUPE	PURSE
SKY			

****
Statistics

Number of Words Sampled from Passage = 105
Number of Sentences Sampled from Passage = 15
Average Sentence Length = 7 Words
Number of UNIQUE Words NOT ON the HARRIS-JACOBSON Word List = 5
Number of FAMILIAR Words ON the HARRIS-JACOBSON Word List = 100
HARRIS-JACOBSON Predicted Score = 2.29767

HARRIS-JACOBSON Index Grade Level = LOW SECOND

FIGURE 43

DALE-CHALL PROFILE

****

C.I.T.H. Readability Index System / (c)1982 GJH/RDE/C.I.T.H.

Passage: BFABI009

****

Words in Passage - FOUND - on the DALE-CHALL Word List

ASK	AN	AIRPLANE	ARE
ASK	ABOUT	A	A
AN	AIRPLANE	ANSWER	A
A	AIR	A	A
AN	AIRPLANE	AND	A
A	BIRTHDAY	BEEN	BEAUTIFUL
CANNOT	CITY	CANNOT	CANNOT
DO	DOLL	DISH	DISH
DOLL	DOLL	FOR	FATHER
FATHER	FARAWAY	FLY	FLY
FATHER	FATHER	HER	HAD
I	I	I	I
I	INTO	I	INTO
I	LIKE	LOVE	MOTHER
MOTHER	NO	OR	OR
ON	ON	PRETTY	PURSE
PURSE	PRETTY	PURSE	PURSE
RIDE	RED	SAID	SURE
SKY	STORE	SAY	SHE
SAID	SAW	THINK	TO
THE	THE	TO	THE
THAT	UP	WHAT	WANT
WANT	WOULD	WANT	WANT
WENT	WOULD	YOU	YOUR
YOU	YOU		

****

Words in Passage - NOT FOUND - on the DALE-CHALL Word List

LUPE'S	LUPE	LUPE	LUPE'S
LUPE'S	LUPE	LUPE'S	

****

Statistics

Number of Words Sampled from Passage = 105
Number of Sentences Sampled from Passage = 15
Average Sentence Length = 7 Words
Number of Words NOT ON the DALE-CHALL Word List = 7
Number of Words ON the DALE-CHALL Word List = 98
DALE Score = 6.66667
Formula Score = 5.03637

DALE-CHALL Index Grade Level = 5TH - 6TH GRADE features: (1) A systematically organized sequence of objectives in major instructional areas (Language Arts, Math, Writing, and Spelling) accessible by computer; (2) computer storage on local diskette of student-related information--demographics, test scores, and other records; (3) an automatic daily data storage and retrieval system; (4) a user interactive method of recording daily progress on instructional objectives; (5) a system for logging the use of materials related to objectives taught.

Because of the difference in distribution and utilization of information by the MCCSC district special education administrators and teachers, the prototypical version of CIMS developed for use in the Indianapolis Schools had to be modified. The major change in the software entailed identifying the instructional objective that each of the three project teachers selected, rewriting them using the format suggested by Mager (1963) and loading these on storage diskettes for use by the teachers. The MCCSC staff already had developed an extensive list of stems for instructional objectives. The stems were used by the teachers to develop an IEP. However, we found that after the initial IEP is developed, teachers only rarely evaluated students' progress on individual objectives, chiefly by simply binary choice whether the student had passed or needed further work on the particular objective. The CIMS enables the teacher to enter each student's entire annual academic program into the computer. At regular intervals (ideally daily) teachers call up the students IEP from the microcomputer storage diskette and enter objective data--test scores, percentage grades on papers, or observational information--as a means of updating the students' progress on their IEP. The computer automatically prompts the teacher regarding the instructional objective on which a student was working, and requires the teacher to enter the objective data. This system was modified for use by the MCCSC teachers by programming software that would allow each student's IEP to be entered beforehand rather than having the teacher enter the individual objectives. The system was designed to require the teacher to: review the particular objective the student was assigned, require the teacher to enter objective data or use observational data for making decisions regarding a particular student's progress on specific instructional objectives, maintain an up-to-date record on each student's progress, and provide hardcopy printouts of this information for case conferences.

The CIMS was therefore designed to incorporate the use of databased decision-making into the teachers' planning and record keeping. Moreover, as the system requires teachers to periodically supply information regarding the selection of materials used for each objective, teachers automatically recorded the specific lessons they had used to program each objective. This development allowed teachers not only to objectively evaluate the efficacy of their lesson plans, but provided a permanent record of which assignments they had chosen to teach particular objectives. This feature was designed to further reduce the teachers' work loads by facilitating, planning, and thereby increasing the amount of time teachers had available for instruction. Its effectiveness as well as the effectiveness of the other features of the CIMS is dependent upon the teachers continually updating the records every few days (ideally daily).

To facilitate the teachers use of the CIMS, the project staff held three demonstrations and inservice training sessions designed to desensitize the teachers to the use of a microcomputer, and to instruct them in the use of the software program and its advantages. In addition, project staff made regular consultation visits to the classroom to answer teachers' questions concerning the program, and to troubleshoot problems as they arose. Consultants also encouraged the teachers to use the CIMS and to evaluate the data for instructional planning. In addition, teachers were encouraged to discuss problems they were encountering in using the software program in the inservice training sessions; this information was used to identify and alter features of the software program to facilitate user interaction.

In addition to the program just described, teachers had access to both demographic data that project staff had entered onto the teachers' computer diskette as well as standardized test information. These and other information were easily accessible to teachers through menus designed into the computer software. Teachers had only to log onto the machine, and select the data they wished to review for a particular student. As indicated in the first quarter report, all teacher and student use in terms of data and number of minutes was recorded automatically by the computer. This fact was not divulged to teachers so as not to bias in any way their use of the software.

As indicated previously, interaction with the teachers during training sessions and consultation contacts enabled us to identify a need for the development of a method of automatically measuring students' progress in reading during the course of the school year. Teachers indicated that this type of information would be very valuable to them for continually determining appropriate placement of a particular student during the school year as well as for providing repeated measures of a student's progress on graded reading passages.

From this information, we began development of a Computerized Informal Reading Inventory (CIRIS). Development of the CIRIS begun during this quarter with completion slated for the third quarter. Development of the CIRIS was designed to further extend the primary objective of the grant, that of evaluating methods of increasing the available instructional time for the special education classroom teacher, as well as exploring procedures that would increase the teachers' reliance on use of data for placement, programming, and decision making in the classroom. Field tests of this program will be conducted in the third quarter and will be described in the next report.

Data Collection

Data collected during this quarter consisted of daily measures of the frequency and duration with which the teachers used the computer software programs. To control for expectancy effects, this information was collected automatically and stored on the microcomputer data diskettes without the teacher's knowledge. Information taken from interviews with the teachers conducted at the end of the year (and summarized later in this report) were compared with the microcomputer-based data to determine the relationship between the teacher's actual versus reported use of the machines for various purposes. We, therefore, had access to direct measures of how much time teachers spent analyzing reading materials, updating computer-based student IEP's, and student's use of computer-assisted instructional software.

The intent of the teacher selection and training program was to attempt to maximize potential contributing variables to the adoption and utilization of microcomputer technology in special education classrooms. By a flexible system, interested teachers, well-designed software, and providing continuing excellent training and consultation service, it was anticipated that there would be considerable modification in teacher behavior in terms of planning, assessment and evaluation of student performance. In effect, this approach was designed to motivate teachers to use microcomputers, not solely for instruction, but for keeping track of student performance and for adjusting instructional materials and methods to reflect student needs on a continuing basis.

A key issue in determining the outcome of this effort was the teachers acceptance of and use of the CIMS system. It was hoped that by presenting teachers with the rationale and advantages of using this program, and discussing the program, it could then be modified to meet their individual needs, hence the teachers would discuss the advantages of their operation and adopt it. The CIMS, of course, represents our solution to increasing Academic Learning Time in the classroom by facilitating more accurate and responsive individualized programs and by functioning as a classroom aid in collecting data and providing sophisticated drill and practice instruction.

A product of the inservice sessions was the conclusion that the MCCSC teachers were not interested in using the prototype version of the CIMS, which was designed as an individual educational program (IEP) management system, that had been developed years before for the Indianapolis Public Schools. They were able to designate to the project staff features of the system which were useful or cumbersome due to the idiosyncrasies of the MCCSC IEP System. These meetings then served to test improvement sessions as well as teacher training sessions. They provided an impetus for considerable software development.

YEAR TWO QUARTER THREE

During the third quarter of this project several operating objectives were accomplished. First, the CIRIS program was completed during this quarter. Second, teachers participating in the project were provided inservice training on use of the CIRIS. Third, post test student data were collected and summarized. Fourth, consumer satisfaction information was collected from teachers regarding their evaluation of the project and suggestions for improvement.

TEACHER TRAINING

Teachers were also given another two inservice training workshops related to the use of the CIMS and CIRIS (to be described later) during the third quarter. In the first of these teachers were demonstrated the prototye CIRIS program and asked for their criticism. Based on results of these evaluations and in-house evaluations, revisions were made in the program to increase useability and to add various features. One suggestion made by the teachers involved integrating the CRIS program with the CIRIS, thereby allowing a teacher to select reading passages from various sources (newspapers, magazines, other texts, technical manuals, etc.), run readability indexes on them using the CRIS, and enter them into the CIRIS program in the proper point in the reading sequence. A teacher might, for example, in addition to having the four or five existing reading passages in the CIRIS program, enter reading passages and comprehension questions from other material into CIRIS and thereby create his/her own individualized informal reading inventory. Such a modification not only would add diversity to the content of CIRIS, but enable the teacher to closely monitor a student's ability to read various types of material. In addition to these modifications, the teachers suggested that a method of providing students with feedback regarding their performance also be included in the final CIRIS software program. Feedback from teachers related to features they considered important from the CMMRS program revealed that a "motivator" for students was the summary of their performance given them at the end of the daily session. Thus we incorporated a similar feature into the CIRIS program and programmed it as an option for teachers to use.(see Appendix A)

DATA COLLECTION AND ANALYSIS

During the third quarter of the project we also collected end of the year standardized test information using the Stanford Diagnostic Reading and Math tests. These results were summarized and presented to the teachers for use in their end-of-year case conferences. They, of course, were also used to evaluate the effects of the instructional programs. The results of these data will be presented in the fourth quarter report.

In addition to these activities, a structured interview was adminstered to each teacher participating in the project regarding their teaching practices, changes as a result of participating in the project, their personal evaluation of the importance of the microcomputer in their classrooms, their use and evaluation of the computer software programs, and their evaluation of the project and its probablity of being successfully used in other classrooms.

COMPUTER SOFTWARE DEVELOPMENT

As mentioned above, during the third quarter of the project, the CIMS final refinements were completed and the field testing of this program was conducted. Further modifications of the CIRIS also completed were:

The CIRIS program that was mentioned in the second quarter report was field tested in one of the classrooms during the third quarter of the project. The program was installed during the last six weeks of school at the Dyer Middle School site. A continuing problem of the teacher in this class involved identifying students' reading problems and keeping track of their reading rate and comprehension. For the most part, the teacher assigned students to standard texts at the first of the year based on results from standardized tests administered at the end of the preceeding year. It was hoped that field tests of the CIRIS would produce information pertaining to how the children accepted the program, and its potential importance to classroom teachers in allowing them to use information to make decisions.

The CIRIS software package currently includes four or five brief (100-300 words) standard reading passages at each grade-levels one through eight taken from the Britannica Reading Series. Comprehension questions related to recall of information have been written for each of the passages and are accessible by the student readers. Students read the passages directly from the videoscreen and answer comprehension questions through either multiple choice responses or providing brief (one to two word) answers that must be typed in from the keyboard. Student responses to these answers are compared by the computer against a list of acceptible answers previously entered. As indicated in the previous report teachers have access to either video display of a student's progress record or hardcopy output in either short or long forms. An option now incorporated into the program allows the teacher to create his or her own reading passages, accompanying comprehension questions and to convert passages entered from the CRIS program directly for use in the CIRIS.

In addition to these developments, as described in the preceeding section of this report. We also created a student feedback feature that can be used at the teacher's discretion. Upon completing the comprehension questions, students are presented with a video figure of a rocket ship taking off and stopping at various percentages correct corresponding to the actual percentage of comprehension questions they completed correctly. The results of field tests of this program and others will be presented in the final quarter report.

YEAR TWO QUARTER FOUR

In the final quarter of the second year of the project, a considerable amount of activities were conducted. During this quarter, post tests were collected on children from the various classrooms, years end teacher interviews were conducted, and teachers' computer usage data were collected. In addition, consumer satisfaction interviews were scheduled with the Monroe County School Corporation (MCCSC) Administrative staff. During this period, we also collected information on two software programs and modified this software program based upon teacher's suggestions. Fourth quarter activities also included presentations of preliminary results of the project at State and National Conferences. In addition, data collected were evaluated and summarized.

Post-test data collected during this project included results from the Stanford Diagnostic Reading Test (SDRT) and the Stanford Diagnostic Math Test (SDMT). Results from these measures appear in Tables 12 through 15 in the evaluation section.

The three MCCSC teachers participating in the project were interviewed using a structured interview format developed by project staff. The scale was administered in the latter weeks of the school year to record attitudes and perceptions of the teachers toward using the computer for monitoring pupil performance, assessing and remediating pupil academic problems, and its utility for storing information related to IEP's found measuring readability of various materials.

Another measure taken included the actual teacher time spent on the computer as surreptitiously collected by the computer. The results of the teacher logs appear in the evaluation section.

The CRIS and the CIMS software programs were devised somewhat to accommodate the particular needs of the teachers. Further reading passages were added to the CRIS and comprehension items were written for each of these. The CIMS was streamlined to simplify its use and to speed up operations. The data from year two were also summarized and evaluated. These results are presented in the Evaluation section to follow.

EVALUATION

Bloomington High School North

SDRT results. Overall, the results indicate that very little change in student achievement occurred during the school year (see Tables 12 and 13). In fact in three of the four areas assessed the students scores actually regressed. This may have been a function of: collecting the assessment data during the days of the school year when the students were generally apathetic about the prospect of having to take yet another year-end test; prefunctory test administration; or the students lack of academic progress.

SDMT results. The mean grade level score attained on both the numeration and computation subtests increased slightly during the school year (see Tables 14 and 15). Overall the students scored substantially higher from pre to post test scores on the computation subtest. The data indicated that the students scores were only two years below grade level expectation, yet the rate of progress during the 1981-1982 school year was such that it was substantially less than their preceeding rate of achievement. Anecdotal, observational and computer records suggested that the teacher allocated relatively small amounts of time for math computation instruction. Indeed, the teacher spent more time on applications and higher level computation.

Dyer Middle School

SDRT results. Students improved their reading level achievement scores slightly on each subtest. Overall, scores indicated that the students achievement levels were substantially below grade level.

SDMT results. The students increased their achievement on both the numeration and the computation subtest. The greatest growth occurred on the computation subtest which was the academic area in which the students received computer based assessments and instruction (CMMRS) that was correlated with teacher lead instruction.

Edgewood Middle School

SDRT results. Overall, the results indicated that the students attained little academic growth in reading during the 1981-1982 school year.

SDMT results. The math achievement results were comparable to those obtained in reading since the students demonstrated little academic growth. It is interesting to note that this teacher used the computerized math program substantially during the year. Observational records show however that the teacher had the students go through the program repeatedly despite the fact that many of the students had the request skills when they entered the program. Student records suggest that the students did however increase the speed of their computation.

TABLE 12

Stanford Diagnostic Reading Test

1981 - 1982

PrePost Test Data

	Auditory Vocabulary	Literal Comprehension	Inferential Comprehension	Total	Phonetic Analysis	Auditory Discrinination
Dyer Middle School N=13						
Pretest	3.59	1.80	2.02	2.95	2.41	2.23
Postest	4.69	2.17	2.33	3.29	2.66	2.50
Edgewood Middle School N=20						
Pretest	4.96	4.20	4.30	4.47	4.02	3.95
Postest	5.31	3.71	4.40	4.38	4.92	3.97
Bloomington High School North N=5						
Pretest	8.04	5.90	5.28	5.76		
Postest	7.82	5.46	5.32	5.54		

TABLE 13

Stanford Diagnostic Reading Test

1981 - 1982

Pre-Post Test Data
N=38

	Auditory Vocabulary	Literal Comprehension	Inferential Comprehension	Total	Phonetic Analysis	Auditory Discriminatic
Pretest	5.15	3.60	3.65	4.12	3.39	3.27
Postest	5.43	3.42	3.81	4.16	4.03	3.39

TABLE 13

Stanford Diagnostic Reading Test

1981 - 1982

Pre-Post Test Data
N=38

	Auditory Vocabulary	Literal Comprehension	Inferential Comprehension	Total	Phonetic Analysis	Auditory Discriminatio
Pretest	5.15	3.60	3.65	4.12	3.39	3.27
Postest	5.43	3.42	3.81	4.16	4.03	3.39

TABLE 14

Stanford Diagnostic Math Test

1981 - 1982

Pre-Post Test Data

	Numeration	Computation
Dyer Middle School N=13		
Pretest	3.59	3.93
Postest	3.89	4.50
Edgewood Middle School N=21		
Pretest	4.54	4.55
Postest	4.45	3.55
Bloomington High School North		
Pretest	4.82	7.12
Postest	5.14	7.48

TABLE 15

Stanford Diagnostic Math Test

1981 - 1982

Pre-Post Test Data
N=41

	Numeration	Computation
Pretest	4.06	4.45
Postest	4.15	4.16

Teacher Interview Data

Each of the participating teachers was interviewed twice during the 1981-1982 school year. The first interview was conducted in March with the follow-up interview being conducted during the middle to latter part of May. The first interview was conducted after they had been using the CMMRS and CRIS systems for five months but, immediately before the teachers began to use the CIMS system that had been customized to accomodate the objectives that had been specifically developed for the individual students enrolled in their resource rooms. The second interview was conducted during the final days of the school year and was designed to determine the teachers evaluation of using the computer to monitor student performance and to assess and remediate student academic performance. The questions asked, and the transcribed responses are presented in pages 86 through 101 The data indicated that the teachers were able to use CIMS to monitor student progress, however, they had some difficulty modifying their schedules in order to incorporate the activity into their daily regimen. Perhaps, their overall response is best summarized by the teacher, who used the system most diligently, when she reported that "no one wanted to look at our daily work or objectives accomplished. Student IEP planning conference recommendations were based solely on teacher recommendations. Neither the conference coordinator, nor any of the particpants, were interested in looking the students program objectives." This teacher went on to indicate that no one in the school system looks at the instructional objectives that the student accomplished. Thus, while she found CIMS useful for planning individual student programs, she was also concerned by the lack of recognition and commitment by the school administration and other teachers. These concerns coupled with the additional time requirements prompted this teacher to reconcile her own use of the system. These findings, which are repeated across the other teachers interviewed, suggest school systems must reconsider the requirements imposed for the development. Implementation and evaluation of student performance since they appear to be encouraging teachers to comply minimaly with the requirements of the law. In addition, such short cuts appear to adversely affect student academic achievement.

All of the teachers interviewed endorsed the notion of having computers in their classrooms and were most impressed with the assessment and remediation programs that enabled them to assess and tutor individual students and obtain information regarding the readability of textual material. These activities enable the teachers to use their time more efficiently and enable them to complete more work without having to spend additional time on the job. Basically, the research team concluded that this group of teachers were interested most in using service software systems, that is, software that provided a service that fits in the current ecological and instructional structure of the classroom. This suggests that they were generally happy with the way that the classroom was being run and if the computer enabled them to provide more individual instruction to students and keep copious records of the students performance, then that constituted an appropriate computer application.

STRUCTURED INTERVIEW

1. Approximately how much total time per day do you devote to teaching?

2. How much time per day or week do you typically engage in the following activities:

   A. Reviewing and correcting student papers.
   B. Writing daily instructional objectives for (some, all) students (*circle one*).
   C. Developing informal test information, analyzing formal test information.
   D. Analyzing informal test information.
   E. Reviewing instructional materials.
   F. Reviewing and updating student IEPs.
   G. Assessing instructional objectives.
   H. Evaluating the effectiveness of instructional materials.

3. What student performance records do you keep?

4. How often do you review and update these records?

5. How often do you administer standardized tests?

6. How often do you administer informal tests?

7. How do you typically select an instructional technique for a student?

8. How do you select curricular materials?

9. How do you evaluate the effectiveness of curricular materials?

10. How helpful are student's IEPs in planning daily lessons?

11. How much time do you have for planning daily instruction?

12. How important are daily lesson plans for each student?

13. How does your school system encourage daily planning?

14. What single piece of information do you find most useful in determining whether a student is succeeding or not?

15. How helpful would you find computer-prepared lists of student daily performance information.

16. How often would you review such information given your present load?

17. How often would you review such information if you had time?

18. How helpful would it be for you to have weekly information on the reading rate and comprehension scores on your students based on standardized grade-level?

19. How helpful would it be for you to have daily graphs available for charting each of your students progress on basic arithmetic skills in terms of percentage correct, correct rate, and error rate?

3/2/82 STRUCTURED INTERVIEW, Part I

1. Varies from 10 to 12 hrs. per day plus 6 to 8 hrs. on weekends

2. A. 2 hrs. per day

   B. On lesson plans...30 to 45 min.'s per day for ALL stude[nts]

   C. 2 hrs. per week on developing informal test info; analyzing informal test info occurs "nightly," "all the time," daily quizzes given, summary: 1 hr. per day approx.

   D. Beginning & end of yr. during Pre & Post (about a two weeks duration) spent on analyzing formal test info.

   E. 5 or 6 hrs. per week spent searching for appro. materials... looking through I.U. materials library getting lesson plan books from other teachers, etc.

   F. weekly to every 2 weeks..."a weekend ritual"... "getting faster"... 2 to 3 hrs. every other week

   G. taken from informal info/test data...reviewing objectives through the lesson plan...sometimes write "not relevant" or "not appropriate" for the student's curriculum...not dated daily, but everyone's work is looked at & assessed every day (NOTE: this response relates to D above: approx.'ly 1 hr. a day)

   H. a couple of hours a week

3. All grades from quizzes and tests...grades on certain projects or assignments...
   Keep some of their work showing what they're having difficulty with in each area... in thick file folders...

4. Pull them everyday to put something in them, esp. 2 or 3 times a week... esp. now w/conf's coming up... no one but the teacher (Gizzi) looks at them.

5. Twice a year

6. Almost daily

7. Based a lot on student's reading ability... after 1 or 2 months of trying diff. methods you decide what works best... what's most motivating... e.g., like using the blackboard for math.

8. Soc. studies, science, & lang. arts: it's what's available b/t special ed. teachers...
   Reading & math: depends where they individually place on pre-tests...

9. By using them... reading through the teacher's manual first if it exists...lookir to see what sequence they use...may want to skip units that aren't appropriate.

3/3/82 STRUCTURED INTERVIEW, Part II

10. "somewhat helpful on daily basis"..."more helpful in planning units."... Need to work through intervening steps...IEPs more helpful as goals.

11. "time after school...spenf time preparing & correcting tests...How long is an evening? I probably spend 3 or 4 hours a day in planning... searching for and writing materials."

12. "I think extremely important...I'm compulsive about it...The day goes so much smoother..." Might not accomplish everything...but unless you plan it daily, you end up winging it... which many other teachers do.

13. "They don't." Coordinator and principal each once glanced at her lesson plans on a school year... "A sub should be able to use mine." They are done on the teacher's own individual choice because no one says anything if you don't.

14. Daily work and test scores...don't have to be long and formal...like a little quiz of 12 problems.

15. "Information I get from math is very helpful...If I'm feeding it in?... I guess it could be...If you were made accountable it would be... But only if a supervisor checks that it's done... Most people only start pulling daily student work performance 2 weeks before a conference... The conferences go too fast to utilize the data."

16. Maybe once a week.

17. Daily or every other day.

18. "Very...It would be really helpful to see if they're progressing at all... If it's something they could [illegible] all the time you would have something concrete to look at... as it [illegible] now we pull reading marks out of our head."

19. "If the kids could see it could be real important..." Sometimes for the teacher, too, it's easier to visualize something for comprehension regarding the student's progress.

STRUCTURED INTERVIEW - 5-13-82 (Post)

1. Teaching and Prep. 8 - 9 hours a day

2. a. 1 1/2 - 2 hrs/day
   b. Planning objectives 1 - 1 1/2/day
   c. 2 hours/week writing tests
   d. Refer back to Stanfords once/month & IEPs scores also
   e. Planning 1 1/2 hours hard to say how much time I spend looking for materials
   f. IEPs = At least once/month but usually every 2 weeks
   g. Formal tests = weekly group tests are given
   h. Sometimes immediately = usually every day by Prep period

3. Spelling - graphing student test performance
   Math - in multiplication & division administer 3 min. timed test weekly
   Weekly scores language arts papers
   Behavior problem, critical incidents, tardiness/absence
   SRA weekly tests in reading
   Written work - no grades - attitude, on task

4. Daily

5. Pre - Post Spring & Fall

6. One 3-min. timed Math
   One unit test per student per week in Social Studies, language arts, math & spelling, science, also language arts-creative writing. (S.S., L.A., Math-Fri., Spelling-Fri. Science one semester & Social Studies one semester)

7. For an individual child = 1 & 1 1/2 weeks to try an instructional technique

8. Select lower objective on hierarchy - as students acquire skill-go in sequence, e.g., Use a lot of supplementary ideas in Addison-Wesley (1979) can provide drill and examples for S.S. and Math.
   In other areas: teach whole class in standard materials

9. Answers above.

10. Not always helpful - sometimes O's are unrealistic
    Helpful in that supposed to be something they can do
    Parent Contact information is helpful

11. 45 min - prep period

12. Extremely

13. 45 minutes expect plan but they don't monitor lesson plans

14. Daily work--even ~~more~~ than tests. Some students panic on tests--looking at math tests, e.g., working one on one--making informal observations

15. Sometimes CIMS - When criterion were established in % somewhat difficult to calculate. No one (consultant) wanted to look at daily work or objectives accomplished. Conferences based solely on teacher recommendations. Conference coodinator did not look at objectives. No one looks at objectives accomplomed. Many teachers do not keep daily objectives for that reason or refer to IEPs

16. Used it only to understand CIMS. Found CIMS frustrating because it took a long time to plug in information. Should have had it whole school year. But didn't rely on it for conferences. Received it too late, no one wanted feedback. However, on math - which wanted feedback, kids wanted to see how well they were doing.

17. Would probably review it weekly - not enough time daily

18. Would really like to have CIRIS - I do it subjectively now - would like to have some time of measure -- mid to upper readers. Lower readers may have a problem because they are reliant on others to provide words that they didn't know

19. What were some of the advantages of having the computer in your room?

    a. Students liked the computerized math program and working on the computer. They thought they had a better class because they had a computer whereas other classes didn't.

20. What were some of the problems you encountered with the computer?

    a. Math program software. Nasty "glitches" were worked out but there are some in division. For example, I have two kids in division and if they make a mistake, it gives them the same problem over and over again indefinitely.

    b. If everything went smoothly I didn't have trouble with scheduling. I scheduled children during reading and during math program. However, if there was a break in routine all the kids didn't get on the machine

    c. Other problems included one child who was very compulsive who would linger over one problem at all time. Another child was off task totally and it was difficult to keep him motivated.

    d. Students liked it better when they got immediate feedback on their performance. (e.g., "great", "wrong") and were interested in knowing how they performed at the end of the session. I didn't try out the graphic of performance options (graphing)

21. What is the interest in computers in your classroom next year?

    a. Very interested

    b. Parents are interested

    c. Especially interested in the math programs

    d. I used the readability index a lot to advise teachers and for ordering new materials.

22. What do you see as the future of microcomputers and its use in the classroom and your involvement with them?

a. I'd like to learn to program, to develop my own software.

b. I'd like a spelling program on diskettes.

c. I'd like something to store test information.

3/10/82 STRUCTURED INTERVIEW

1. 8 hours

2. A. One hr. a week..."most of it's done as they're doing it...on the spot."

   B. "Zero...probably an hour a week."

   C. Half an hour a week

   D. "For case conferences and case reviews...25 hours through the year."

   E. ½ hour per week

   F. IEPs are kept on cards made up by Jill..."check once every couple of weeks...½ hour every two weeks seeing what they need to do..."

   G. 1 hour or ½ hour per week

   H. 15 minutes a week

3. "Grades...products for case conferences..."

4. Grades and daily.

5. 30 hours a year assessing for case conference

6. 2 hours

7. "Their learning style...whether it's visual or auditory...trial and error."

8. "Don't have a lot to choose from...what I can find...myself, other teachers, library..."

9. "Whether they got the material across...; whether they were interesting, whether kids complained; whether variety offered..."

10. "Not real helpful...they give you direction...but daily lesson plans come from me..." IEPs provide "overall direction" but teacher is not tied into IEP.

11. 5 minutes

12. "So many classes I teach are self-contained... but they are important even though subjects are taught as a class."

13. They provide prep period.

14. daily work

15. "The way things are now, it wouldn't be real useful for case conference... because the information isn't necessary or expected by the (Special Education) Department."

16. "Maybe weekly...not daily."

17. "Do it daily."

18. "Wouldn't need it...my kids don't make great strides..."

19. "Not real useful either."

Structured Interview: Post

5/13/82

The interview started with Mrs. Grabinger mentioning she's only been working with CIMS for 2 weeks.

1. "It's the same (as last interview)...It hasn't changed."

2. A. "Hasn't changed ..."

   B. "Hasn't changed. It goes with planning...for all students."

   C. "Hasn't changed. Particularly because of the time of year. IEPs and case conferences have already been done."

   D. "Stayed the same."

   E. "Stayed the same."

   F. "Stayed the same." IEPs were all done and handed in before receiving CIMS.

   G. "About the same." Now instead of putting on cards in my little book it takes longer to put it on computer. To put five kids on the computer on Friday it took 12 minutes compared to 5 minutes with recording in grade book. Probably quite a bit more time right now. Don't think the time will improve that much. Takes time to get back to beginning to start next student. Takes more time to document with the computer. Have to take notes while assessing kid to get data for the computer.

   H. "The same."

3. "Same as last time- grade book, individual files of IEP objectives on individual cards. Since conferences have been reviewing in math." (I. e., don't need to keep cards.)

4. "Same as last time- when I'm doing it. Last couple of months don't need to."

5. "Pre and Post"...Q..."per year"

"The same as before- weekly, but it hasn't changed since CIMS."

7 "Their strengths and weaknesses- the need of the student...trial and error... If it's worked before."

8. "What's available." Q "To me at my building. Depends on needs of students."

9. "Informal tests. In assessment of sitting with kids to see how they're doing." (i.e., observation)

10. "They give you the long-range goals to work toward- but the daily lesson plans are teacher-initiated."

Q: What do you do since you don't have IEPs anymore this year?

A: "Continue teaching from IEP even after the annual conference. Keep progressing, depending on what student needs. Teacher discretion."

11. "55 minutes a day."

12. "Very important...to keep continuing in progress. To keep clarity for myself. To be able to break it down to see the progression of what we're working from. Need that organization."

13. "They give you the time to do it- but they don't require you turn your plans in as some schools do."

14. "Daily work."

15. "Right now I wouldn't find it useful because we're not required to keep detailed information. Right now the way we're set up..." Q
"The system- it's 80% accuracy. Since we're not required to do that... But even so, a daily performance print-out wouldn't be that useful."

16. "Probably weekly... I would look at those when I do my weekly planning for the next week- and for long range."

17. "Ideally? Daily."

18. "I don;t feel that would be useful at all. Maybe monthly. Or quarterly. But not weekly. For example, I've been on CIMS four times in the last two or three weeks." (She said she could do it- CIMS- because of having a student teacher, because she didn't have to use planning time for her class.)
"Even without having planning time, only once this week did I have time during prep to use CIMS."
"Can't say every day I would have ten minutes during prep- depends on what needs to be done that particular day."

19. "The kids might like it- sometimes the kids are motivated by seeing their progress plotted. For the teacher, no utility. Teachers need the information, but not necessarily daily, and not in graph form. But the kids mught like the graph."

Additional Comments:

1. If we do this next year, I'd like to have the post-tests done before conferences, which means the end of February in order for the data to be useful to me. We teast anyway at the end of February. The kids get really bummed out being tested so much."

2. I would like all instructional materials to be put at 80% criteria, since that is what we use. Because otherwise the data is useless.

(She was reminded that she could have reset the criteria if she had wished.)

3. "Some of the rates are unrealistic. I would like to see rates ignored, because I'm more concerned with accuracy and not speed.

"It's okay to have rate on math software program but not on CIMS' other math objectives. Our kids work very slowly- hard enough to teach accuracy without worrying about speed. Sometimes it's okay...e.g., for multiplication facts. But fractions or long division, no. Also, too deifficult to keep time record for CIMS- not realistic in the classroom. I don't care if they (students) do it slow.You wouldn't get to other skills if you spent time teaching rate. Don't know it they would ever improve on speed, even if we worked consistently on it. Who's to say they're not working that fast versus they're off-task (e.g., going to the bathroom, talking to peers, sharpening pencil)."

"Classrooms just aren't sterile situations."

3/5/82 STRUCTURED INTERVIEW

1. 8 hours

2. A. "I do them as they come...when they do their math sheets I give them calculators to check them... It's a continual process"(reviewing & correcting papers).

   B. Teach directly from the student's IEP... doesn't have time to write other lesson plans...goes ahead and teaches other skills from the IEP even when the student doesn't accomplish lower objectives because "the student gets stuck and can't learn" something. Thus the IEPs enable the teacher to do a lot of reviewing and eventually the student learns the skills...
   Summary: daily instructional objectives are written for NO students.

   C. She tests main concepts from the test which the reg. ed. teacher send with the child.
   Everyday informal evaluation is done in math class.
   Summary: One-third of each class period actually spent preparing & evaluating...the rest of the time the child is actually doing the class work.

   D. "About 2 hours a week...an overestimate...not every week..." She checks the Stanford Diagnostics...and during a real need she checks the psychologicals in the principal's office.

   E. Modern Curriculum Press ordered to meet student objectives:..

   "Preparing teacher-made things for math happens all the time... omputer only resource for math... Constantly making worksheets for science and social studies..."

   "1½ hours [illegible] down on paper what's needed...half-day or longer mixed in w[illegible]her teaching responsibilities..."

   F. "I don't update it...average about once to twice a week make notations on the IEP...Each student gets hit once or twice a week."

   G. "Formal tests aren't done, but everything they do is being evaluated even though child doesn't know it..."

   H. "I suppose I don't consider whether material's effective,"but whether child is suited to the material...

3. Keep work samples of what math objectives met...keep a grade book...notations on behavior goes in grade book...files with work samples and workbooks... data on the computer...

4. Don't-until case conference when looking for examples to show parents...anything not needed then gets tossed out...

5. "I don't usually at all... but there's a Stanford given here at the school... All I give is informal... But Brigance Essential Skills are given..." and Brigance Basic Skills... at the end of the year by all Special Ed. teachers...

6. "Not unusual to be daily, but sometimes we (the teacher, Mrs. Granger) don't."

7. "I look at what needs to be learned... I attempt to break it down in simplest, largest way I can...I rely on old favorites..." e.g., list of vocabulary cards she makes for science, or nutrition, or some other topic the child is studying in another class...

Note: Mrs. Granger is both a resource teacher and has some students assigned directly and only to her for some subjects.

8. "Talk with other teachers to see what's effective in reading rooms...look through catalogs...there is a materials conference in Indpls. (at CEC)... look to see how others are doing things..."

9. If students show growth... if they're accomplishing what materials say they should do... via informal testing... whether kids show interest..."

10. "quite helpful...used a lot as reference point... I expand a lot on what they request."

11. One period for preparation...50 minutes...They're (IEPs, not lesson plans) very important."

12. "For me to know each day what I'm going to do is very important."

13. "They give you a plan book...Principal insists on picking up the plan book" at the end of the year... They assume you use it...In one's evaluations, the special ed. coordinator looks for lesson plans on your desk...The coordinator was in twice last year and not at all this year.

14. In conference: test results on standardized & informal tests

On daily basis: "It's his (student's) attitude and behavior."

15. "Which would mean I'd have to plug in everything we did...I don't know... Something's got to happen with time factor and organizational factor... I don't have much time to plug in the information."

But once the data is there, "I'm sure if I could look back at the lists it would be helpful...I don't know how I could plug in information all day anymore than use the plan book."

16. "I would imagine once a week...If I could set aside one day...as I'm putting in new information, the old wouldn't be relevant (a negative consideration)..."

17. If she had unlimited time to see how all were doing on IEP objectives, probably would still look at it only once a week. "Sometimes I lose track of time/period on teaching an objective...maybe could see a pattern."

18. "I'd like that a lot."

19. "That would be excellent."

Structured Interview: Post

5/13/82

1. "Busy all day- 7 periods...8:05 - 3:20"

2. A. "That's tricky because I often give the calculator to the students to go over their math sheets. Hard to say because it's incorporated into other activities. Total maybe an hour a day- depends on how much paper work is involved (in their school work). Science and social studies tests have to be graded...study work sheets...

B. "I don't write down in my plan book. I don't use my plan book. I don't actually make notations (just mental notes of what kid is having problem with). Just walk around the group to see how kids are doing. Too many things going on at the same time. Do check-ups once a week on states in science and social studies."

C. "My informal stuff- that's a continuous process- I don't know how to put a time on it."

D. "I take the Stanford Diagnostic grade level in reading...Grade level in math doesn't help because I'm dealing with specific objectives... then I've arranged a color-coded chart to see if Johnny can read(in such and such a reading kit passage). If the kid hasn't moved in grade level in years, I keep the same (grade level). If they move, I give a range of materials...but it dodn't take more than 20 minutes to write the whole thing down. When I find out what readability level is, I check the chart to see that they'r reading in the right book. It's an easy, clear-cut way of seeing it all in one place on one sheet."

E. "I don't know. I've got the textbooks for science and social studies and we're stuck with it. And once I've ordered what I need to order, we're stuck with that. I probably do more reviewing of the literature aspects and things we use from the library. A lot of the math is teacher-made, constantly changing depending on what they need. I'll adjust and simplify materials into an easier mode of learning from the regular ed. teacher's material or test. By cuing them they do better than (otherwise).

F. "I don't feel I can change the IEP... it doesn't happen that often that a student is moved to a less restrictive environment. If they do go to a less restrictive class, we'll often leave them on indirect consultation. If the student is meeting grades and successful in regular ed. class, then at the conference we recommend FT regular ed. All I do then is keep tabs on his grades. Q To find out if he's flunking or not to keep the parent informed."

G. "To say when they're met" (Yes) "Twice a month or so- it takes awhile to learn things, and then I take notes. But also after you've been teaching awhile you know the progression of what they need to do by looking at the math objectives. It's more the English and Reading objectives you need to double-check mor often.

H. "If the student still fails, after you've prepared some material, then you know immediately you need to try something else. It happens more with science and social studies."

3. "I keep (1) samples of work, (2) notations on behavior (in a file on each kid, where IEP and letters home are kept...), and (3) whne we have a flareup I immediately write what happened, what should have been done."

4. "Once they go in the folder they pretty much stay there until conference time. Then I can show reasons why he's not performing. Although every time I stick something in I glance in to see what's there. On the whole, several times a week I'm poking things in there. I delete behavior stuff and work samples if they're going to the high school. I keep them if I'll have the student next year."

5. "I like to pre-test and post-test. Monroe County likes you to use post-tests in the spring as the pre-tests for the fall. So I'm going back to my way and pre-test in the fall. The students like to better themselves, because they want to be in regular classes. Some feel defeated before they start, but the majority are eager to know how they're doing."

6. "A Lot... They don't know that they're tests but I regard it as a test, I.e., a check on their abilities. They Know they're tested weekly. I test them more often."

7. "Trial and error...what ever works...you get some information, clues from the psychometric report... Just by how the student's working. Try 'til you find what works & finally knowing your students."

8. "The textbooks are adopted by a textbook committee and I have no say... Greater say in language arts, but funds are so limited... The BFA (a reading Kit) was just handed to me... When I'm ordering materials I look for simple lay-out, a lot of repetition, very clear directions,... do they meet my objectives..."

9. "If they're effective, can the student actually meet the objective after using the materials... I'd probably design an informal way of checking that out."

10. "They're more helpful in general kinds of ideas... A guideline of things to get accomplished. In some instances, like the phonemes, you work out specific flash cards."

11. "They give us one hour of prep time, but I'm planning off and on each hour of the day...planning the next day."

12. "They're very important...need to keep track of your goals."

13. "They hand out a plan book that they collect at the end of the year. I'm writing tomorrow's work sheets even though I'm not writing it down in the planning book. Time to write it down isn't there."

14. "How comfortable he is with what he's doing... Inability to perform something creates a lot of negative feelings and frustrations. Besides the obvious of getting them all right on the sheet.

15. "It would be helpful if I didn't have to take time to put it in. I'm going to have to readjust how I do things. I would rather spot-check. Ideally it would be wonderful but time-wise it's impractical. You'd need another whole half-day to fo your computer properly. Sampling would be more effective. Like Monday and Tuesday sample all math and social studies. Another couple of days just the langauge arts... and that wouldn't be the total population.
There's no place to record behaviors, and I have behavior objectives and it's real tough to show how they've improved.

16. "Honestly I would look at it whenever I was having trouble with a group or series to see what was happening- (otherwise) I'd glance at it weekly. If I <u>wasn't</u> successful, I'd go to daily looks.

17. "If I had the time I'd so it as often as I could... more often with a troublesome group. Daily would be nice, but weekly for sure..."

18. "THat would be very helpful- that would be wonderful. I see it as a tremendous aid and support and back-up and confirmation of how you're doing. Not only for my knowledge, but for the student's knowledge.

19. "From the teacher's standpoint I can get the graph or the tabular,I like both of them, but I would like to see the graph for the student to see."

<u>Additional Comments</u>

I"m real concerned about the Brigance (reading comprehension passages) not being what they say they are.

I find the time aspect to be a real problem.

The compilation of the number of minutes that the individual teachers used the three computer software programs is presented in Table 16. The data clearly shows that the Edgewood teacher used the system far more than either of the other two teachers. In math she used the computer twice as long as the cumulative time accrued by the other teachers. One must question the appropriateness of frequent use, since the mean math achievement test score attained by the students in her class was approximately fifth grade, which exceeds the difficulty level of most of the CMMRS content. In addition, we found that many students went through the entire CMMRS program twice during the school year. This represents an inappropriate use of the program. It appears that the teacher expected each student to spend approximately 5 minutes a day on the computer, regardless of whether, they needed the work or not. The same teacher used the readability system the most extensively. She established a cooperative arrangement with the school librarian and the other special education teachers whereby, they could enter stories for which they wanted to know the readability level of the passages. Consequently her aggregated time on the machine far exceeded the other teachers. The teacher at Edgewood again accumulated the most time using the CIMS program. Part of the difference is attributed to the fact that she conducted her year-end case conference during April, while the other teachers had been compelled to complete them during March.

TABLE 16

Teacher Use of CMMRS:
Number of Minutes Per Month, 1981-82

School	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	School Year Total Min's
North	20	54	7	0	0	0	0	0	0	81
Edgewood	90	232	312	2	139	168	197	21	13	1,174
Dyer	*	*	271	21	92	1	206	0	0	591

Teacher Use of Readability System:
Number of Minutes Per Month, 1981-1982

School	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	School Year Total Min's
North	172	66	230	2	0	36	0	23	0	529
Edgewood	768	7	0	0	59	392	0	325	13	1,564
Dyer	*	*	13	0	280	36	33	31	0	393

Teacher Use of CIMS:
Number of Minutes Per Month, 1981-82

School	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	School Year Total Min's
North	--	--	--	--	--	--	0	38	48	86
Edgewood	--	--	--	--	--	--	89	580	4	673
Dyer	*	*	--	--	--	--	84	65	0	149

* Computer in classroom during this month.

-- Software program not available during these months.

Correlations Data Review

The data clearly indicates that there is not a significant relationship between the amount of time that the students spent working on the CMMRS and their score on the Stanford Diagnostic Math Test. In fact the Edgewood data indicates a negative relationship between the amount of time that the students spent on the computer and their achievement as measured by the SDMT. The data reinforced the hypothesis that the teacher did not use the program correctly. Rather than using the program to supplement the classroom instruction of the students, who needed needed additional drill and practice on computational facts, the teacher assigned every student to the program. Judging form the pretest data a preponderance of the students in the class should not have been assigned to work on the program. On the other hand the teacher at Dyer incorporated the CMMRS program into her classroom instructional program and assigned students to the program selectively. This approach appeared to produce the most affective results. A final caveat, which must be noted, is that the CMMRS taught skills were not highly correlated with student scores attained on the SDMT. (see tables 17-19) Thus student growth on CMMRS may not be accurately measured by the SDMT.

The remaining data indicates that there were only low order correlations between the amount of time that teachers spent using CRIS extensively but, that by itself, did not correlate with academic gains. Teacher reports suggest that the CRIS data influenced the selection of some relatively small number of instructional materials assigned to the students. Obviously, these data need to be incorporated broadly into the selection process in order to exert any influence on student achievement. In addition, the other data collected suggested that instructional variables could exert an even more pervasive influence on the students achievement.

NIE SUMMARY 1981-82

TABLE 17

CORRELATION I: SDMT Computations vs. CMMRS Time (student) '81-'82

All Schools:

	Mean	S.E.	S.D.
SDMT Gain Score (N=41)	+0.023	[illegible].162	1.035
Minutes on CMMRS (N=39)	166.872	10.66[illegible]	66.583

CORRELATION: +.1717; N=39; P=.148

Edgewood JHS:

	Mean	S.D.
SDMT Gain Score (N=21)	-.3762	.7880
Minutes on CMMRS (N=20)	159.000	5[illegible].2855

CORRELATION: -0.0486; N=20; P=.422

North H.S.:

	Mean	S.D.
SDMT Gain Score (N=7)	+.2571	1.6[illegible]2
Minutes on CMMRS (N=7)	111.4286	13.4519

CORRELATION: +0.1125; N=7; P=.405

Dyer M.S.:

	Mean	S.D.
SDMT Gain Score (N=13)	+.5415	.7376
Minutes on CMMRS (N=12)	212.3333	80.7784

CORRELATION: +0.3023; N=12; P=.169

NIE SUMMARY 1981-82

TABLE 18

CORRELATION II: SDRT Comprehension vs. CRIS Teacher Time '81-'82

All Schools:

	Mean	S.E.	S.D.
SDRT Gain Score (N=38)	+.124	.241	1.484
Minutes on CRIS-Teacher (N=38)	969.447	94.143	580.337

CORRELATION: -.0326; N=38; P=.423

NIE SUMMARY 1981-82

TABLE 19

CORRELATION IV: SDRT Comprehension vs. Student Time on CIRIS '81-'82

Dyer M.S. (only one to use CIRIS in '81-'82)

	MEAN	S.E.	S.D.
SDRT Gain Score (N=6)	+.750	.615	1.516
Minutes on CIRIS (N=6)	3.367	.713	1.745

CORRELATION: -.2073, N=6, P=.346

YEAR THREE

YEAR THREE

Teachers and administrators from the Monroe County Special Education Cooperative approached the project staff requesting the opportunity to work on the project for a second year. The rationale given was the general utility of the CMMRS, CIRIS and CRIS programs. Since additional field testing of the software programs and additional research on monitoring student behavior was deemed essential, therefore, we submitted a request for an extension that was subsequently approved. This being granted, the project staff began working with two of the teachers, who cooperated during Year 2, and added a third teacher working with a middle school population in a rural community located 15 miles from Bloomington. The goals for the third year were to study the use of microcomputers to obtain data regarding student academic performance, to monitor student performance and to prepare reports to assist teachers in data-based program planning decision-making. In addition, we were interested in analyzing the effect of teacher training upon the amount and appropriateness of the teachers use of the computer for decision-making purposes. Finally, to conduct a highly controlled study to analyze the effects of systematically using CMMRS on the academic performance of a group of students.

The following section will provide a narrative discussion of the pre/post test scores attained on the Stanford Diagnostic Reading and Math Tests (see Tables 20 through 23).

<u>Stanford Diagnostic Reading Test.</u> Overall, in the six month period that elasped between the pre and post tests, modest

Table 20

Stanford Diagnostic Reading Test

1982-1983

Pre-Post Test

	Aud. Voc.	Literal Comp.	Infer. Comp.	Total Comp.	Phonetic Anal.	Struct. Anal.	Aud. Discrim.
Pretest	4.57	3.41	3.52	4.09	3.66	3.88	3.43
Postest	5.16	3.39	3.78	4.14	4.51	4.41	3.83

Table 21

Stanford Diagnostic Reading Test

1982-1983

Pre-Post Test

Owen Valley	Aud. Voc.	Literal Comp.	Infer. Comp.	Total Comp.	Phonetic Anal.	Struct. Anal.	Aud. Discrim.
Pretest	4.40	2.49	2.61	3.45	3.20	3.79	2.42
Postest	4.85	2.50	3.00	3.57	4.74	4.43	3.49
Edgewood							
Pretest	4.71	4.36	4.89	4.98	4.43	4.63	4.22
Postest	5.59	4.43	4.78	4.97	5.23	5.03	4.61
Dyer							
Pretest	4.62	3.47	2.89	3.78	3.22	2.89	3.73
Postest	5.00	3.25	3.50	3.78	3.07	3.43	3.19

Table 22

Stanford Diagnostic Math Test

1982-1983

Pre-Post Test Data

	Numeration	Computation
Pretest	4.03	4.51
Postest	4.53	4.74

Table 23

Stanford Diagnostic Mathematics Test

1982-1983

Pre-Post Test

	Numeration	Computation
Owen Valley		
Pretest	3.26	3.32
Postest	3.84	3.15
Edgewood		
Pretest	5.16	5.03
Postest	4.92	5.30
Dyer		
Pretest	4.02	5.00
Postest	4.64	5.61

achievement tests gains were evidenced. On the auditory vocabulary subtest, the students gained one month of achievement per month in the program. The gains in comprehension were much more modest, since the students gained one to two months on the average per subtest. The greatest gains on these subtests were attained by the students at Owen Valley Middle School, while the smallest growth occurred for the students at Edgewood. On the phonetic analysis subtest, the students obtained over one month per month in the program. Substantial gains were made by the students at Owen Valley and Edgewood Middle Schools, while the test scores of the students from Dyer Middle School actually decreased. Teacher reports suggest that the teachers at Owen Valley and Edgewood allocated substantially more instructional time to this instructional area than the teacher at Dyer. On the structural analysis subtest, the students gained approximately one achievement growth per month in the program. The gains by schools were fairly consistent on this particular subtest. Modes achievement gains were attained on the auditory discrimination subtest. In analyzing the results by school, we found that the students at Owen Valley attained approximately one years growth during the six months that elapsed between the administration of the pretest and the postest. The scores of the students at Dyer, on the other hand, decreased on this particular subtest. The reasons for this decrease are not clear. On one hand, the teacher did not allocate a great deal of time to the subject content area. This subtest was the last administered during the postesting, so the students may have been tiring due to testing and, consequently, did not score as well as one would have expected.

On the Stanford Diagnostic Math Test, the students made slight gains between the pre and post test. On the numeration subtest, the students at Owen Valley and Dyer gained approximately one month's achievement per one month in the program, while the scores of the Edgewood students slightly decreased. On the computation subtest, the scores of the students at Owen Valley decreased, while the students at Edgewood increased slightly and the scores of the students at Dyer increased at a rate of one month per month in the program.

Table 24
Teacher Use of CMMRS:

Number of Minutes Per Month, 1982-83

School	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	School Year/Tot. Min.
Edgewood	0	0	0	0	129	3	0	0	0	132
Dyer	0	26	46	25	0	82	6	7	0	192
Owen Valley	0	0	281	32	140	48	29	8	14	552

Teacher Use of CRIS:

Number of Minutes Per Month, 1982-83

School	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	School Year/Tot. Min.
Edgewood	0	0	4	4	0	0	0	0	0	8
Dyer	0	0	0	0	45	0	0	241	0	296
Owen Valley	0	0	0	0	0	0	13	0	0	13

Teacher Use of CIRIS:

Number of Minutes Per Month, 1982-83

School	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	School Year/Tot. Min.
Edgewood	0	0	0	0	0	0	0	0	0	0
Dyer	0	0	0	0	0	4	2	2	0	8
Owen Valley	0	0	0	0	26	11	27	0	0	64

The correlation between student time using CMMRS and their achievement test scores attained on the SDMT during the 1982-1983 school years was slight and negative. These data on first inspection suggest little relationship between time spent using the CMMRS program and student academic growth. Data collected in the study described in the preceeding section, however, indicated the target students typically increased their performance on the CMMRS and in some cases this growth transferred to the SDMT despite the absence of a statistically significant relationship between the achievement gains and the amount of time that they spent working on the microcomputer. One explanation for the low correlations observed is that the student spent very little time on the CMMRS program for it to be much benefit. For clever youngsters enrolled in the Owen Valley program, the students were only exposed to the CMMRS an average of 25 minutes in one month. Obviously, such scant exposure to any program is not enough to warrant a conclusion as to its efficacy.

Thus, it would appear, that subsequent studies should be designed to examine student responses and systematically manipulate the time that students spend working on CMMRS. It may be that short periods of high quality and high intensity responding on those skills, which have been acquired but not mastered, is sufficient to maximize student achievement and that additional time spent produces a detrimental approach. These findings suggest additional research is needed to carefully evaluate the efficacy of not only the computerized math programs, but other software in general.

particularly since most school systems assign students to computers and rarely monitor their success or progress.

The other correlations reported in Tables 25 through 30 are also not significant. The results clearly support the finding that time on machine by itself is not highly correlated with student academic achievement. The data suggest that one must examine the instructional content, the responses required and the relationship of the computer coursework and the other components of the curriculum.

NIE SUMMARY 1982-83
Table 25

CORRELATION VI: Stanford Math Computation vs. Student Time on CMMRS '82-'83

All Schools:	Mean	S.E.	S.D.
SDRT Gain Score (N=47)	+.115	.178	1.223
Minutes on CMMRS (N=43)	110.535	9.391	61.582

CORRELATION: -.1578; N=43; P=.156

Edgewood J.H.S.:	Mean	S.D.
SDRT Gain Score (N=20)	.125	.882
Minutes on CMMRS (N=19)	86.450	45.149

CORRELATION: +.1733; N=20; P=.233

Dyer M.S.:	Mean	S.D.
SDRT Gain Score (N=12)	+.6083	.805
Minutes on CMMRS (N=12)	100.333	40.114

CORRELATION: -.1521; N=12; P=.318

Owen Valley M.S.:	Mean	S.D.
SDRT Gain Score (N=15)	-.2933	1.721
Minutes on CMMRS (N=11)	165.455	75.378

CORRELATION: -.1456; N=11; P=.335

NIE SUMMARY 1982-83
Table 26

CORRELATION: SDRT Comprehension vs. Teacher Time on CRIS '82-'83

All Schools:	Mean	S.E.	S.D.
SDRT Gain Score (N=49)	+.045	.139	.970
Minutes on CRIS (N=49)	80.469	17.719	124.035

CORRELATION: -.0255; N=49; P=.431

NIE SUMMARY 1982-83

Table 27

CORRELATION: SDRT Comprehension vs. CIRIS Teacher Time '82-'83

All Schools: (Dyer and Owen Valley--Edgewood didn't use CIRIS)

	Mean	S.E.	S.D.
SDRT Gain Score (N=31)	+.077	.100	.554
Minutes on CIRIS (N=31)	42.323	4.980	27.728

CORRELATION: +.1129, N=31, P=.273

NIE SUMMARY 1982-83

Table 28

CORRELATION: SDRT Comprehension vs. CIRIS Student Time '82-'83

All Schools: (Dyer and Owen Valley--Edgewood didn't use CIRIS)

	Mean	S.E.	S.D.
SDRT Gain Score (N=31)	+.077	.100	.544
Minutes on CIRIS (N=27)	14.185	2.331	12.113

CORRELATION: -.1871, N=27, P=.175

Dyer M.S.:

	Mean	S.D.
SDRT Gain Score (N=12)	-0.000	.5410
Minutes on CIRIS (N=10)	7.950	4.419

CORRELATION: -.2563, N=10, P=.237

Owen Valley M.S.:

	Mean	S.D.
SDRT Gain Score (N=19)	+.1263	.5714
Minutes on CIRIS (N=17)	17.853	13.742

CORRELATION: -.2920, N=17, P=.128

NIE SUMMARY 1982-83

Table 29

CORRELATION: Total Teacher Time on Machine vs. SDMT Computation '82-'83

All Schools:	Mean	S.E.	S.D.
SDMT Gain Score (N=47)	+.115	.178	1.223
Total Teacher Time (N=47)	386.957	32.197	220.731

CORRELATION: -.0714, N=47, P=.317

NIE SUMMARY 1982-83

Table 30

CORRELATION: Total Teacher Time on Machine vs. SDRT Comprehension '82-'83

All Schools:

	Mean	S.E.	S.D.
SDRT Gain Score (N=49)	+.045	.139	.970
Total Teacher Time (N=49)	416.796	31.339	219.372

CORRELATION: .0553, N=49, P=.353

OBJECTIVES AND HYPOTHESES

The math remediation computer programs developed for this research project were designed to achieve two related goals. The first was to maximize research flexibility for a program of research in computer managed and assisted teaching and learning. The second was to develop and validate an effective computer-based application of a basic math computational skills curriculum. This research project was designed to assess the effectiveness of an experimental application of computer-instruction programs; when used with a group of mildly mentally handicapped middle school children. The computer-instruction programs were written to emulate a complete instructional process including:

1) assessment of individual student skills;
2) diagnosis of deficits in individual student skill development;
3) objective referencing for identified student skill deficits;
4) performance of instructional tasks for the remediation of identified skill deficits using modeling and feedback techniques;
5) setting of criterion based performance standards; and
6) automatic record keeping and report generation of all student activities.

Hypotheses

The following hypotheses were proposed:

H1: Post-test measures will be higher than pre-test scores attained on the norm-referenced Stanford Diagnostic Math Test - Computation Subtest.

H2: Individual math computation operation area paper-and-pencil informal math assessment posttest scores will be higher than pretest scores when the measures are taken pre and post of computer instruction in the measured operation area.

H3: Individual math computation operation area paper-and-pencil informal math assessment posttest scores will not be different than pretest scores when the measures are taken pre and post of computer instruction in an operation area other than the measured operation area.

H4: Individual math computation operation area computer-generated math assessment posttest scores will be higher than pretest scores when the measures are taken pre and post of computer instruction in the measured operation area.

H5: Individual math computation operation area computer-generated math assessment posttest scores will not be different from pretest scores when the measures are taken pre and post of computer instruction in an operation area other than the measured operation area.

H6: Pre-post change scores of operation areas in which computer instruction was received will positively correlate with total time students use the computer-instruction program.

METHOD

The purpose of this study was to develop and evaluate the effectiveness of a computer-managed instruction program to teach basic math computation skills to a group of mildly retarded middle school children. The computer programs were written to emulate a complete instructional process which included: assessment, prescriptive teaching, student monitoring, feedback, and record keeping. All of the instructional variables of the computer system other than initial placement and mastery criterion setting were computer controlled.

In consideration of the technical nature of the content of this project this Chapter will be divided into two major sections. The first section, "Research Methodology", will contain information related to research design, subject descriptions, a description of the research setting, and measures used.

The second section, "Computer Methodology," will describe how the instructional programs used by the computer actually work. Included in this section will be the logic of the computer programs and how they implemented an instructional process.

Section I
Research Methodology

Design

To measure the effectiveness of the computer instruction program, a series of single-subject multiple baseline (across math operation computational skills) investigations were undertaken utilizing reversal procedures (Baer, Wolf, and Risley, 1968; Gelfand and Hartmann, 1975; Hersen and Barlow, 1976; Kratochwill, 1978). For each of twelve children, an A-B(1)-A-B(2)-A design was used (A = Baseline phases; B(1) = computer instruction in one of two math operation areas (addition, subtraction, multiplication, or division) individually assigned to each student; B(2) = computer instruction in the alternate math operation area assigned to each student). For the remaining two students an A-A-B(1)-A design was used.

This design was chosen because it provided a means of controlling for instruction and learning taking place outside of the computer-managed curriculum. Prior to computer instruction each student was assigned two math operation areas for instruction during the course of the experiment. Instruction was given in only one operation area during each of the B(x) phases. During each of the baseline phases (A) both operation areas were assessed using alternate form paper-and-pencil and computer generated tests (see Measures). In addition, during the first and third baseline periods a standardized test of math computation skills was administered. Both the experimental design used in this study and the content of each are summarized in Figure 44.

Phase	T	A	B(1)	A	B(2)	A
# days	8	5	10	8	10	5

Content of each experimental phase:

T = Computer use training.

Assignment of two operation areas to each student for computer instruction.

A = Baseline measures of computation skills of each student in their assigned operation areas.

B(1) = Computer instruction in the first operation area assigned to each student.

B(2) = Computer instruction in the second operation area assigned to each student.

Figure 44 Outline of experimental design used in the study.

Instructional effects may be evaluated using this type of research design since instructional method was constant within each instructional phase but the content of instruction within each differed (Simkins, 1971; Tighe and Elliott, 1978). That is, when assessing the effect of instructional phase B(1), the first and second baseline measures were used as a pre-and-post measure while the third baseline measure served as a control. If instruction were effective, the measures taken during the second baseline would indicate an

This increase could then be hypothesized as being a result of intervention supplied during the first intervention phase. If the change in baseline scores between the first and second baseline were due to instruction during the first instructional phase (B(1)) then performance during baseline three should show no change from performance during baseline two. The opposite effect should happen when assessing instructional phase B(2). That is, baseline measures of the operation taught during instructional phase B(2) should show no change between baselines one and two, but should show an increase between baselines two and three.

In addition, with the multiple-baseline design used, the effectiveness of the instructional intervention can be assessed by a comparison of computation performance across the two content areas. Using this multiple-baseline technique a causal relationship between the computer instruction and computation performance may be demonstrated, if computation performance within each instructional area changes when and only when the instruction occurs (Kazdin, 1975).

Students

The subjects in this study were fourteen children, eight boys and six girls, whose ages ranged from 12 to 15 years (mean= 13.5; s.d.= 1.0). All students were enrolled in a self-contained classroom for the Mildly Mentally Handicapped (MMH) in a middle school serving primarily children living in a rural area. All academic subjects were taught in this classroom by one teacher with the aid of an assistant. Children were all mainstreamed into regular classrooms for Art and Physical Education. All students had received an individualized WISC-R by a certified school psychometrist within the previous year. Student I.Q. scores attained on the WISC-R ranged from fifty-two to seventy-four with a mean of 66.5 (s.d.= 7.5).

A fifteenth student was originally included in this study but had to be dropped for non-participation. This student's school records indicated a history of noncompliance in testing situations which unfortunately also occurred during testing required for this study. Reliability of measures, therefore, could not be assumed for her performance.

Setting

All testing, procedural instruction, and computer instruction were conducted in the MMH classroom. Within this classroom a Radio Shack TRS-80 Model I Level II microcomputer with 48K of memory and two external 5.25 inch single density disk drives were placed in a study carrel. The location of the computer was physically removed from the normal student seating area; it was placed in the rear of the classroom out of the direct line of sight of students not working on it.

Daily Classroom Routine

During each day of this study each student worked on the computer independently. Within the ecology of their normal classroom approximately fifty percent of the day was spent doing independent seat work. The scheduling of the students to work on the computer was determined daily by the classroom teacher according to individual student availability.

During baseline phases (A) students worked on the computer for two minutes per day. One minute was included for each of two tests administered by the computer (see below "Measures - Computer Generated and Presented Tests"). Including transition from student seat to computer, initiation of computer programs, working computer presented tests, and receiving computer feedback, total student time each day was approximately four minutes.

During the instructional phases (B(1) and B(2)) of this research project, students worked on the computer six minutes per day. Five minutes were spent interacting with the instructional programs (see below "Computer Instruction Program") and one minute was spent testing the operations area in which they were receiving instruction (see below "Measures - Computer Generated and Presented Tests). Including transition from student seat to computer, initiating the computer programs, receiving computer instruction, working the computer-presented test, and receiving computer performance feedback, the total time spent by the student was approximately eight minutes.

Measures

There were two objectives for measuring student math computation skills: initial screening for computer curriculum placement and instruction; and determination of the effectiveness of the computer-instruction curriculum. Considering these two objectives and the interrelationship of the content of the computer programs to the external measures, a brief description of the content of the computer curriculum will follow. A fuller description of the computer curriculum can be found in "Section II - Computer Methods."

Measures for Placement and Instruction. Each student in this study was assigned for computer instruction two math operation areas. As this study was conducted in a public middle-school classroom in which students exhibited a wide range of academic abilities and deficits, students were assigned only to operation areas in which they displayed performance deficits on the placement measures. Performance was measured initially by both a standardized test resulting in grade equivalence scores and an expanded version of the Informal Math Inventory used in the SST project (Sterling, 1976) which corresponded to the computer instruction curriculum (see Appendix B for a complete copy of this instrument). Each of these two measures are described below.

Standardized Measure. The Stanford Diagnostic Math Test - Computation Subtest (SDMT) (Beatty, Madden, Gardner, and Karsen, 1976) was chosen as the norm-reference instrument for three reasons. First, the test included a Computation Subtest which produced a grade equivalence score separate from the total test score. Second, test forms were available for each grade-level with a standard measure for cross form test score comparisons. And third, alternate forms for post instruction measurement were available.

Initially classroom teacher was consulted regarding which form of the SDMT would be most appropriate for administration to each child. Ten level "Green" (Grade levels 3.5 - 6.5) and four level "Red" (Grade levels 2.5 - 5.5) were administered to participating students. The classroom teacher's initial assessments of student abilities were demonstrated to be correct; the four children administered the lower level, "Red", scored at the teacher's predicted grade equivalence of grade three or lower, and the ten children given the higher level, "Green", scored at or above the fourth-grade level.

The researcher administered the test to the subject group following procedures recommended for group assessment in the test administration manual. Individual student scores are reported in the Results chapter.

Informal Math Inventory. On the day following the administration of the standardized test (SDMT), an Informal Math Inventory (Sterling, 1976) was administered to all students. This test was intended to identify specific computation skill weaknesses which could be targeted for computer instruciton. The test consisted of sixteen one minute tests, each measuring one math skill Cluster area in the curriculum (see Appendix B - Informal Math Inventory Tests). A single one-minute testing period for each Cluster was considered an appropriate timing for securing an accurate index of student ability since extensive and repeated pilot test results (Rieth, 1981) have consistently correlated at .98 or higher on test-retest applications of the instrument.

In addition to the computation tests, a one-minute "speed" test was given. This test required the student to copy numbers as fast as possible. This test gave an index of the students' fine motor abilities, information useful for setting mastery levels for student performance (see "Criterion Setting" below). It also provided a copy:computation speed ratio index for future research (this area was neither hypothesized nor speculated upon in this current research).

The primary measures of student performance on this test were rate-based (Ellis and Prelander, 1973; Haughton, 1972; McCraken, 1971; Starlin, 1971; Starlin and Starlin, 1973a, 1973b, 1973c). The rate measures used were response digits per minute correct (DPMC) and response digits per minute error (DPME). This type of measure, enables one to detect fine gradations of change in pupil performance measured and define and measure absolute minimum student performance (Haring and Gentry, 1976).

<u>Student</u> - <u>Curriculum</u> <u>Placement</u>. After each student was given the Stanford Diagnostic Math Test - Computation Subtest (Beatty et al., 1976) and the Informal Math Inventory (Sterling, 1976), both the classroom teacher and the experimenter examined the individual scores of the students on both of the measures and independently recommended two math Operation areas in which each student should receive in-

struction. The general criteria for these recommendations were:

1. The student must have performed at an unacceptable level of proficiency within the selected operation areas.
2. Since the curriculum was designed for remedial and not initial instruction, students were required to demonstrate a basic knowledge of the computation processes within the asigned operation areas.

The separate and independent recommendations the classroom teacher and the experimenter formed were identical in identifying the two target operation areas for each student. Assigning the student to instructional phase (B(1) or B(2)) was completed by the experimenter. Table 31 depicts type of instruction and instuctional phase assigned for students in the program.

	Instructional Phase	
Operation Area	B(1)	B(2)
Addition	2	1
Subtraction	6	6
Multiplication	3	4
Division	1	3
Total	12	14

Table 31 Number of Students Receiving Operation Area Instruction During Each Instructional Phase

During instructional phase B(1) two additional students were assigned to receive instruction in division but instruction was prohibited by student school absence. Instruction for these students during instructional phase B(2) was accomplished.

Measures for Computer-Instruction Effectiveness

To determine the effectiveness of the computer-instruction given each student, three different types of measures were taken: standardized test scores, paper-and-pencil informal math inventories, and computer generated and presented tests. The procedures used for and the measures taken from each of these types of tests are described below.

Standardized Measures. The Stanford Diagnostic Math Test - Computation Subtest (Beatty, et.al., 1976) was administered before computer instruction began and again after the study was completed. Standard scores were used as an informative index of the transference of computer-taught skills to a generalized application.

Informal Math Inventory. The Informal Math Inventory (Sterling, 1976) described above under "Measures for Placement and Instruction - Informal Math Inventory" was also used as a measure of student math computation skill acquisition. This measure was used to ascertain generalization of specific skills taught using the computer to a traditional pencil-and-paper medium. It also provided further pre and post measures of computer instruction that facilitated analysis with the A-B(1)-A-B(2)-A experimental design.

The generalizability of math skills taught using the computer-instruction program were directly measured with this test since each of its sixteen subtests directly correspond to the sixteen Cluster areas included within the computer curriculum. Therefore, any increase in computation performance within a Cluster area resulting from computer instruction should be reflected by an increase in performance on the paired subtest of the paper-and-pencil Informal Math Inventory.

To ascertain the generalization to paper-and-pencil tasks, alternate forms of the Informal Math Inventory were administered to all students during each of the three baseline (A) phases of the study. The initial administration given for "Student-Curriculum Placement (see above) served as the first baseline measure. The remaining two baseline administrations were given on the same day of the week and at the same time of day as the first administration (Tuesday - 10:00 A.M.) using alternate forms.

<u>Computer Generated and Presented Tests</u>. Computer generated and presented tests were given to the students to measure skill acquisition across time, using a standard measure in the medium in which they received instruction. Testing via the computer was performed daily during both the three Baseline periods (A) and two instructional phases. Following is a description of the procedures used during computer testing as well as their content. The testing schedule is depicted below in Figure 45.

Experimental Phase

	A	B(1)	A	B(2)	A
Instruction		1111111111		2222222222	
Test(s)	11111 22222	1111111111	11111111 22222222	2222222222	11111 22222

A = No instruction. Daily test in both operation areas assigned to each student.

B(1) = Instruction in the first operation area assigned to each student. Daily test on only the first operation area.

B(2) = Instruction in the second operation area assigned to each student. Daily test on only the second operation Area.

Figure 45 Schedule of Computer Generated and Administrated Tests.

<u>Baseline computer measures</u>. Everyday during each of the three baseline phases the computer presented each student with two separate one-minute tests. Each test measured performance in one of the two designated instructional areas. Each test consisted of a random selection of math problems which included all Skills within each Cluster of the operation area being assessed.

The computer-student interaction procedures used during baseline periods were as follows: Student individually sat in front of the microcomputer and typed their access code on the keyboard. The computer programs then matched the student with the appropriate test content. During the tests one math problem at a time was presented on the computer video screen. The student provided the answer using the numeric keyboard. After a student provided the answer to a math problem, the problem was immediately replaced with a new problem to solve. After one minute, the computer informed the student that the test was over and that the second one minute test was started. The time interval between tests was student controlled: that is, the computer did not start the second test until the student pressed the SPACE BAR on the computer keyboard. At the completion of both tests, the computer presented the student with performance feedback for the tested operation areas via a graph drawn on the computer video screen. A separate graph was presented for each operation area tested. The data presented on the graph were digits per minute correct (DPMC) achieved by the student for each day of the current baseline period. Included on the graph was the individual student's "GOAL LINE". The level of the goal line represented the DPMC criterion for the student's daily work assessment (see below "Criterion Setting"). Figure 46 depicts the screen presentation given to student A9 after the fifth day of his second baseline period.

```
              DIGITS PER MINUTE CORRECT
                   MULTIPLICATION
40 !
   !
   ! *
   !
30 !
   !
   !                  *
   !
   !   *                   *
20 !_ _ _ _*_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ GOAL
   !             *
   !
   !
10 !
   !
   !
   !
 0 !---!----!----!----!----!----!----!----!----!
```

Figure 46 Example of Computer Generated Graph Used for Performance Feedback.

<u>Daily computer measures</u>. During each day of both instructional phases, B(1) and B(2), a measure was taken on student performance in the operation area in which they were currently receiving instruction. Immediately following the five-minute computer instruction (see below "Computer Instruction") the computer automatically initiated a testing program identical to the one described above (see Baseline Computer Measures). The only differences between these daily tests and the baseline tests were that the student received only one test daily - in the operation area of current instruction. The operation area in which they were not currently being instructed was not tested. At the completion of the test, students were presented a graph on

the video screen depicting their performance during that instructional phase (see Figure 40). Data presented consisted of digits per minute correct (DPMC) for each of the daily tests taken during the current instructional phase as well as their "GOAL LINE".

<u>Content of the Computer-Instruction Programs</u>

The premise of this instructional program was that efficient and measurably successful student learning would occur when specific academic skill weaknesses can be identified, and the student received direct instruction to correct these (see "Chapter II - Review of Literature" for a more thorough explanation). The computer-instruction programs developed for this project rely heavily on a remedial math curriculum originally developed for the Seattle-Spokane-Tacoma (SST) project (Sterling, 1976). This curriculum covers basic math computation skills within the math operation areas of addition, subtraction, multiplication, and division. The foundation of this curriculum is that proficiency in basic math computation can be demonstrated only after all skills in a hierarchy are mastered. Therefore the curriculum first identifies students' specific skill deficits, and then provides them with remedial instruction in the identified deficit skill area.

To accomplish the above goals, the generic area of "Basic Math Computation Skills" is divided into three hierarchically arranged configurations: 1) Operations; 2) Clusters; and 3) Skills. Definitions of each of these terms are as follows and are depicted in Figure 47 (see Appendix for a complete list of Operations, Clust and Skills).

<u>Operations</u>. Operations are the four main mat areas of Addition, Subtraction, Multiplication, and Division. In this research two opertion areas were assigned to each student for computer instruction.

<u>Clusters</u>. Within each operation area specific computation Skills are grouped into hierarchically-arranged Clusters. These Clusters are sequenced such that a demonstration of mastery of any single Cluster would not be possible without a mastery of lower level Clusters. For example, Clusters #9 and #10 within the operation area of Subtraction are:

> Cluster #9. Subtraction facts with the minuend >9 but <19 and the subtrahend <10, with borowing necessary.
>
> Cluster #10. Subtraction facts, double-digit minus single-digit numbers, with borrowing required,

Mastery of Cluster #10 would be impossible to demonstrate without a requisite mastery of Cluster #9 since Cluster #9 essentially covers all specific computations involving subtracting from a "teens" number when performing Cluster #10 the "borrowing" requirement mandates that the units portion of the minuend be re-grouped to form a "teens" number.

Skills. Within each Cluster all computation Skills necessary for demonstration of mastery are included. "All inclusive Skills" assumes that all lower-level Clusters have been mastered. For example, the Skills within Cluster #9 include subtracting the digits 1 through 9 from any "teens" number. If a student were having difficulties subtracting the digits "8" and/or "9" from a "teens" number, mastery of this Cluster could not be demonstrated.

Cluster Area	Inclusive Skills		Skill #
# 9. Subtraction facts, with the minuend > 9 but < 19 and the subtrahend < 10, with borrowing.	Subtrahend =	-1	9.1
		-2	9.2
		-3	9.3
		.	.
		.	.
		-8	9.8
		-9	9.9
#10. Subtraction facts, double digit minus single digit, with borrowing.	Subtrahend =	-1	10.1
		-2	10.2
		-3	10.3
		.	.
		.	.
		-8	10.8
		-9	10.9

Figure 47. Example of Cluster and Skill relationships (example taken from Appendix C).

Student - Computer Use Instruction

Prior to this study, none of the subjects had experience using a microcomputer. Therefore, computer use instruction was necessary for all students on the general operation of the computer, and on how to work the computer-instruction programs. The following instruction was given to all students individually by the experimenter.

Computer Familiarization. When students demonstrated proficiency on four main objectives they were able to work successfully and independently through the computer-managed math curriculum. Thus, all students were taught to:

1) successfully initiate a computer program;
2) use the computer keyboard;
3) read and interpret graphic data on the computer video screen;
4) attempt to solve computer-presented math computation problems.

Instruction took place while the students were sitting in front of the computer. On the first day, students were instructed in the procedures of initiating a computer program, entering numeric answers using the computer keyboard, and reading and interpreting graphs.

Initiation procedures involved copying a message taped to the computer keyboard. The message read RUN "A". Throughout the entire study a taped message was present. The content of the message varied between RUN "A", RUN "B", and RUN "C", depending on which computer programs the investigator wanted the students to initiate. After typing the RUN"A" message correctly a computer use training program was initiated and run by the computer.

Within this training program students were presented and performed the following tasks: entering their individual computer identification number, matching numbers appearing on the screen with number keys on the computer keyboard, and reading a graph of their "speed" at the completion of every one minute. The experimenter sat with students as they worked and explained and prompted each task for five consecutive cycles of program initiation, entering student number, copying digits, and interpreting the graph.

On the second day, each student performed a complete cycle with aid from the experimenter five times. While students were performing these tasks the student verbally explained them to the experimenter.

On the third and fourth days students worked independently. The experimenter was not present in the classroom. The teacher's assistant reported that no child requested help during these days.

On the fifth day, each student performed five cycles on the computer with the experimenter observing from across the room, not interacting. At the completion of the fifth cycle the experimenter asked each student to explain the graph with such questions as "Are you getting better (faster) - Show me how you know this."

In addition to training the students to use the computer, the training program also provided the experimenter with a baseline rate of each student's non-computational digit copying speed corresponding to the random number paper -and-pencil copying task described above (see above, "Student - Curriculum Placement - Informal Math Inventory"). Since the primary measures in this study were rate based, Digits per Minute Correct (DPMC), and Digits per Minute Error (DPME), these measures were needed to help select a criterion level for student performance (see below Criterion Setting).

Math Program Training. After the fifth day of computer familiarization training each student was introduced to the computer math program. On the first day of math training the message taped to the computer was changed to reflect the name of the computer program that initiated a series of two tests, one each in the two operations areas in which they were assigned to receive computer instruction. The content, format, and procedures used for these tests were identical to the "Baseline Computer Measures" (see above). A variation in the procedures outlined above involved the experimenter individually tutoring the students on how to use the computer keyboard to respond to the problems. Tutoring included explanations, demonstrations, and verbal prompting. Following two minutes of practice, performance graphs (see Figure , above) were presented to the student. The experimenter then explaned how to interpret the graphic data. Following this practice session, the experimenter required the student to explain the procedures just performed. This complete cycle was then performed independently by the student two additional times.

After one day of computer problem solving instruction with the experimenter present, the students completed two cycles per day (initiating the program, solving problems, reading the graph) for the next two days, with the teacher's assistant as a backup for student difficulties. The assistant reported no difficulties during this period. Total practice time was approximately five minutes per day for three days.

Criterion Setting

An integral part of the computer curriculum is the determination of "mastery". Mastery decisions were made using a comparison of actual student performance against a performance criterion. Within this curriculum the setting of levels for criterion performance are completely teacher/researcher controllable. Once performance criterion is set, the computer records this information and automatically uses it as the basis for all decisions. For this research project the criterion for mastery decisions was the same for both Cluster assessment and specific Skill remediation assessment.

The criteria used for mastery decisions were as follows:

1) 90% of all problems attempted must have been correct;

2) a maximum of two response digits per minute were allowed to be in error (DPME);

3) a minimum number of digits per minute correct must have been obtained (DPMC). For this requirement one-half of the students in the study were required to achieve a minimum of 15 DPMC and the other one-half were required to achieve 20 DPMC. The criterion for assigning these levels were standardized test results. Those in the lower one-half of test scores (below grade level equivalent 4.6) were assigned the lower performance level. Those scoring in the upper one-half were assigned the higher level.

One additional criterion for demonstrating mastery of Cluster areas was imposed. All students were required to meet or exceed the above criterion two consecutive times during this assessment. This additional performance criteria was used in order to assure that an adequate sample of all Skills included within the Cluster being measured were presented to the student.

Section [illegible]
Computer Methodology

Design

The purpose of this study was to develop and evaluate a computer instruction program for teaching basic math computation skills. The computer curriculum included the ability to do student assessment, prescriptive teaching, student monitoring, feedback, and record keeping. The following section describes how the computer-instruction programs work internally and interactively. A general flowchart of the tasks performed by the computer is shown in Figure 48. For specific computer logic flowcharts see Appendix D.

SELECTION OF CLUSTER TO ASSESS

ASSESSMENT OF CLUSTER SKILLS

(yes) MASTERY DECISION (no)

DETERMINATION OF SPECIFIC SKILL DEFICIT

INSTRUCTION IN SPECIFIC SKILL DEFICIT

ASSESSMENT OF SPECIFIC SKILL PERFORMANCE

(no) MASTERY DECISION (yes)

PERMANENT STUDENT PERFORMANCE RECORD

STUDENT PERFORMANCE FEEDBACK

Figure 48 General Flowchart of the Computer-Managed Math Remediation Program

As is shown in Figure 48 the computer-instruction programs work in a "Closed Loop" fashion. That is, once a student is entered into the system all decisions, instruction, and record keeping are mutually dependent and require no external interaction. Since the path of instruction (assessment, decisions, and instruction) is student performance dependent, the exact sequences for each students' progression through the computer instruction program were different. Therefore, the following description is a general format describing each path option for each computer function. Specific procedures used in this study (i.e.; frequency of instruction, daily scheduling, etc.) have been described earlier in this chapter (see Design, Setting, and Measures). The following sections describe each of the components of the computer curriculum outlined in Figure 48.

Selection of Cluster to Assess. On the first day of computer-instruction in an operation area the Cluster assessed is the first within that area. For example, if a student is assigned to receive instruction in Subtraction, the Cluster to be assessed would have been Cluster #7 - Subtraction facts, Single Digit minus Single Digit with the remainder < 10. On subsequent days, the selection is dependent on Mastery Decisions (see below). When students demonstrated mastery within a Cluster the computer automatically advanced them to the difficulty level of the next higher Cluster.

Assessment of Cluster Skills. After a Cluster is selected for assesment, the computer presents the student with a one-minute test consisting of a random sample of all Skills included with the Cluster. During the test, the computer internally recorded the correct or incorrect performance of the student by specific skills represented in each problem presented (see Appendix B for a complete list of Clusters and Skills). For example, if the problem presented to the student was 9 - 2 = 7, the computer would record that the student attempted a problem which included the following skills within Cluster #7 "Subtraction facts, single digit minus single digit":

Skill	7.9	minuend = 9
Skill	7.2	subtrahend = 2
Skill	7.16	remainder = 7

If the student answered this problem correctly, each of these skills would be recorded by the computer as successfully attempted. If the student had answered incorrectly (i.e., answered with the digit 6) the computer would record that the student was unsuccessful in one attempt of the above three listed Skills. In addition, it would have also recorded that the student was unsuccessful in the Skill of the incorrect response (Skill 7.15 - remainder = 6; in the error example).

Mastery Decision. After the one minute test of Cluster Skills, the computer assessed the student's performance for demonstration of mastery (see above Criterion Setting). If the student demonstrated mastery, the computer automatically recorded his/her performance and returned to the "Selection of Cluster to Assess" routine.

Determination of Specific Skill Deficit. If the student failed to demonstrate mastery during the "Assessment of Cluster Skills" by not meeting one or more of the criterion standards, the computer automatically assessed the student's performance for specific Skill deficits. As described above the computer recorded the specific skills included in all problems presented to the student. The assessment for specific Skill deficits uses this stored information. The Skill in which the student performed the least well is then automatically targeted by the computer for remedial instruction. For example, if the student was tested in Cluster #7 (described above) and consistently made errors on problems which included the digit 4 as the subtrahend (Skill 7.4) the computer would recognize this and assign this specific Skill for remedial instruction.

Instruction in Specific Skill Deficit. The "Instruction in Specific Skill Deficit" routine of the instructional program consisted of intensive practice in math problems matched by the computer to the specific Skill deficit identified during the Cluster assessment. To avoid redundancy and to maintain motivation, approximately 80% of the problems presented to the student during this instruction period were in the identified weakness skill area. Specifically, using the example above, 80% of the math problems presented to the student would have the digit 4 as the subtrahend.

The remaining 20% of the problems would be randomly drawn from all other Skills included within the Cluster in which the student failed.

The instructional strategy used during this procedure included corrective feedback, modeling, and performance feedback. Each of these procedures are described below.

Corrective feedback. After answering a math problem the student was immediately informed whether the answer was right or wrong. For wrong answer the computer displayed the word "WRONG" for a period of 3 seconds, then erased the video screen and re-presented the same problem for the student to attempt. If the answer were correct, the computer informed the student by randomly selecting a positive statement from a menu and displaying the statement for 3 seconds. This menu included such statements as "VERY GOOD", "GREAT", "CORRECT", "PERFECT", "KEEP IT UP".

Modeling. When a student incorrectly answered a problem two times in a row the computer modeled the problem - including the correct answer - for the student. The correct model of the problem remained on the screen, with the answer "blinking" for 3 seconds. After the 3 seconds were over the computer erased the video screen and re-presented the error problem for the student to attempt again. The error - model sequence continued until the student answered the problem correctly.

Performance feedback. There were two types of performance feedback provided to the students. The first occurred at the completion of each one minute work session for both Assessment of Cluster Skills and Remediation. The second occurred at the completion of the five minute work session.

At the completion of each one-minute work session the computer listed on the screen both the student's performance and the criterion for performance. Both the information given the student and its presentation format are shown in Figure 49. This display remained on the screen for 8 seconds. After this time the computer automatically erased the images on the video screen and initiated the Daily Performance Chart described below.

	Today's Performance	
	Your Work	Goal
Digits per Minute Correct	xx	yy
Digits per Minute Error	xx	yy
Percent Correct	xx	yy

Figure 49. Example of One-Minute Performance Feedback

At the completion of the five-minute work session the student was presented on the video screen a graph depicting their digits correct per minute (DPMC) for each of the five one-minute work sessions performed during that day. The graph was in the same format as the one shown in Figure The graph remained on the screen for 8 seconds. After this time, the computer automatically erased the video screen and intitiated the "Daily Baseline Measure (see above).

Mastery Decision. The criteria used to determine mastery for the Specific Skill training were the same as those used for mastery determination during the Cluster Assessment.

If the student demonstrated mastery (matched or exceeded all criteria) the computer automatically reevaluated the student for Cluster mastery by returning to the Assessment of Cluster Skills routine which the student earlier failed. If the student did not demonstrate mastery the Instruction in Specific Skill Deficit routine would begin again. The student could not branch or return to any other computer routine until mastery was demonstrated in the specific skill failed.

RESULTS

The design of this study was an A-B(1)-A-B(2)-A, within which each student was instructed in two math operation areas (addition, subtraction, multiplication, or division). During each of the A phases, students were tested via paper-and-pencil and computer generated tests. They received no instruction during these phases. During each of the B(x) phases students received computer instruction in only one of their assigned operation areas.

This design was chosen because it provided a means of controlling for instruction and learning taking place outside of the computer-managed curriculum (Baer, Wolf, and Risley, 1968; Gelfand and Hartman, 1975; Hersen and Barlow, 1976; Kratochwill, 1978). Using a multiple-baseline with a reversal procedure, it was predicted that students would show increased performance in specific operation math computation performance on post measures taken after that specific operation area was instructed in. It was further predicted that pre and post measures taken over instructional periods that a specific math operation area was not instructed in would show no change in performance.

The results from this study will be presented in two sections. The first, will report individual student performance using single-subject descriptive techniques (Baer et al., 1968, Kratochwill, 1978). The second section will present student data using group analysis procedures.

Section I - Individual Student Data

Student A1

Student A1 was a male aged 15 years 5 months with a measured full scale WISC-R score of 75. This student was assigned to receive computer instruction during the first and second instructional phases in subtraction and multiplication respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Green Form this student obtained a standard grade equivalence score of 5.6 on the pretest and a 6.1 on the posttest. The positive change of .5 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation areas of subtraction and multiplication were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 32.

Operation Area	Measure	Baseline Period 1	2	3
Subtraction	DPMC	22.5	33.5	29.2
	DPME	1.8	.3	0.0
Multiplication	DPMC	24.7	24.0	26.7
	DPME	2.0	2.3	.7

Table 32. Student A1 Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Subtraction and Multiplication.

Student A1 received computer instruction in the operation area of subtraction during the first instructional phase. A comparison of his performance during the baseline periods pre and post to this instructional period (baselines one and two) show both an increase of 49% in his DPMC, from 22.5 to 33.5, and a decrease in his DPME by 83%, from 1.8 to .3. During the instructional phase in which the student did not receive computer instruction in the operation area of subtraction, an analysis of baselines two and three shows a decrease in DPMC performance of 13%, from 33.5 to 29.2. DPME performance during this period decreased 0.

This student received computer instruction in the operation area of multiplication during the second instructional phase. His performance during baselines two and three shows an increase of 11%, from 24.0 to 26.7 DPMC. During this same period his error rate decreased by 67%, from 2.3 to .7 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows a slight decrease in his performance on the DPMC measure of 3%, from 24.7 to 24.0. DPME performance increased by 15% from 2.0 to 2.3.

Overall, this student's performance supports an acceptance of hypothesis 2. That is, paper-and-pencil baseline measures taken pre and post to computer instruction show an increase in performance in both operation areas of subtraction and multiplication.

Hypothesis 3 is rejected. DPMC performance decreased in both subtraction and multiplication during instructional phases in which they were not instructed. Performance on the DPME measure across these same periods increased in multiplication and decreased in subtraction. Therefore, this "no change" hypothesis is rejected.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of subtraction and multiplication are shown below in figures 9 and 10 respectively. In the operation area of subtraction measures taken pre and post of instruction show an increase in performance from an average of 10.0 DPMC (s.d.= 3.2) during baseline one to 17.2 DPMC (s.d.= 1.9) during baseline two. During this same period his error rate decreased from an average of 1.8 (s.d.= 2.5) to 0 DPME. Measures taken before and after the noninstruction phase show a decrease in his performance from an average of 17.2 DPMC (s.d.= 1.9) in baseline two to 15.5 DPMC (s.d.= 2.5) in baseline three. Average DPME during this same period increased slightly from 0 to .5 (s.d.= 1).

Baseline measures of student Al's performance taken pre and post to instruction in the operation area of multiplication (baselines two and three) show an increase in average DPMC from 12.5 (s.d.= 4.4) to 22.3 (s.d.= 4.7). Average DPME decreased from 1.3 (s.d.= 2.3) to .5 (s.d.= 1) during this same period. Computer measures taken pre and post of the noninstructional phase show a slight increase in average DPMC from 11.8 (s.d.= 4.8) during baseline one to 12.5 (s.d.= 4.4) in baseline two. Average DPME during this time decreased from 2.6 (s.d.= 2.3) to 1.3 (s.d.= 2.3).

Student Al's performance in both the operation areas of subtraction and multiplication support an acceptance of hypothesis 4. Post instruction computer measures reflect increased performance when compared to preinstruction measures.

Hypothesis 5 is rejected. In the operation area of subtraction student performance decreased in both DPMC and DPME measures over the period of noninstruction. Multiplication performance measured pre and post to noninstruction show increased performance.

Figure 50

Figure 51

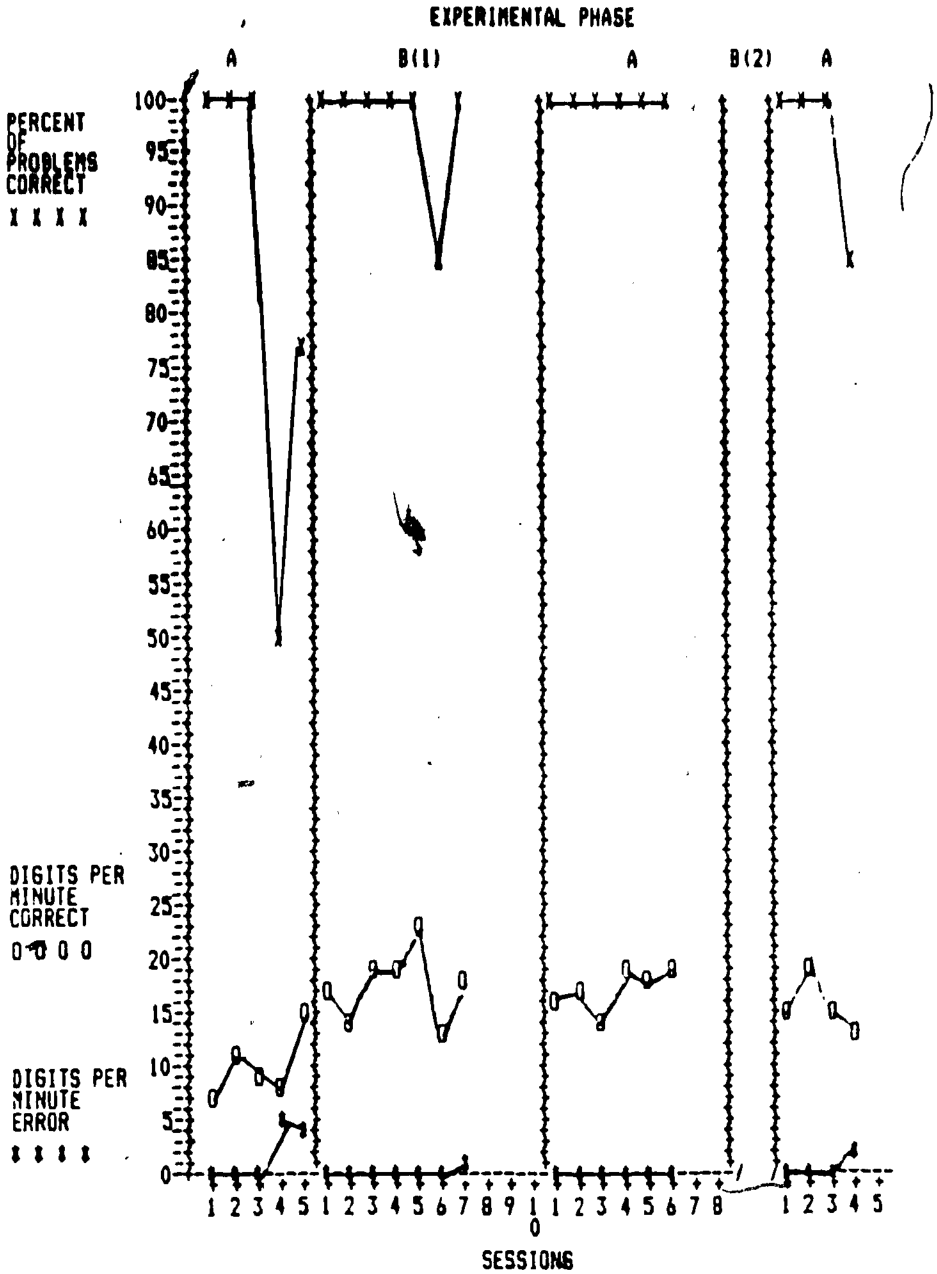


FIGURE 50 STUDENT A1
COMPUTER MEASURES IN SUBTRACTION

A = BASELINE MEASURES IN SUBTRACTION

B(1) = MEASURES IN SUBTRACTION WHILE RECEIVING INSTRUCTION IN SUBTRACTION

B(2) = INSTRUCTION IN MULTIPLICATION NO SUBTRACTION MEASURES TAKEN

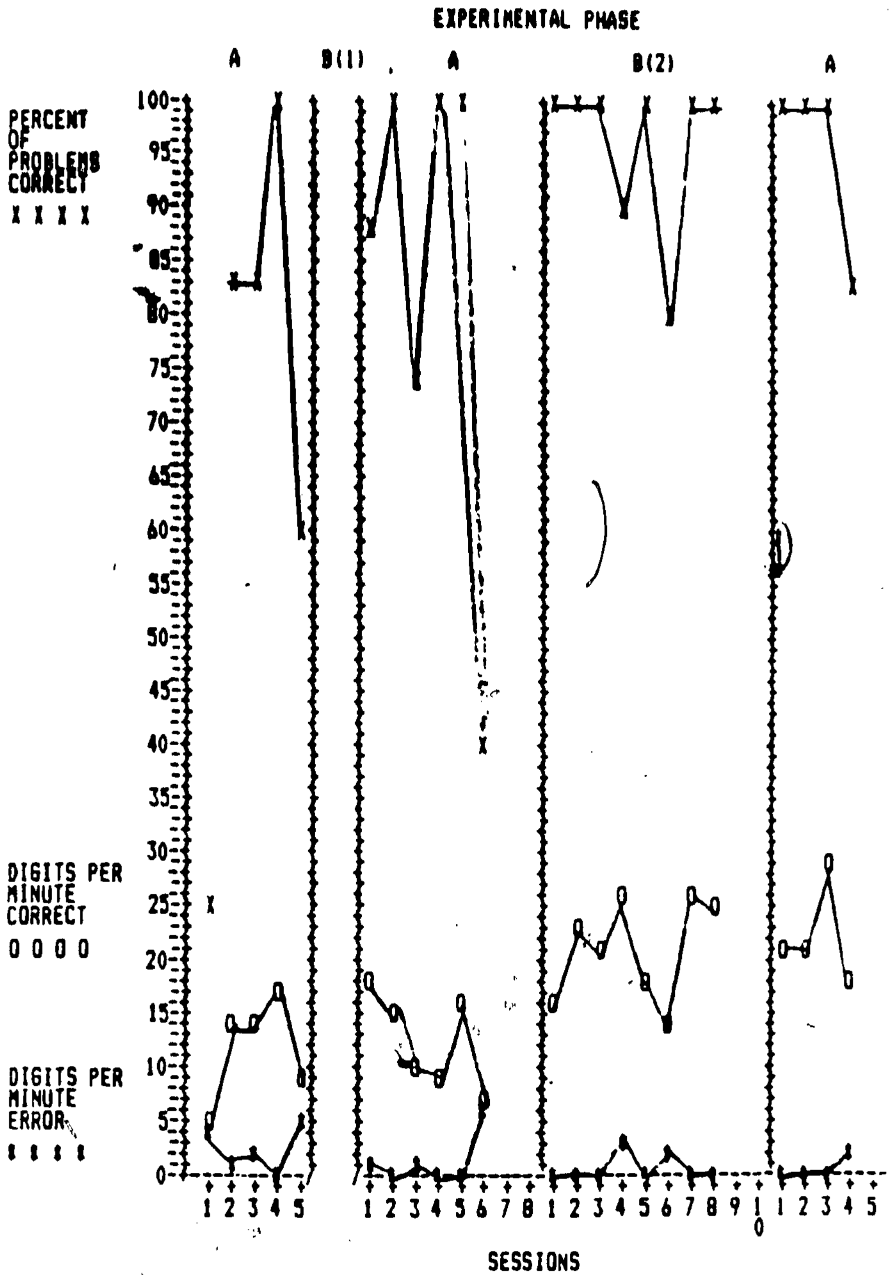


FIGURE 51 STUDENT AI
COMPUTER MEASURES IN MULTIPLICATION

A = BASELINE MEASURES IN MULTIPLICATION

B(1) = INSTRUCTION IN SUBTRACTION
NO MULTIPLICATION MEASURES TAKEN

B(2) = MEASURES IN MULTIPLICATION WHILE
RECEIVING INSTRUCTION IN MULTIPLICATION

Student A2

Student A2 was a female aged 14 years 9 months with a measured full scale WISC-R score of 64. This student was assigned to receive computer instruction during the first and second instructional phases in multiplication and subtraction respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Green Form this student obtained a standard grade equivalence score of 4.8 on the pretest and a 6.1 on the posttest. The positive change of 1.3 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation area of multiplication and subtraction were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 33.

Operation Area	Measure	Baseline Period 1	2	3
Multiplication	DPMC	26.7	32.3	29.7
	DPME	1.0	2.3	0.0
Subtraction	DPMC	14.0	18.0	23.0
	DPME	4.5	6.0	0.0

Table 33. Student A2 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Multiplication and Subtraction.

Student A2 received computer instruction in the operation area of multiplication during the first instructional phase. A comparison of her performance during the baseline periods pre and post to this instructional period show both an increase of 21% in her DPMC, from 26.7 during baseline one to 32.3 during baseline two, and an increase in her DPME of 130%, from 1.0 to 2.3. During the instructional phase in which this student did not receive computer instruction in the operation area of multiplication, an analysis of baselines two and three shows a decrease in DPMC performance of 83%, from 32.3 to 29.7. DPME performance during this period decreased from 2.3 to 0.

This student received computer instruction in the operation area of subtraction during the second instructional phase. Her performance during baselines two and three shows an increase of 28%, from 18.0 to 23.0 DPMC. During this same period her error rate decreased by 100%, from 6.0 to 0 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows an increase in her performance on the DPMC measure of 29%, from 14.0 to 18.0. DPME performance increased by 33% from 4.5 to 6.0.

Hypothesis 2 is accepted for both operation areas of multiplication and subtraction. Pencil and paper measures taken pre and post to instruction show increased performance in each operation area.

Hypothesis 3 is rejected. DPMC performance increased in both subtraction and multiplication during phases in which they were not instructed. Performance in the DPME measure across these periods increased in multiplication and decreased in subtraction.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of multiplication and subtraction are shown below in figures 11 and 12 respectively. In the operation area of multiplication measures taken pre and post of instruction show an increase in performance from an average of 14.6 DPMC (s.d.= 4.3) during baseline one to 19.1 DPMC (s.d.= 6.1) during baseline two. During this same period her error rate increased from an average of 1.2 (s.d.= 1.8) to 1.9 (s.d.= 1.8) DPME. Measures taken before and after the noninstruction phase show a decrease in her performance from an average of 19.1 DPMC (s.d.= 6.1) in baseline two to 17.6 DPMC (s.d.= 1.7) in baseline three. Average DPME during this same period decreased slightly from 1.9 (s.d.= 1.8) to 1.6 (s.d.= 1.5).

Baseline measures of student A2's performance taken pre and post to instruction in the operation area of subtraction (baselines two and three) show an increase in average DPMC from 12.9 (s.d.= 2.6) to 15.6 (s.d.= 3.4). Average DPME remained at a rate of 1 during both baselines (s.d.= .9 and 1.2 respectively). Computer measures taken pre and post of the noninstructional phase show an increase in average DPMC from 8.4 (s.d.= 2.7) during baseline one to 12.9 (s.d.= 2.6)

in baseline two. Average DPME during this time decreased from 1.8 (s.d.= 1.8) to 1.0 (s.d.= .9).

Student A2's performance in both the operation areas of subtraction and multiplication support an acceptance of hypothesis 4. Post instruction computer measures reflect increases in performance when compared to preinstruction measures.

Hypothesis 5 is rejected. In the operation area of subtraction student performance increased in DPMC and decreased in DPME measures over the period of noninstruction. Multiplication performance measured pre and post to noninstruction decreased in both DPMC and DPME performance.

Figure 52

Figure 53

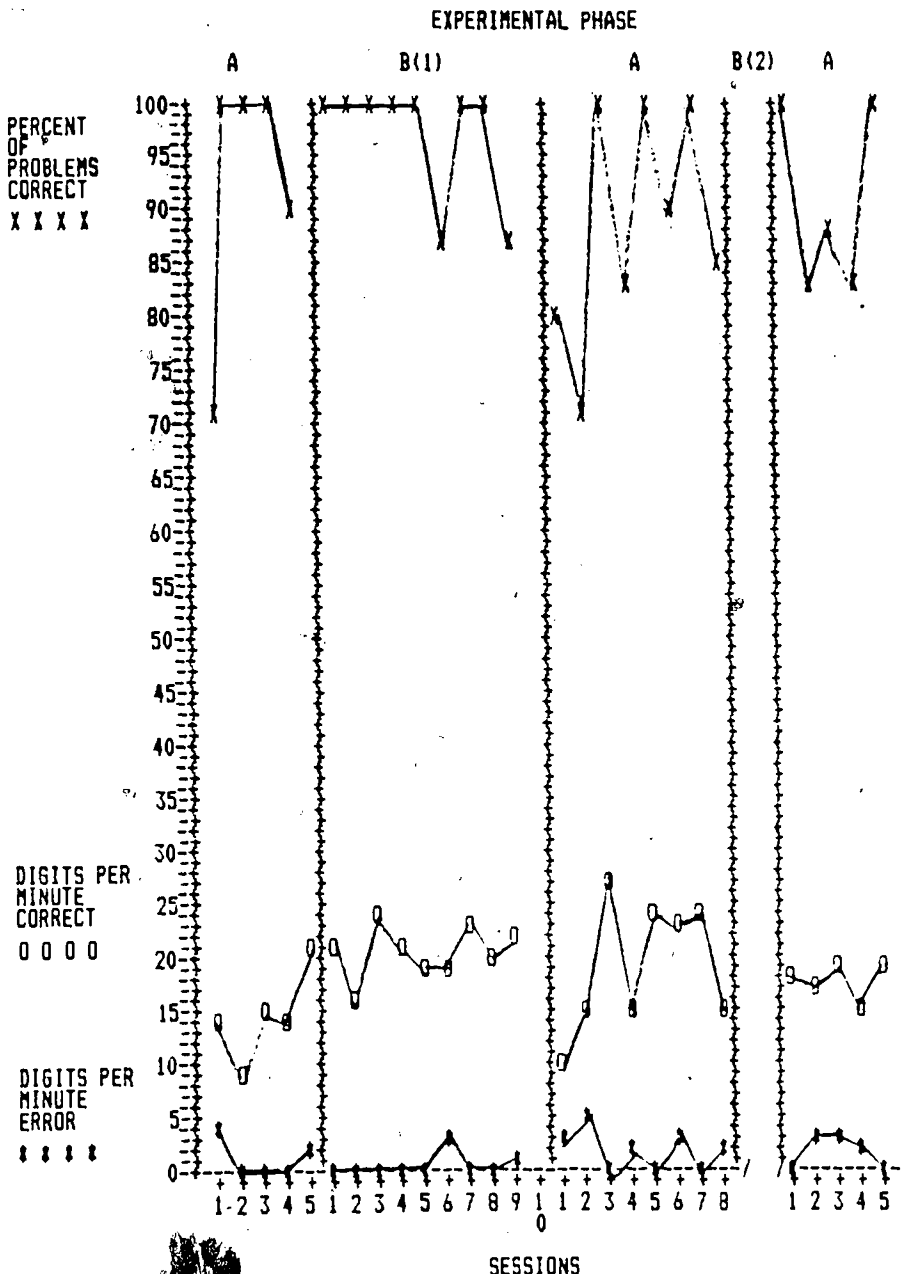


FIGURE 52 STUDENT A2
MULTIPLICATION PERFORMANCE

A = BASELINE MEASURES IN MULTIPLICATION

B(1) = MEASURES IN MULTIPLICATION WHILE RECEIVING INSTRUCTION IN MULTIPLICATION

B(2) = INSTRUCTION IN SUBTRACTION NO MULTIPLICATION MEASURES TAKEN

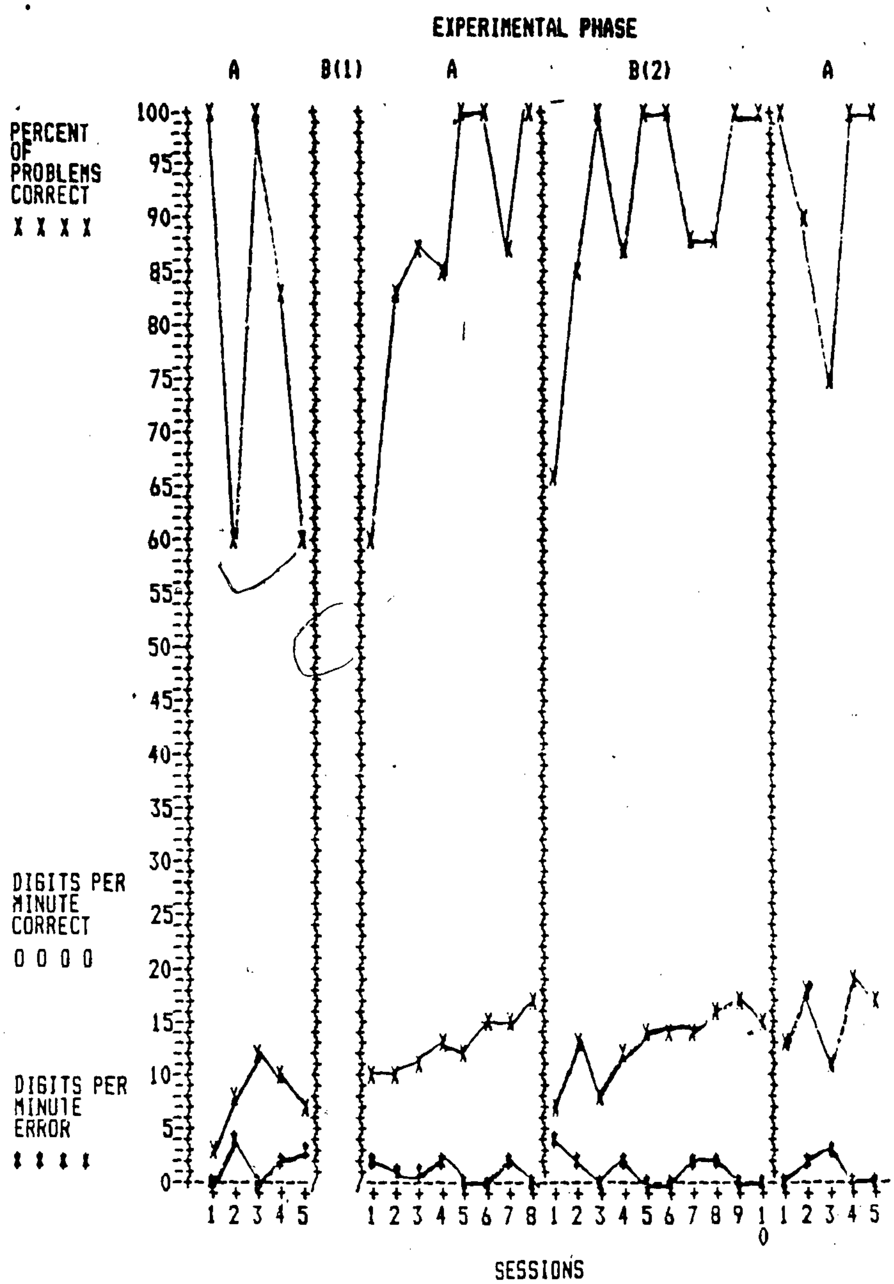


FIGURE 53 STUDENT A2
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = INSTRUCTION IN MULTIPLICATION
NO SUBTRACTION MEASURES TAKEN

B(2) = MEASURES IN SUBTRACTION WHILE
RECEIVING INSTRUCTION IN SUBTRACTION

Student A3

Student A3 was a female aged 12 years 9 months with a measured full scale WISC-R score of 64. This student was assigned to receive computer instruction during the first and second instructional phases in subtraction and multiplication respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Green Form this student obtained a standard grade equivalence score of 3.6 on the pretest and a 4.5 on the posttest. The positive change of .9 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation areas of subtraction and multiplication were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 34.

Operation Area	Measure	Baseline Period 1	2	3
Subtraction	DPMC	16.6	19.3	26.1
	DPME	17.0	12.5	12.2
Multiplication	DPMC	16.0	27.7	36.3
	DPME	6.7	6.0	3.6

Table 34. Student A3 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Subtraction and Multiplication.

Student A3 received computer instruction in the operation area of subtraction during the first instructional phase. A comparison of her performance during the baseline periods pre and post to this instructional period show both an increase of 16% in her DPMC, from 16.6 during baseline one to 19.3 during baseline two, and a decrease in her DPME by 27%, from 17.0 to 12.5. During the instructional phase in which the student did not receive computer instruction in the operation area of subtraction, an analysis of baselines two and three shows an increase in DPMC performance of 35%, from 19.3 to 26.1. DPME performance during this period decreased slightly from 12.5 to 12.2.

This student received computer instruction in the operation area of multiplication during the second instructional phase. Her performance during baselines two and three shows an increase of 31%, from 27.7 to 36.3 DPMC. During this same period her error rate decreased by 40%, from 6.0 to 3.6 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows an increase in her performance on the DPMC measure of 73%, from 16.0 to 27.7. DPME performance decreased by 10% from 6.7 to 3.6.

Hypothesis 2 is accepted for both operation areas of subtraction and multiplication. Paper-and-pencil measures taken pre and post to computer instruction show an increase in performance in both operation areas.

Hypothesis 3 is rejected for both operation areas of subtraction and multiplication. Both DPMC and DPME performance increased in both operation areas during phases in which they were not instructed.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of subtraction and multiplication are shown below in figures 13 and 14 respectively. In the operation area of subtraction measures taken pre and post of instruction show an increase in DPMC performance from an average of 9.0 DPMC (s.d.= 1.4) during baseline one to 12.8 DPMC (s.d.= 3.3) during baseline two. During this same period her error rate increased from an average of 4.8 (s.d.= 4.3) to 10.3 (s.d.= 4.4) DPME. Measures taken before and after the noninstruction phase show an increase in her performance from an average of 12.8 DPMC (s.d.= 3.3) in baseline two to 14.7 DPMC (s.d.= 3.5) in baseline three. Average DPME during this same period decreased from 10.3 (s.d.= 4.4) to 6.7 (s.d.= 3.5).

Baseline measures of student A3's performance taken pre and post to instruction in the operation area of multiplication (baselines two and three) show an increase in average DPMC from 15.8 (s.d.= 6.4) to 21.4 (s.d.= 3.3). Average DPME decreased from 5.75 (s.d.= 2.7) to 4.8 (s.d.= 2.2). Pre and postmeasures of the noninstructional phase show a slight increase in average DPMC from 15.0 (s.d.= 5.8) during baseline one to 15.8 (s.d.= 6.4) in baseline two. Average DPME during this time increased from 4.4 (s.d.= 1.7) to 5.8 (s.d.= 2.7).

Hypothesis 4 is accepted for the operation area of multiplication. Post instruction computer measures reflect increased performance when compared to preinstruction measures.

Hypothesis 4 is rejected for the operation area of subtraction. Although DPMC increased during the period of instruction, the large increase in DPME performance does not support an acceptance of this hypothesis.

Hypothesis 5 is rejected for both operation areas of subtraction and multiplication. Student performance increased over periods of noninstruction.

Figure 54

Figure 55

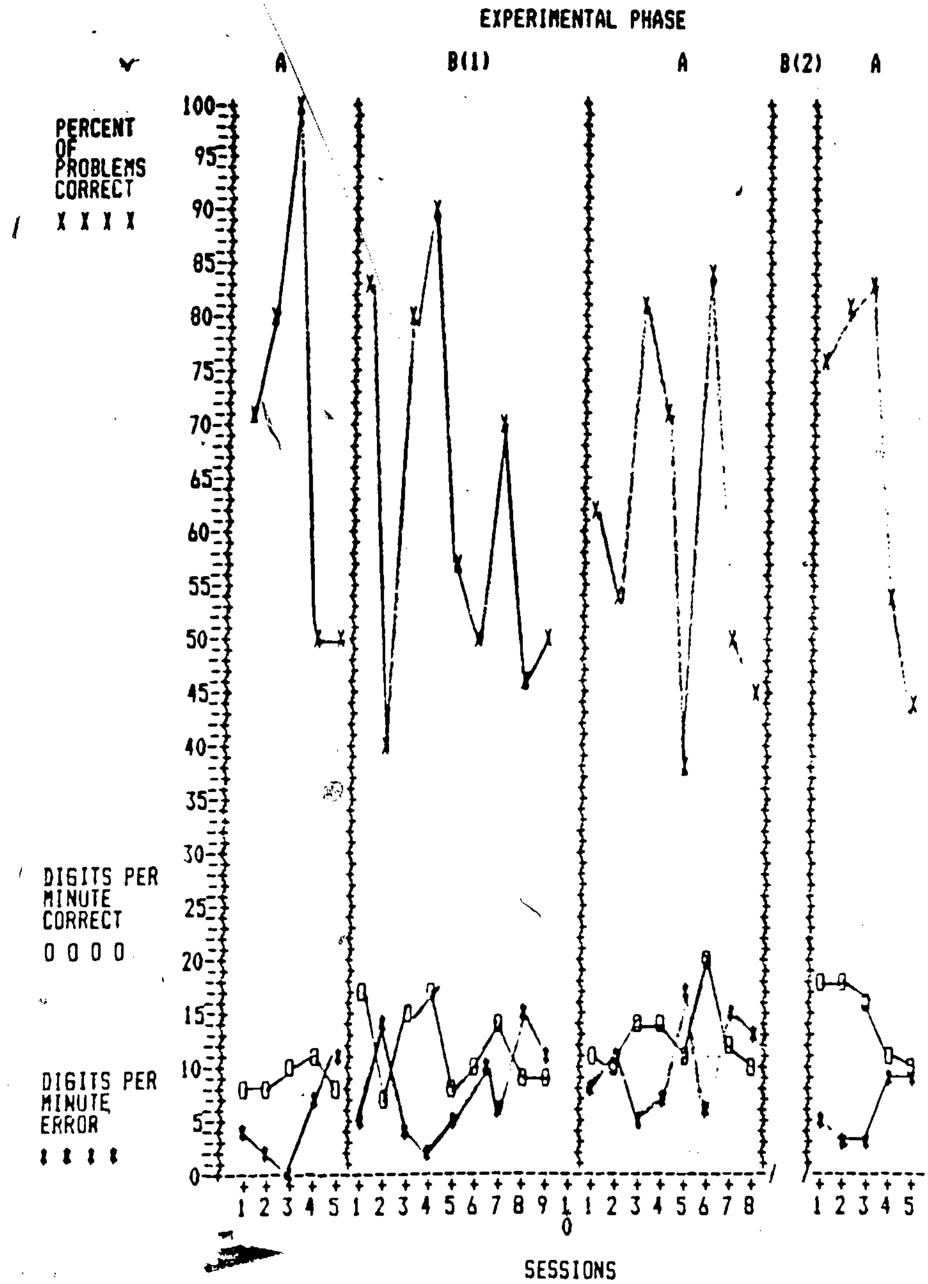


FIGURE 54 STUDENT A3
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = MEASURES IN SUBTRACTION WHILE RECEIVING INSTRUCTION IN SUBTRACTION

B(2) = INSTRUCTION IN MULTIPLICATION NO SUBTRACTION MEASURES TAKEN

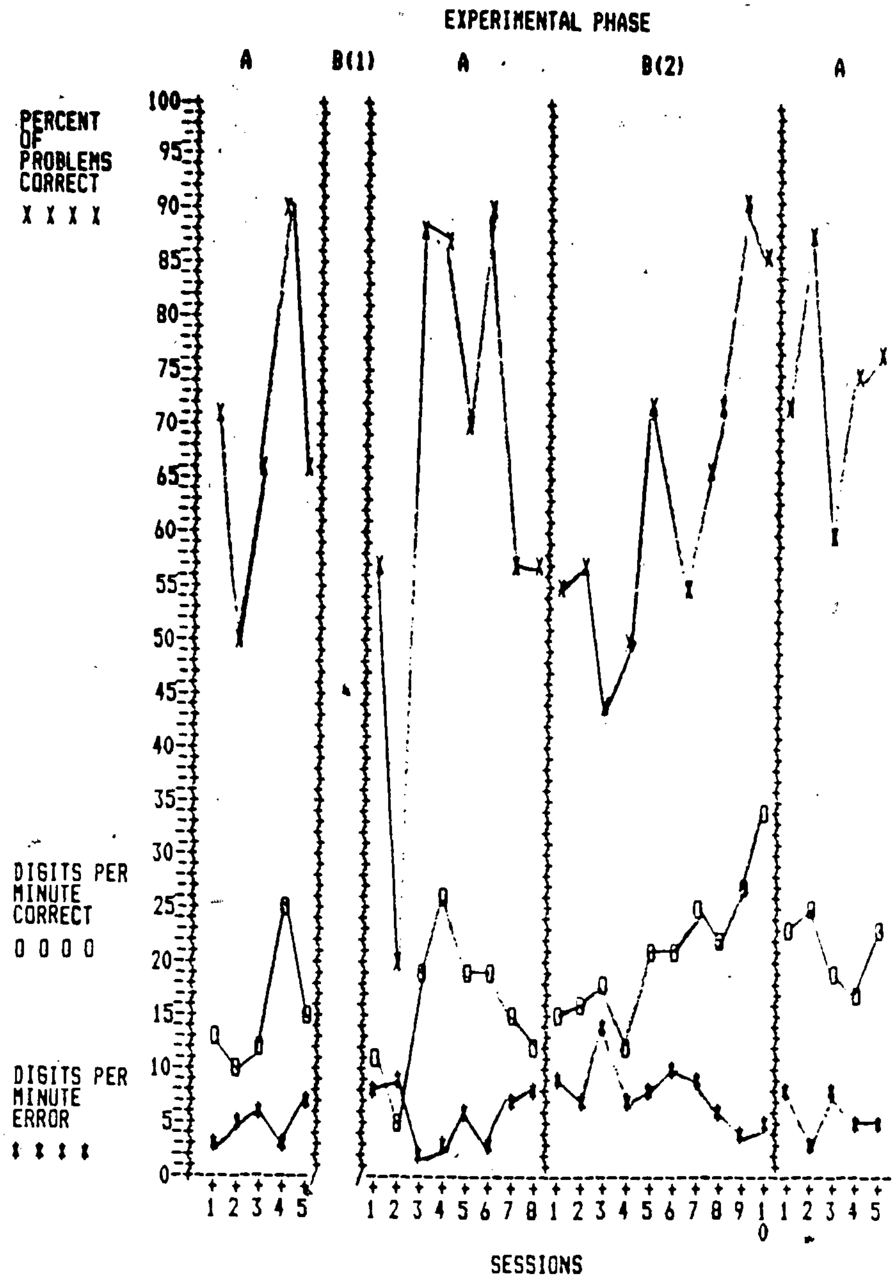


FIGURE 55 STUDENT A3
MULTIPLICATION PERFORMANCE

A = BASELINE MEASURES IN MULTIPLICATION

B(1) = INSTRUCTION IN SUBTRACTION
NO MULTIPLICATION MEASURES TAKEN

B(2) = MEASURES IN MULTIPLICATION WHILE
RECEIVING INSTRUCTION IN MULTIPLICATION

Student A5

Student A5 was a female aged 11 years 9 months with a measured full scale WISC-R score of 64. This student was assigned to receive computer instruction during the first and second instructional phases in addition and subtraction respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Red Form this student obtained a standard grade equivalence score of 2.6 on the pretest and a 5.4 on the posttest. The positive change of 2.8 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation areas of addition and subtraction were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 35.

Operation Area	Measure	Baseline Period 1	2	3
Addition	DPMC	21.7	30.7	40.4
	DPME	1.4	.3	0.0
Subtraction	DPMC	14.3	21.3	30.0
	DPME	0.0	0.0	0.0

Table 35. Student A5 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Addition and Subtraction.

Student A5 received computer instruction in the operation area of addition during the first instructional phase. A comparison of her performance during the baseline periods pre and post to this instructional period shows an increase of 42% in her DPMC, from 21.7 during baseline one to 30.7 during baseline two. DPME decreased during this period 79%, from 1.4 to .3. During the instructional phase in which the student did not receive computer instruction in the operation area of addition, an analysis of baselines two and three shows an increase in DPMC performance of 32%, from 30.7 to 40.4. DPME performance during this period decreased from .3 to .0.

This student received computer instruction in the operation area of subtraction during the second instructional phase. Her performance during baselines two and three shows an increase of 41%, from 21.3 to 30.0 DPMC. During this same period her error rate remained at 0. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows an increase in her performance on the DPMC measure of 49%, from 14.3 to 21.3 DPME performance remained at 0.

Hypothesis 2 is accepted for both operation areas of addition and subtraction. Paper-and-pencil measures taken pre and post to computer instruction in these operation areas show an increase in her performance.

Hypothesis 3 is rejected for both operation areas of addition and subtraction. Paper-and-pencil measures taken pre and post to noninstructional phases show performance increases.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of addition and subtraction are shown below in figures VF15 and VF16 respectively. In the operation area of addition measures taken pre and post of instruction show an increase in performance from an average of 9.2 DPMC (s.d.= 2.9) during baseline one to 15.5 DPMC (s.d.= 2.7) during baseline two. During this same period her error rate increased from an average of .8 (s.d.= 1.1) to .9 (s.d.= 2.1) DPME. Measures taken before and after the noninstruction phase show a decrease in her performance from an average of 15.5 DPMC (s.d.= 2.7) in baseline two to 15.0 DPMC (s.d.= 2.2) in baseline three. Average DPME during this same period decreased from .9 (s.d.= 2.1) to .6 (s.d.= .9).

Baseline measures of student A2's performance taken pre and post to instruction in the operation area of subtraction (baselines two and three) show a decrease in average DPMC from 9.1 (s.d.= 2.2) to 8.8 (s.d.= 1.3). Average DPME decreased from 5.6 (s.d.= 2.3) to 8.0 (s.d.= 1.4). Pre and postmeasures of the noninstructional phase show an increase in average DPMC from 6.6 (s.d.= 3.9) during baseline one to 9.1 (s.d.= 2.2) during baseline two. Average DPME during this time increased from 3.2 (s.d.= 2.8) to 5.6 (s.d.= 2.3).

Hypothesis 4 is accepted for the operation area of addition. Computer measures taken pre and post to instruction show an increase in performance.

Hypothesis 4 is rejected for the operation area of subtraction. Computer measures taken pre and post to instruction show a decrease in performance.

Hypothesis 5 is accepted for the operation area of addition. Computer measures taken pre and post of the noninstructional phase show no significant change in performance.

Hypothesis 5 is rejected for the operation area of subtraction. Computer measures taken pre and post to the noninstructional phase in this operation area show increased performance.

Figure 56

Figure 57

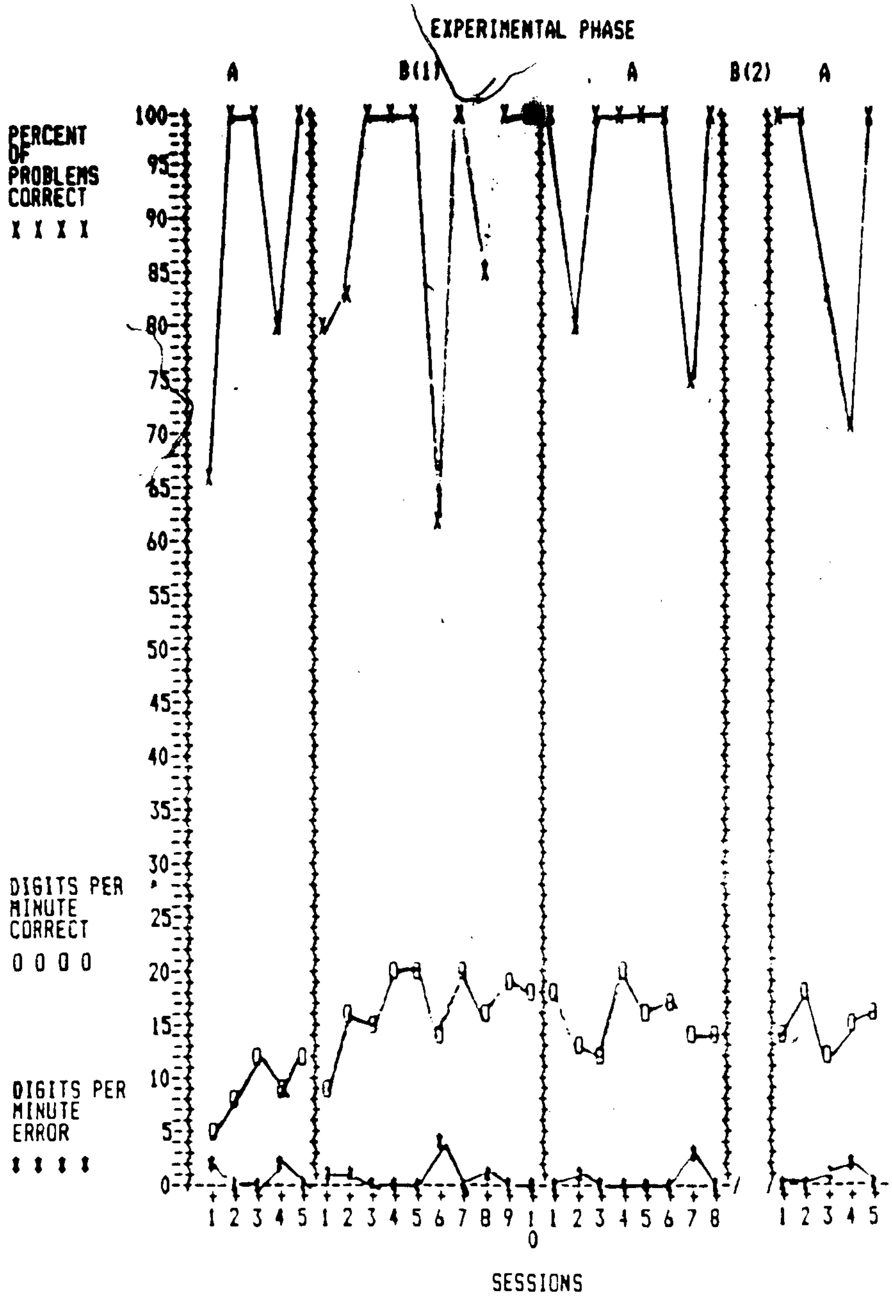


FIGURE 56 STUDENT A5
ADDITION PERFORMANCE

A = BASELINE MEASURES IN ADDITION

B(1) = MEASURES IN ADDITION WHILE RECEIVING INSTRUCTION IN ADDITION

B(2) = INSTRUCTION IN SUBTRACTION NO ADDITION MEASURES TAKEN

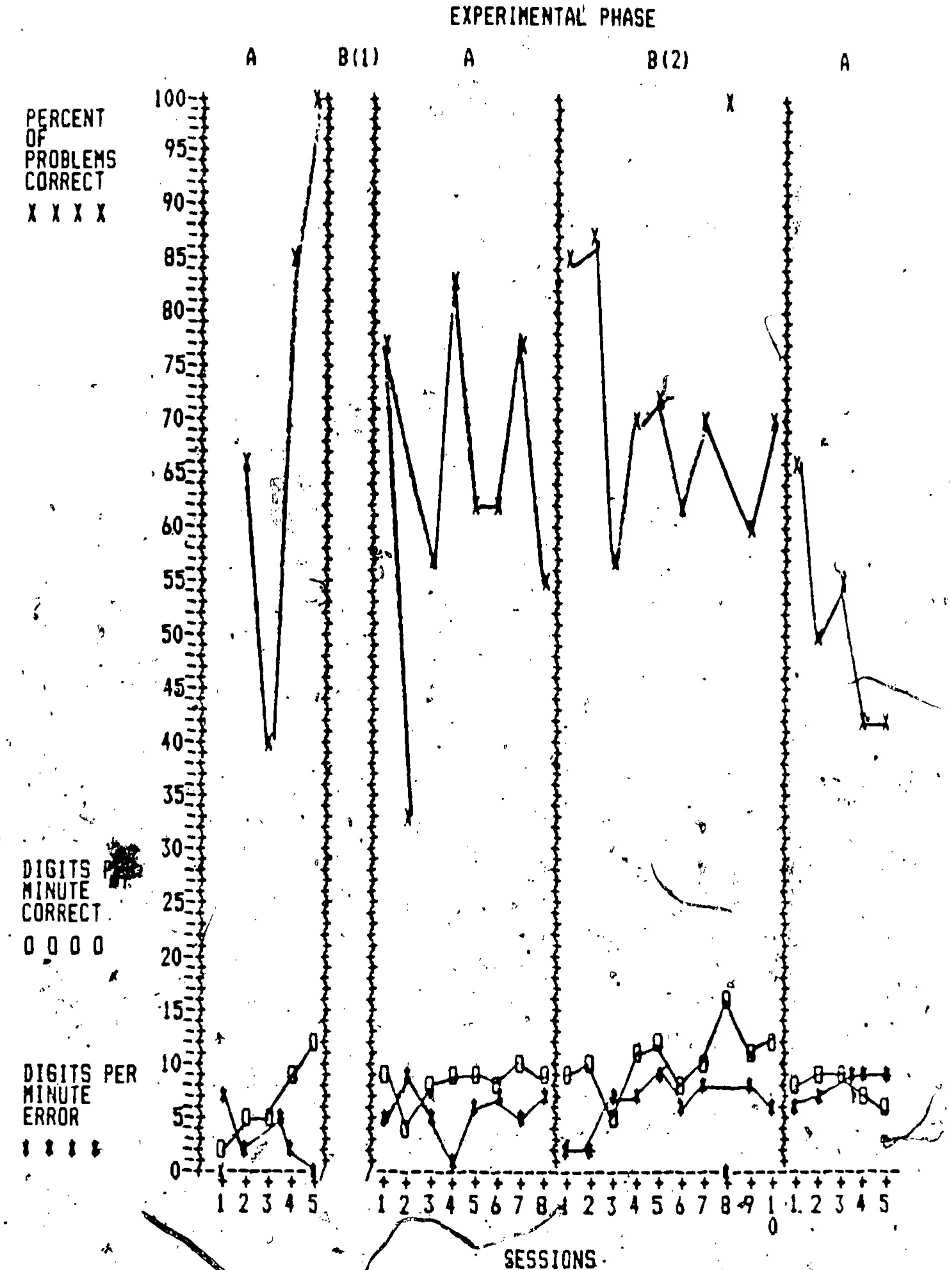


FIGURE 57 STUDENT A5
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = INSTRUCTION IN ADDITION
NO SUBTRACTION MEASURES TAKEN

B(2) = MEASURES IN SUBTRACTION WHILE
RECEIVING INSTRUCTION IN SUBTRACTION

Student A6

Student A6 was a male aged 13 years 11 months with a measured full scale WISC-R score of 52. This student was assigned to receive computer instruction during the first and second instructional phases in subtraction and addition respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Red Form this student obtained a standard grade equivalence score of 2.4 on the pretest and a 2.6 on the posttest. The positive change of .2 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation areas of subtraction and addition were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 36.

Operation Area	Measure	Baseline Period 1	2	3
Subtraction	DPMC	7.7	16.7	16.7
	DPME	7.2	1.5	0.0
Addition	DPMC	21.3	32.1	30.4
	DPME	2.1	.1	0.0

Table 36. Student A6 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Subtraction and Addition.

Student A6 received computer instruction in the operation area of subtraction during the first instructional phase. A comparison of his performance during the baseline periods pre and post to this instructional period (baselines one and two) show both an increase of 117% in his DPMC, from 7.7 to 16.7, and a decrease in his DPME by 79%, from 7.2 to 1.5. During the instructional phase in which the student did not receive computer instruction in the operation area of subtraction, an analysis of baselines two and three shows DPMC remaining at 16.7. DPME performance during this period decreased to a rate of 0 from 1.5.

This student received computer instruction in the operation area of addition during the second instructional phase. His performance during baselines two and three shows a slight decrease of 5%, from 32.1 to 30.4 DPMC. During this same period his error rate decreased to 0 from .1 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows an increase in his performance on the DPMC measure of 51%, from 21.3 to 32.1. DPME performance decreased by 95% from 2.1 to .1.

Hypothesis 2 is accepted for the operation area of subtraction. Paper-and-pencil measures taken pre and post of instruction show an increase in performance.

Hypothesis 2 is rejected for the operation area of addition. Paper-and-pencil measures taken pre and post of instruction shows a decrease in performance.

Hypothesis 3 is accepted for the operation area of subtraction. Paper-and-pencil measures taken pre and post of the noninstructional phase shows no change in performance.

Hypothesis 3 is rejected for the operation area of addition. Paper-and-pencil measures taken pre and post of the noninstructional phase shows an increase in performance.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of subtraction and addition are shown below in figures 17 and 18 respectively. In the operation area of subtraction measures taken pre and post of instruction show an increase in performance from an average of 7.0 DPMC (s.d.= 1.2) during baseline one to 11.3 DPMC (s.d.= 2.0) during baseline two. During this same period his error rate decreased from an average of 5.6 (s.d.= 2.1) to 3.25 (s.d.= 1.8) DPME. Measures taken before and after the noninstruction phase show a decrease in his performance from an average of 11.3 DPMC (s.d.= 2.0) in baseline two to 10.7 DPMC (s.d.= 2.3)in baseline three. Average DPME during this same period increased slightly from 3.3 (s.d.= 1.8) to 3.7 (s.d.= 1.2).

Baseline measures of student A6's performance taken pre and post to instruction in the operation area of addition (baselines two and three) show an increase in average DPMC from 16.1 (s.d.= 1.9) to 19.4 (s.d.= 2.3). Average DPME decreased from 1.3 (s.d.= 1.3) to .2 (s.d.= .5) during this same period. Computer measures taken pre and post of the the noninstructional phase show a slight increase in average

DPMC from 15.4 (s.d.= 2.3) during baseline one to 16.1 (s.d.= 1.9) in baseline two. Average DPME during this time increased from .2 (s.d.= .5) to 1.3 (s.d.= 1.3).

Student A6's performance in both the operation areas of subtraction and addition support an acceptance of hypothesis 4. Post instruction computer measures reflect increases in performance when compared to preinstruction measures.

Hypothesis 5 is rejected for the operation area of subtraction. Computer measures taken pre and post of the noninstructional phase show an increase in performance.

Hypotheis 5 is accepted for the operation area of addition. Computer measures taken pre and post of the noninstructional phase show no change in performance.

Figure 58

Figure 59

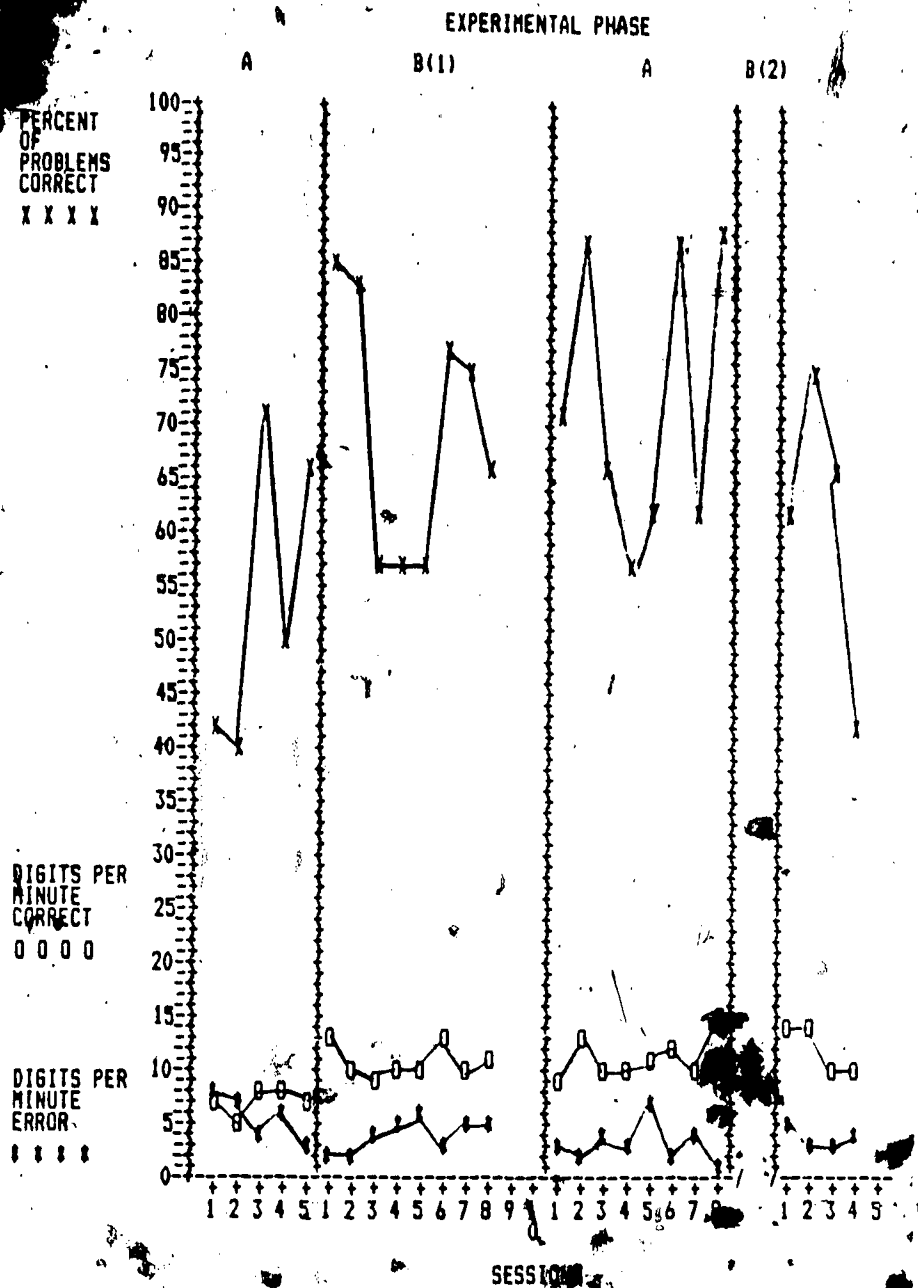


FIGURE 58 STUDENT A6
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = MEASURES IN SUBTRACTION WHILE RECEIVING INSTRUCTION IN SUBTRACTION

B(2) = INSTRUCTION IN ADDITION NO SUBTRACTION MEASURES TAKEN

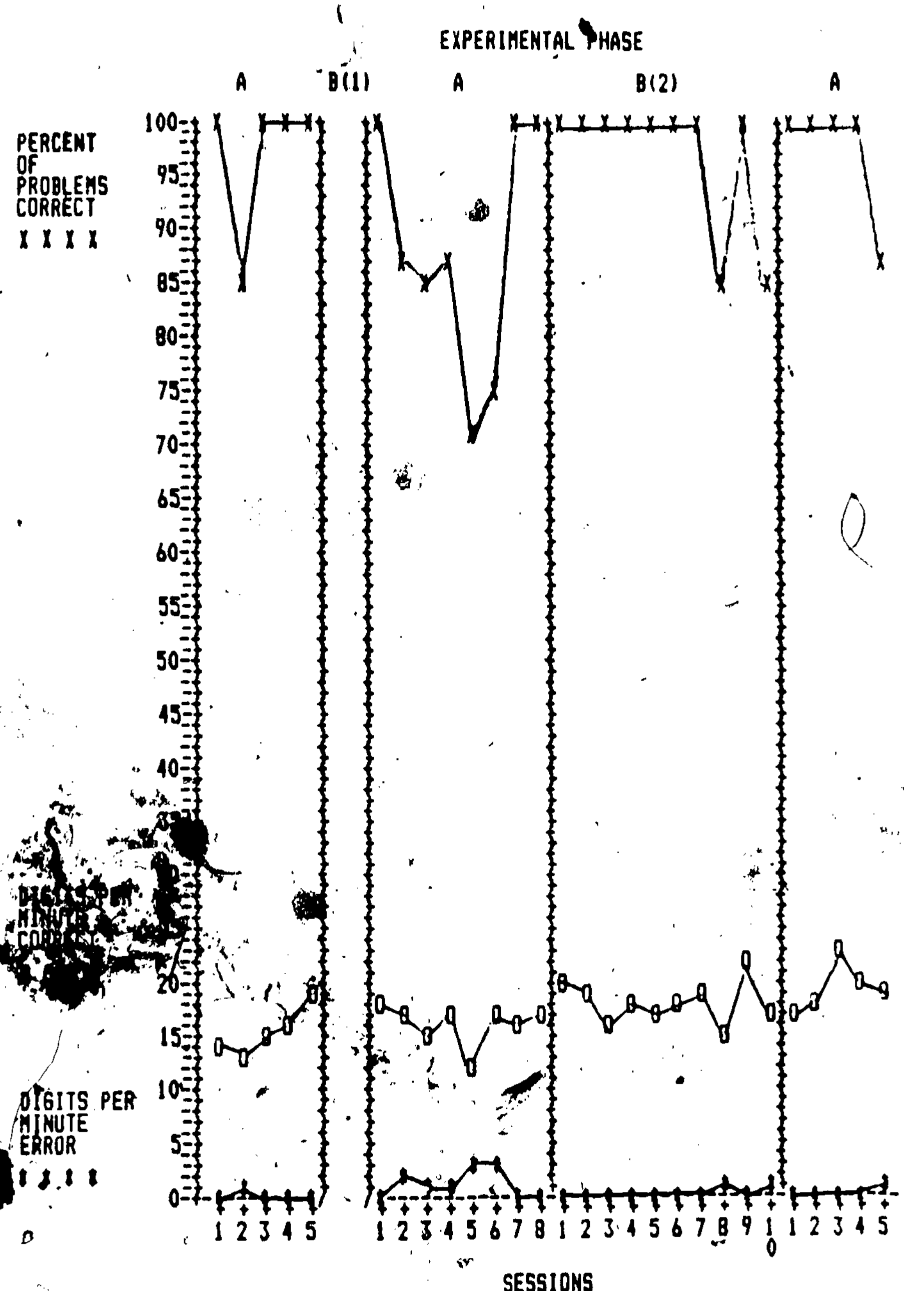


FIGURE 59 STUDENT A6
ADDITION PERFORMANCE

A = BASELINE MEASURES IN ADDITION

B(1) = INSTRUCTION IN SUBTRACTION
NO ADDITION MEASURES TAKEN

B(2) = MEASURES IN ADDITION WHILE
RECEIVING INSTRUCTION IN ADDITION

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Student A7

Student A7 was a male aged 14 years 6 months with a measured full scale WISC-R score of 74. This student was assigned to receive computer instruction during the first and second instructional phases in subtraction and division respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Green Form this student obtained a standard grade equivalence score of 4.7 on the pretest and a 5.1 on the posttest. The positive change of .4 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation areas of subtraction and division were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 37.

Operation Area	Measure	Baseline Period 1	2	3
Subtraction	DPMC	10.2	17.8	16.0
	DPME	7.6	3.0	.8
Division	DPMC	15.0	[illegible]	19.0
	DPME	0.0	0.0	0.0

Table 37. Student A7 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Subtraction and Division.

Student A7 received computer instruction in the operation area of subtraction during the first instructional phase. A comparison of his performance during the baseline periods pre and post to this instructional period show an increase of 75% in his DPMC, from 10.2 during baseline one to 17.8 during baseline two, and a decrease in his DPME of 61%, from 7.6 to 3.0. During the instructional phase in which the student did not receive computer instruction in the operation area of subtraction, an analysis of baselines two and three shows a decrease in DPMC performance of 10%, from 17.8 to 16.0. DPME performance during this period decreased by 73%, from 3 to .8.

This student received computer instruction in the operation area of division during the second instructional phase. His performance during baselines two and three shows no change in performance. His DPMC rate remained at 19.0. During this period his error rate increased, from 0 to 1 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows an increase in his performance on the DPMC measure of 27%, from 15.0 to 19.0. DPME performance remained at 0 during both baseline measures.

Hypothesis 2 is accepted for the operation area of subtraction. That is, paper-and-pencil measures taken pre and post to computer instruction show an increase in performance.

Hypothesis 2 is rejected for the operation area of division. Paper-and-pencil measures taken pre and post of instruction show no change in performance.

Hypothesis 3 is rejected for both operation areas of subtraction and division. DPMC performance decreased in subtraction and increased in division during phases in which they were not instructed.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of subtraction and division are shown below in figures 19 and 20 respectively. In the operation area of subtraction measures taken pre and post of instruction show an increase in performance from an average of 5.3 DPMC (s.d.= 2.6) during baseline one to 12.3 DPMC (s.d.= 3.6) during baseline two. During this same period his error rate increased from an average of 3.2 (s.d.= 1.3) to 5.6 (s.d.= 4.4) DPME. Measures taken before and after the noninstruction phase show a decrease in his performance from an average of 12.3 DPMC (s.d.= 3.6) in baseline two to 9.0 DPMC (s.d.= 4.1) in baseline three. Average DPME during this same period decreased from 5.6 (s.d.= 4.4) to 3.8 (s.d.= 1.5).

Baseline measures of student A7's performance taken pre and post to instruction in the operation area of division (baselines two and three) show an increase in average DPMC from 13.4 (s.d.= 2.8) to 16.2 (s.d.= 4.0). Average DPME increased from 1.25 (s.d.= .7) during baseline two to 2.2 (s.d.= .8) during baseline three. Computer measures taken pre and post of the noninstructional phase show an increase in average DPMC from 12.0 (s.d.= 2.8) during baseline one to 13.4 (s.d.= 2.8) in baseline two. Average DPME during this time decreased from 2.2 (s.d.= .8) to 1.3 (s.d.= .7).

Student A7's performance in both the operation areas of subtraction and division support an acceptance of hypothesis 4. Post instruction computer measures reflect increases in performance when compared to preinstruction measures.

Hypothesis 5 is rejected for both operation areas of subtraction and division. Computer measures taken pre and post of noninstructional phases show an increase in both subtraction and division performance.

Figure 60

Figure 61

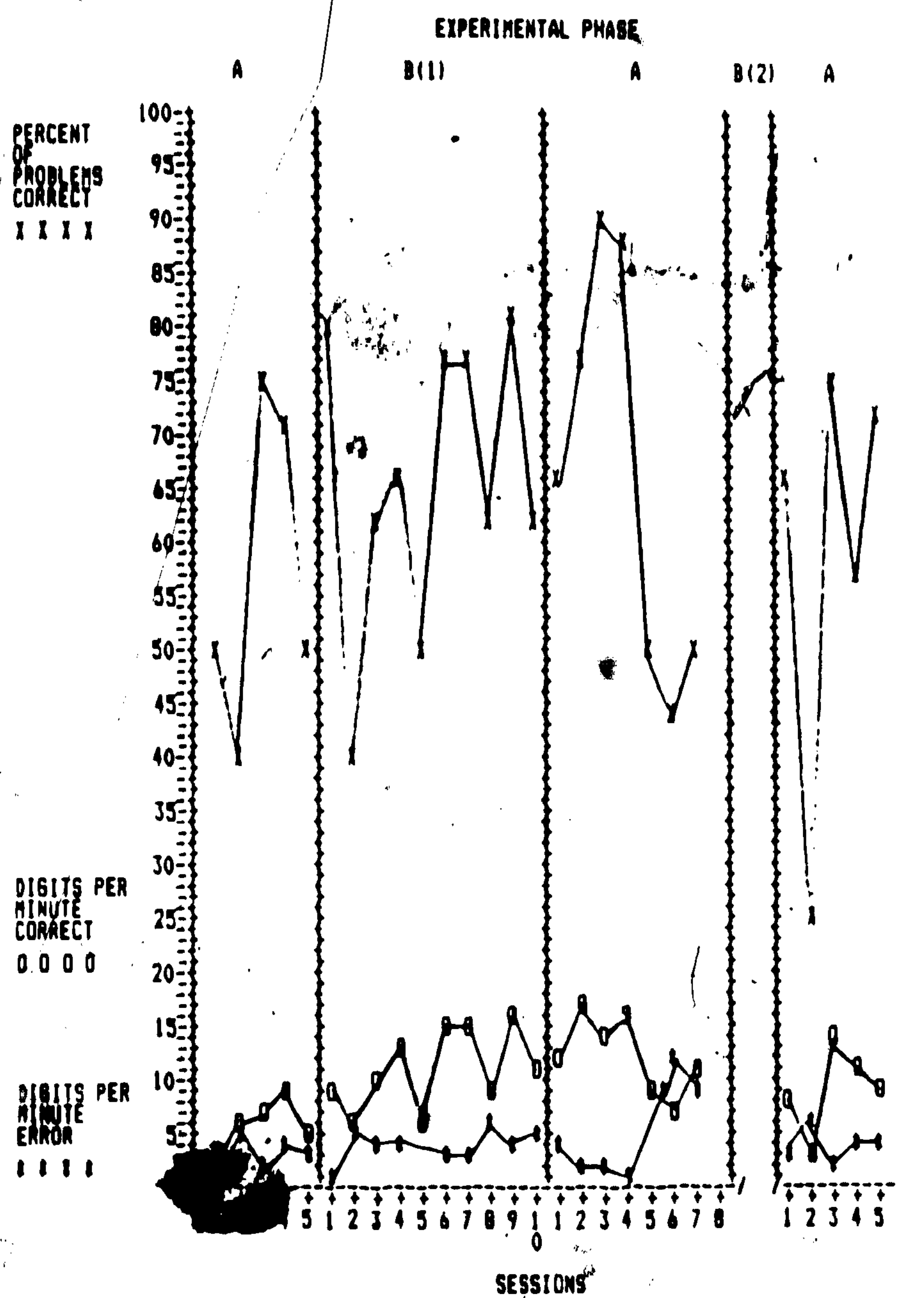

FIGURE 60 STUDENT A7
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = MEASURES IN SUBTRACTION WHILE RECEIVING INSTRUCTION IN SUBTRACTION

B(2) = INSTRUCTION IN DIVISION NO SUBTRACTION MEASURES TAKEN

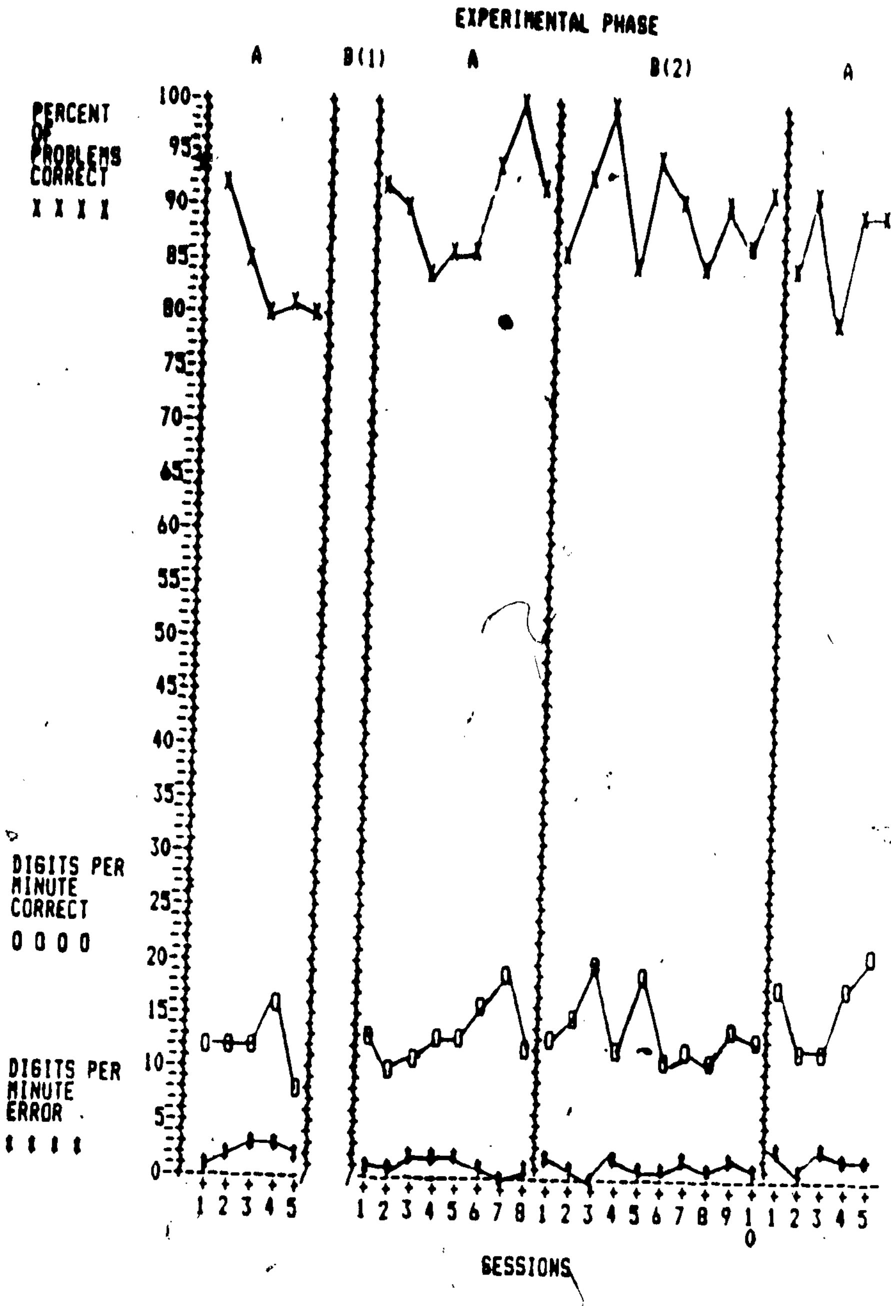

FIGURE 61 STUDENT A7
DIVISION PERFORMANCE

A = BASELINE MEASURES IN DIVISION

B(1) = INSTRUCTION IN SUBTRACTION
NO DIVISION MEASURES TAKEN

B(2) = MEASURES IN DIVISION WHILE
RECEIVING INSTRUCTION IN DIVISION

Student A8 received computer instruction in the operation area of multiplication during the first instructional phase. A comparison of his performance during the baseline periods pre and post to this instructional period show both an increase of 33% in his DPMC, from 24.6 during baseline one to 32.7 during baseline two, and an increase in his DPME of 8%, from 8.6 to 9.3. During the instructional phase in which the student did not receive computer instruction in the operation area of multiplication, an analysis of baselines two and three shows an increase in DPMC performance of 10%, from 32.7 to 36.0. DPME performance during this period decreased 78%, from 9.3 to 2.0.

This student received computer instruction in the operation area of subtraction during the second instructional phase. His performance during baselines two and three shows a decrease of 12%, from 30.7 to 27.0 DPMC. During this same period his error rate increased, from .8 to 13.4 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows an increase in his performance on the DPMC measure of 52%, from 20.2 to 30.7. DPME performance decreased by 71% from 2.8 to .8.

Hypothesis 2 is accepted for the operation area of multiplication. Paper-and-pencil baseline measures taken pre and post to computer instruction show an increase in performance.

Hypothesis 2 is rejected for the operation area of subtraction. Paper-and-pencil baseline measures taken pre and post to computer instruction shows decreased performance

Hypothesis 3 is rejected for both operation areas of multiplication and subtraction. Paper-and-pencil measures taken pre and post on noninstructional phases show increased performance in both operation areas.

<u>Hypothesis 4 and 5</u>. Computer baseline measures in the operation areas of multiplication and subtraction are shown below in figures 21 and 22 respectively. In the operation area of multiplication measures taken pre and post of instruction show an increase in performance from an average of 9.2 DPMC (s.d.= 1.8) during baseline one to 15.1 DPMC (s.d.= 3.1) during baseline two. During this same period his error rate increased from an average of 6.0 (s.d.= 1.6) to 12.0 (s.d.= 3.4) DPME. Measures taken before and after the non-instruction phase show an increase in his performance from an average of 15.1 DPMC (s.d.= 3.1) in baseline two to 23.2 DPMC (s.d.= 4.7) in baseline three. Average DPME during this same period decreased from 12.0 (s.d.= 3.4) to 9.6 (s.d.= 6.5).

Baseline measures of student A8's performance taken pre and post to instruction in the operation area of subtraction (baselines two and three) show an increase in average DPMC from 10.8 (s.d.= 2.3) to 22.8 (s.d.= 1.3). Average DPME decreased from 6.0 (s.d.= 2.6) to 1.0 (s.d.= 1.0). Pre and postmeasures of the noninstructional phase show an increase in average DPMC from 9.5 (s.d.= 4.7) during baseline one to 10.8 (s.d.= 2.3) in baseline two. Average DPME during this time increased from 2.3 (s.d.= 2.6) to 6.0 (s.d.= 2.6).

Hypothesis 4 is rejected for the operation area of multiplication. Although DPMC incresed by 5.9 the corresponding large increase in DPME warrants a rejection of this hypothesis.

Hypothesis 4 is accepted for the operation area of subtraction. Post instruction baseline computer measures reflect increased performance when compared to pre-instruction measures.

Hypothesis 5 is rejected for both operation areas of multiplication and subtraction. Computer measures taken pre and post of noninstructional phases show increased performance in both operation areas.

Figure 62

Figure 63

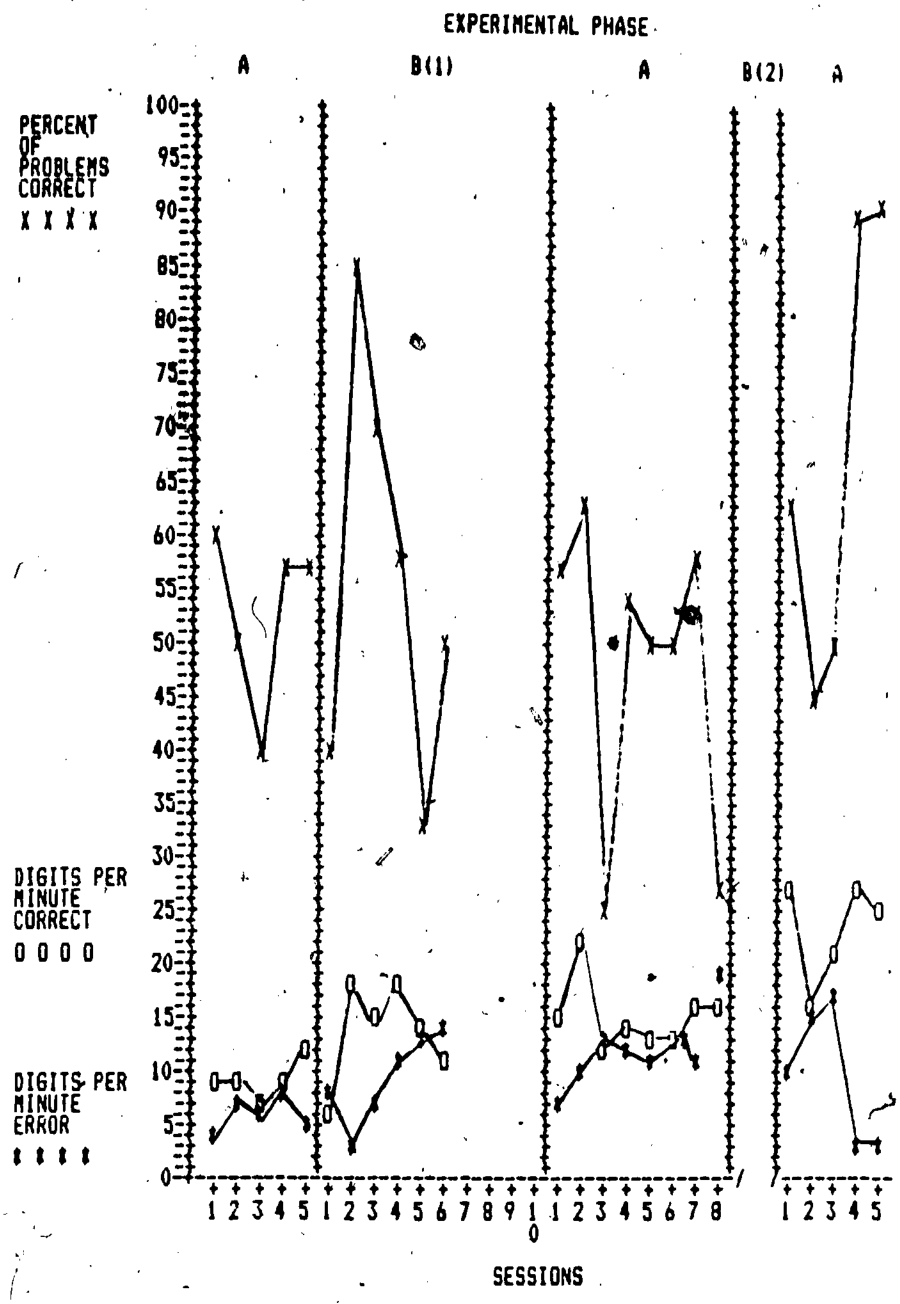

FIGURE 62 STUDENT A8
MULTIPLICATION PERFORMANCE

A = BASELINE MEASURES IN MULTIPLICATION

B(1) = MEASURES IN MULTIPLICATION WHILE RECEIVING INSTRUCTION IN MULTIPLICATION

B(2) = INSTRUCTION IN SUBTRACTION NO MULTIPLICATION MEASURES TAKEN

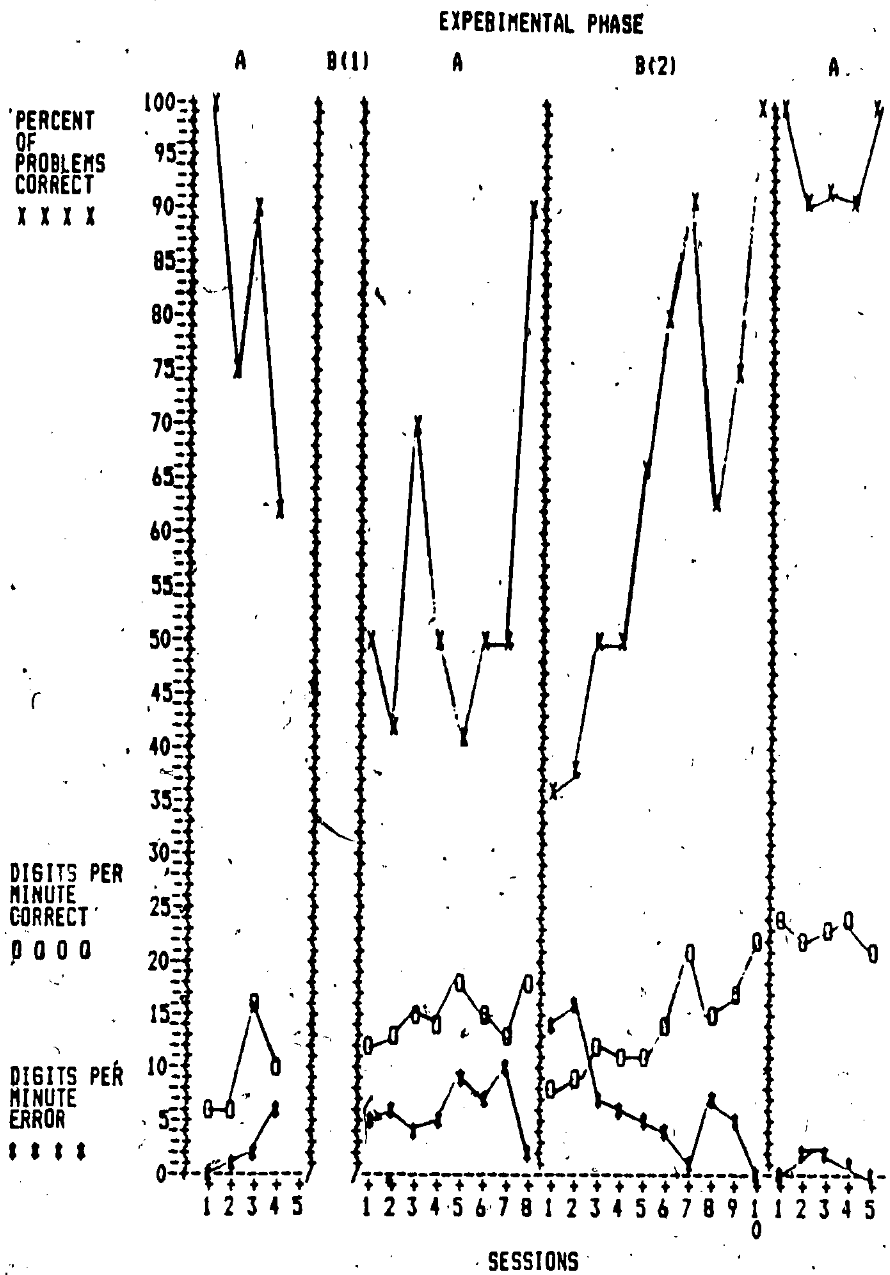

FIGURE 63 STUDENT AB
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = INSTRUCTION IN MULTIPLICATION
NO SUBTRACTION MEASURES TAKEN

B(2) = MEASURES IN SUBTRACTION WHILE
RECEIVING INSTRUCTION IN SUBTRACTION

Student A9

Student A9 was a male aged 15 years 3 months with a measured full scale WISC-R score of 77. This student was assigned to receive computer instruction during the first and second instructional phases in subtraction and multiplication respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Green Form this student obtained a standard grade equivalence score of 5.9 on the pretest and a 6.1 on the posttest. The positive change of .2 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation areas of subtraction and multiplication were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 38.

		Baseline Period		
Operation Area	Measure	1	2	3
Subtraction	DPMC	15.7	29.7	27.5
	DPME	3.7	.8	.7
Multiplication	DPMC	31.3	29.0	44.0
	DPME	2.0	2.3	2.3

Table 38. Student A9 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Subtraction and Multiplication.

Student A9 received computer instruction in the operation area of subtraction during the first instructional phase. A comparison of his performance during the baseline periods pre and post to this instructional period shows an increase of 89% in his DPMC, from 15.7 during baseline one to 29.7 during baseline two. DPME decreased during this period 78% from 3.7 to .8. During the instructional phase in which the student did not receive computer instruction in the operation area of subtraction, an analysis of baselines two and three shows a decrease in DPMC performance of 7%, from 29.7 to 27.5. DPME performance during this period decreased from .8 to .7.

This student received computer instruction in the operation area of multiplication during the second instructional phase. His performance during baselines two and three shows an increase of 51%, from 29.0 to 44.0 DPMC. During this same period his error rate remained at 2.3. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows a decrease in his performance on the DPMC measure of 7%, from 31.3 to 29.0 DPME performance increased 15%, from 2.0 to 2.3.

Hypothesis 2 is accepted for both operation areas of subtraction and multiplication. Paper-and-pencil measures taken pre and post to computer instruction show increased performance in both operation areas.

Hypothesis 3 is rejected for both operation areas of subtraction and multiplication. Paper-and-pencil measures taken pre and post to noninstruction phases show decreased performance in both operation areas.

<u>Hypothesis 4 and 5</u>. Computer baseline measures in the operation areas of subtraction and multiplication are shown below in figures 23 and 24 respectively. In the operation area of subtraction measures taken pre and post of instruction show an increase in performance from an average of 11.8 DPMC (s.d.= 3.4) during baseline one to 12.7 DPMC (s.d.= 2.5) during baseline two. During this same period his error rate increased slightly from an average of .6 (s.d.= .5) to 1.0 (s.d.= .9) DPME. Measures taken before and after the noninstruction phase show an increase in his performance from an average of 12.7 DPMC (s.d.= 2.5) in baseline two to 16.8 DPMC (s.d.= 2.6) in baseline three. Average DPME during this same period increased from 1.0 (s.d.= .9) to 1.6 (s.d.= 2.1).

Paper-and-pencil measures taken pre and post of instruction in the operation area of multiplication (baselines two and three) show an increase in average DPMC from 22.0 (s.d.= 2.8) to 29.4 (s.d.= 3.9). Average DPME decreased from 2.2 (s.d.= 1.2) to 1.8 (s.d.= 1.8). Pre and post-measures of the noninstructional phase show an increase in average DPMC from 20.6 (s.d.= 7.1) during baseline one to 22.0 (s.d.= 2.8) in baseline two. Average DPME during this time increased from 1.0 (s.d.= 1.4) to 2.2 (s.d.= 1.2).

Hypothesis 4 is rejected for the operation area of subtraction. Computer measures taken pre and post to instruction in this operation area show no change in performance.

Hypothesis 4 is accepted for the operation area of multiplication. Computer measures taken pre and post to instruction in this operation area show an increase in performance.

Hypothesis 5 is rejected for both operation areas of subtraction and multiplication. Computer measures taken pre and post to noninstructional phases in these operation areas show increases in performance.

Figure 64

Figure 65

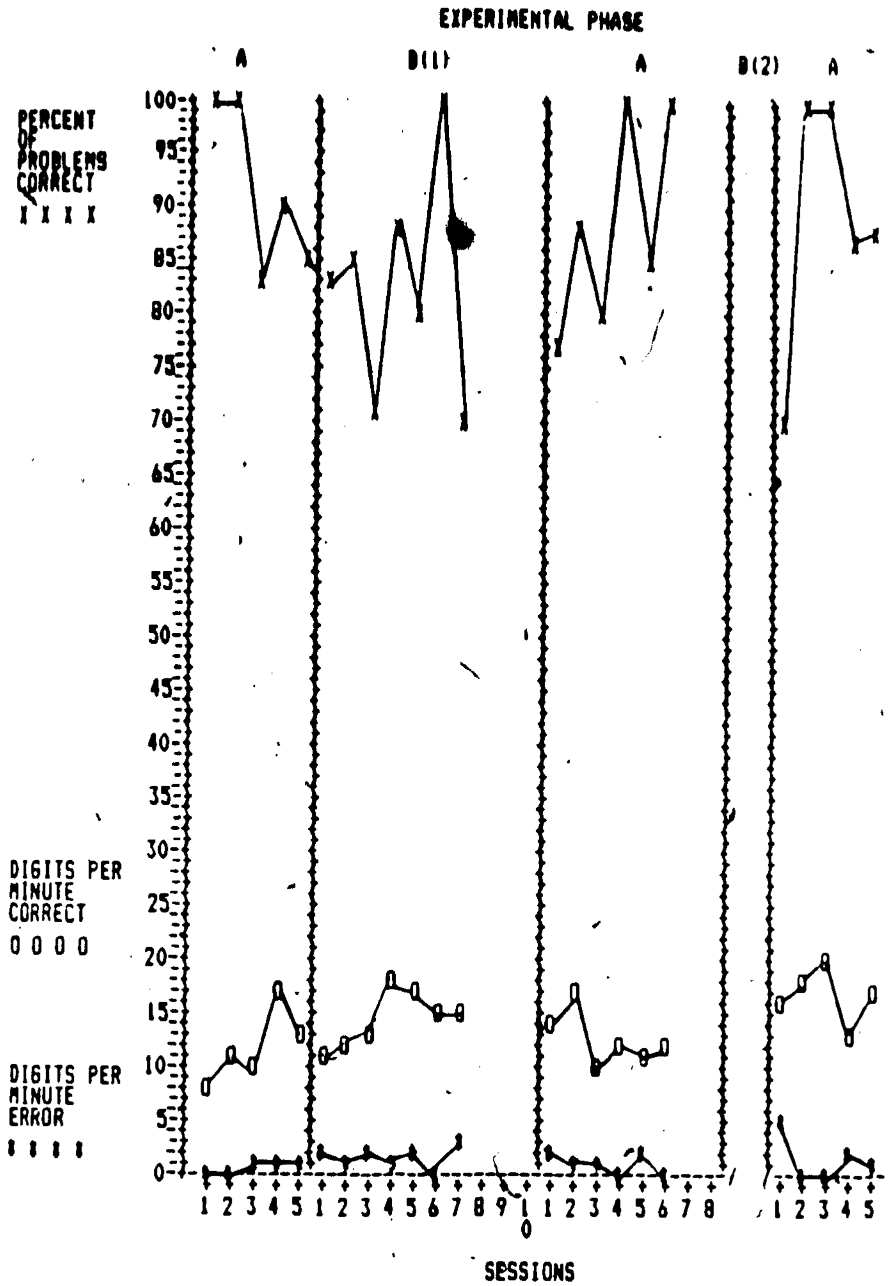

FIGURE 64 STUDENT A9
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = MEASURES IN SUBTRACTION WHILE RECEIVING INSTRUCTION IN SUBTRACTION

B(2) = INSTRUCTION IN MULTIPLICATION NO SUBTRACTION MEASURES TAKEN

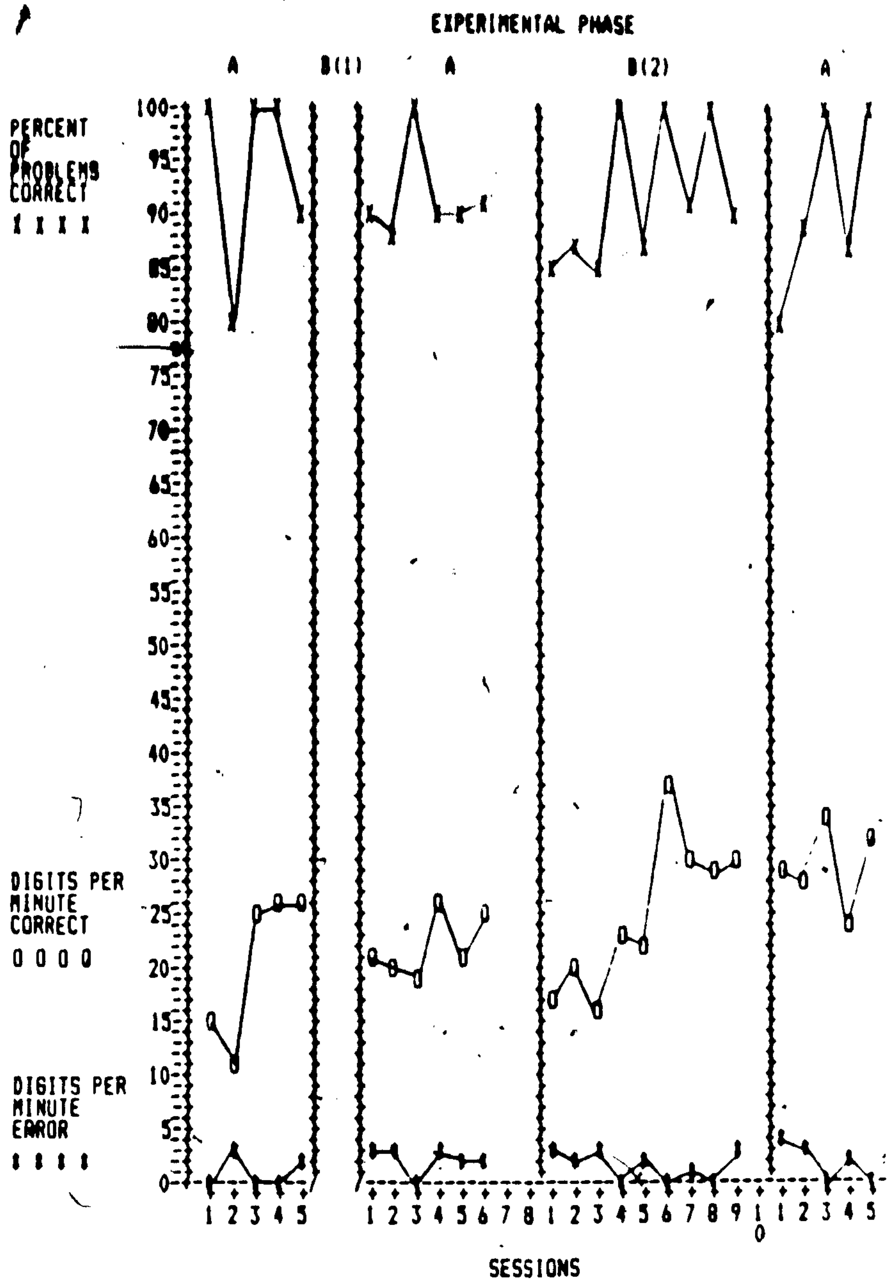

FIGURE 65 STUDENT A9
MULTIPLICATION PERFORMANCE

A = BASELINE MEASURES IN MULTIPLICATION

B(1) = INSTRUCTION IN SUBTRACTION
NO MULTIPLICAITON MEASURES TAKEN

B(2) = MEASURES IN MULTIPLICATION WHILE
RECEIVING INSTRUCTION IN MULTIPLICATION

Student A10

Student A10 was a female aged 14 years 10 months with a measured full scale WISC-R score of 64. This student was assigned to receive computer instruction during the first and second instructional phases in multiplication and division respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Green Form this student obtained a standard grade equivalence score of 4.7 on the pretest and a 5.1 on the posttest. The positive change of .4 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation areas of multiplication and division were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 39.

		Baseline Period		
Operation Area	Measure	1	2	3
Multiplication	DPMC	20.6	19.0	22.3
	DPME	8.3	5.3	1.0
Division	DPMC	15.0	13.0	7.0
	DPME	4.0	1.0	4.0

Table 39. Student A10 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Multiplication and Division.

Student A10 received computer instruction in the operation area of multiplication during the first instructional phase. A comparison of her performance during the baseline periods pre and post to this instructional period (baselines one and two) show both a decrease of 8% in her DPMC, from 20.6 to 19.0, and a decrease in her DPME of 36%, from 8.3 to 5.3. During the instructional phase in which the student did not receive computer instruction in the operation area of multiplication an analysis of baselines two and three shows DPMC increasing by 17% to 22.3 from 19.0. DPME performance during this period decreased to a rate 1.0 from 5.3.

This student received computer instruction in the operation area of division during the second instructional phase. Her performance during baselines two and three shows a decrease of 46%, from 13.0 to 7.0 DPMC. During this same period her error rate increased to 4.0 from 1.0 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows a decrease in her performance on the DPMC measure of 13%, from 15.0 to 13.0. DPME performance decreased by 75% from 4.0 to 1.0.

Hypothesis 2 is rejected for both operation areas of multiplication and division. Paper-and-pencil measures taken pre and post of instruction shows a decrease in performance in both operation areas.

Hypothesis 3 is rejected for both operation areas of multiplication and division. Paper-and-pencil measures taken pre and post of noninstructional phases show a decreased performance in both operation areas.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of multiplication and division are shown below in figures 25 and 26 respectively. In the operation area of multiplication measures taken pre and post of instruction show an increase in performance from an average of 13.8 DPMC (s.d.= 2.4) during baseline one to 22.9 DPMC (s.d.= 3.1) during baseline two. During this same period her error rate increased from an average of 0.0 to 1.8 (s.d.= 2.6) DPME. Measures taken before and after the noninstruction phase shows a slight decrease in her performance from an average of 22.9 DPMC (s.d.= 3.1) in baseline two to 21.4 DPMC (s.d.= 3.6) in baseline three. Average DPME during this same period increased slightly from 1.8 (s.d.= 2.6) to 2.4 (s.d.= 1.7).

Baseline measures of student A10's performance taken pre and post to instruction in the operation area of division (baselines two and three) show an increase in average DPMC from 8.3 (s.d.= 2.5) to 14.4 (s.d.= 5.7). Average DPME increased from 1.5 (s.d.= 1.5) to 2.8 (s.d.= 1.1) during this same period. Computer measures taken pre and post of the noninstructional phase show an increase in average DPMC from 6.2 (s.d.= 1.3) during baseline one to 8.3 (s.d.= 2.5) in baseline two. Average DPME during this time increased from .6 (s.d.= .6) to 1.5 (s.d.= 1.5).

Student A10's performance in both the operation areas of multiplication and division support an acceptance of hypothesis 4. Post instruction computer measures reflect increased performance when compared to preinstruction measures.

Hypotheis 5 is accepted for the operation area of multiplication. Computer measures taken pre and post of the noninstructional phase show no change in performance.

Hypothesis 5 is rejected for the operation area of division. Computer measures taken pre and post of the noninstructional phase show an increase in performance.

Figure 66

Figure 67

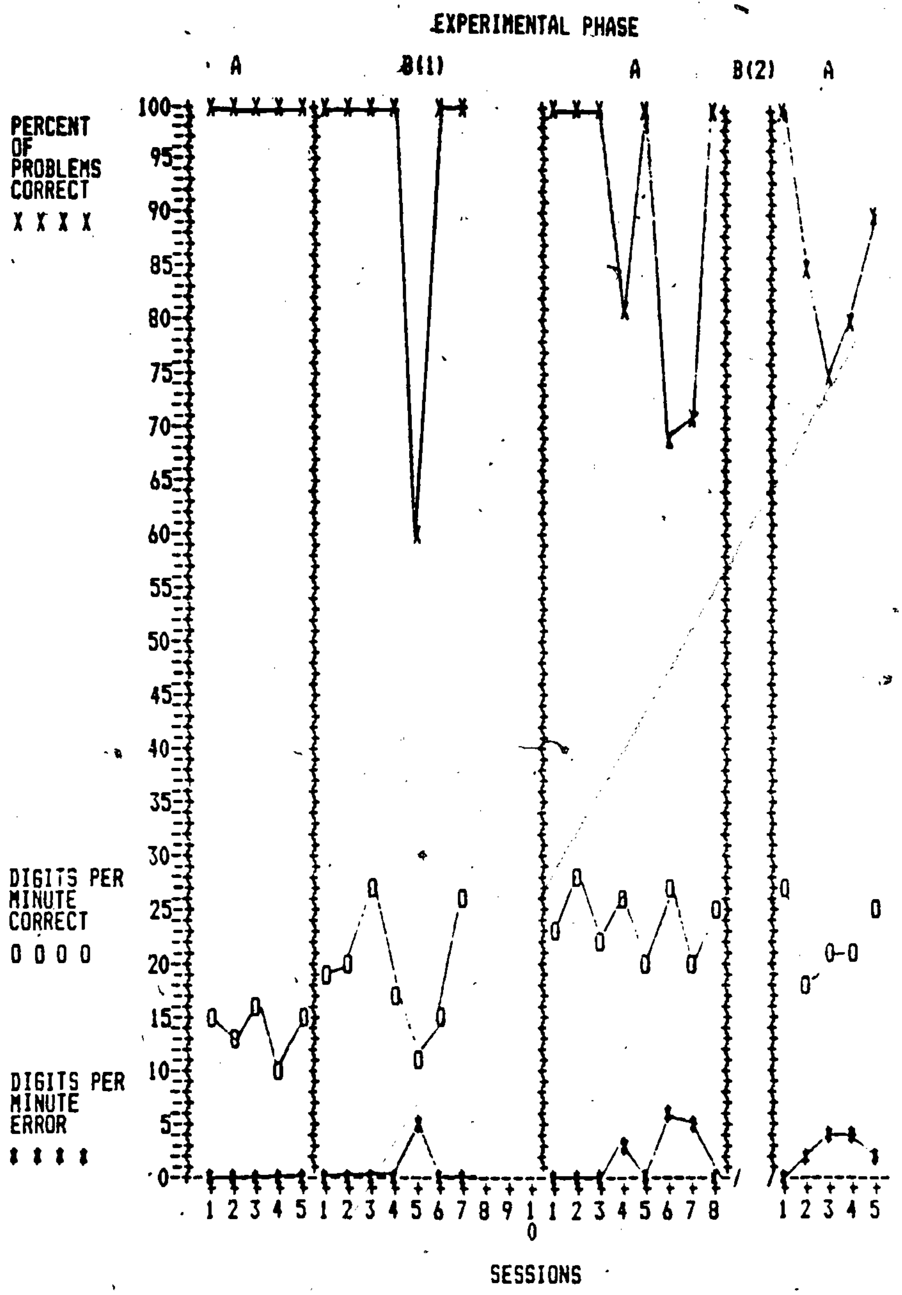

FIGURE 66 STUDENT A10
MULTIPLICATION PERFORMANCE

A = BASELINE MEASURES IN MULTIPLICATION

B(1) = MEASURES IN MULTIPLICATION WHILE RECEIVING INSTRUCTION IN MULTIPLICATION

B(2) = INSTRUCTION IN DIVISION NO MULTIPLICATION MEASURES TAKEN

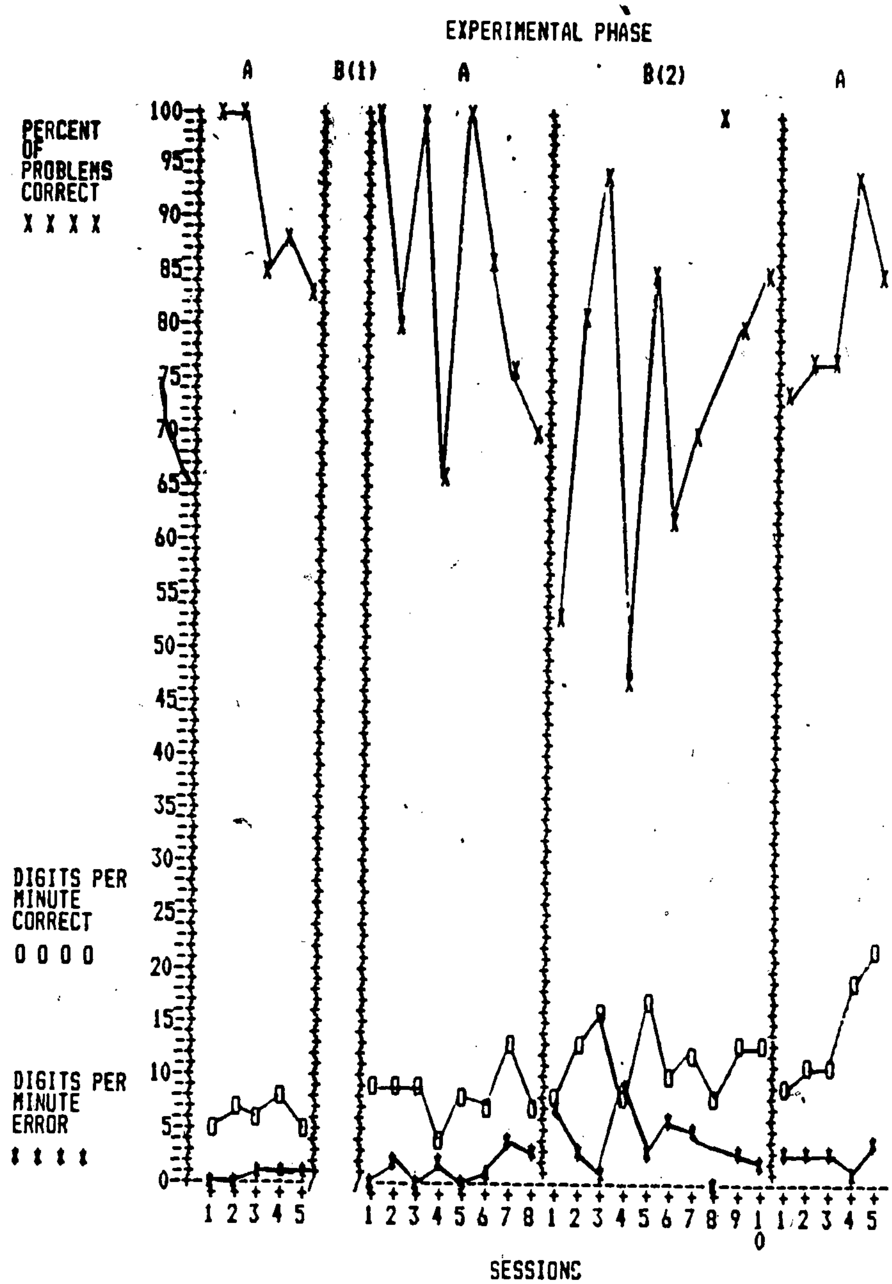

FIGURE 67 STUDENT A10
DIVISION PERFORMANCE

A = BASELINE MEASURES IN DIVISION

B(1) = INSTRUCTION IN MULTIPLICATION
NO DIVISION MEASURES TAKEN

B(2) = MEASURES IN DIVISION WHILE
RECEIVING INSTRUCTION IN DIVISION

Student All

Student All was a male aged 13 years 3 months with a measured full scale WISC-R score of 75. This student was assigned to receive computer instruction during the first and second instructional phases in division and subtraction respectively. Unfortunately, due to excessive absence from school no instruction was provided in the operation area of division during the first instructional phase. Therefore, only performance in the operation area of subtraction will be reported.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Green Form this student obtained a standard grade equivalence score of 3.8 on the pretest and a 3.9 on the posttest. The positive change of .1 was not considered large enough to support an acceptance of hypothesis 1. Therefore, hypothesis 1 is rejected.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation area of subtraction were taken three times during the course of this study. This student's performance in this operation area across each of the baseline periods is shown below in Table 40.

		Baseline Period		
Operation Area	Measure	1	2	3
Subtraction	DPMC	11.8	18.5	19.5
	DPME	8.3	8.4	.7

Table 40. Student All - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Area of Subtraction.

Student All received computer instruction in the operation area of subtraction during the second instructional phase. A comparison of his performance during the baseline periods pre and post to this instructional period show an increase of 5% in his DPMC, from 18.5 during baseline two to 19.5 during baseline three, and a decrease in his DPME of 91%, from 8.4 to .7. During the instructional phase in which the student did not receive computer instruction in the operation area of subtraction, an analysis of baselines one and two shows an increase in DPMC performance of 58%, from 11.8 to 18.5. DPME performance during this period increased very slightly from 8.3 to 8.4.

Hypothesis 2 is accepted for the operation area of subtraction. That is, paper-and-pencil measures taken pre and post to computer instruction show an increase in performance. Although the DPMC measure did not increase significantly the dramatic decrease in DPME warrants this acceptance.

Hypothesis 3 is rejected for the operation area of subtraction. Paper-and-pencil measures taken pre and post the the noninstructional phase shows an increase in performance.

Hypothesis 4 and 5. Computer baseline measures in the operation area of subtraction are shown below in figure 27. In the operation area of subtraction measures taken pre and post of instruction show an increase in performance from an average of 6.9 DPMC (s.d.= 3.3) during baseline two to 8.4

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DPMC (s.d.= 1.3) during baseline three. During this same period his error rate increased from an average of 5.1 (s.d.= 3.5) to 8.0 (s.d.= 2.6) DPME. Measures taken before and after the noninstruction phase shows an increase in his performance from an average of 4.8 DPMC (s.d.= 2.6) in baseline one to 6.9 DPMC (s.d.= 3.3) in baseline two. Average DPME during this same period decreased from 5.5 (s.d.= 4.0) to 3.1 (s.d.= 3.5).

Hypothesis 4 is rejected for the operation area of subtraction. Although post instruction DPMC computer measures indicated an increase in performance the large increase in DPME performance warrants a rejection of this hypothesis.

Hypothesis 5 is rejected for the operation area of subtraction. Computer measures taken pre and post of non-instructional phases show an increase in performance.

Figure 68

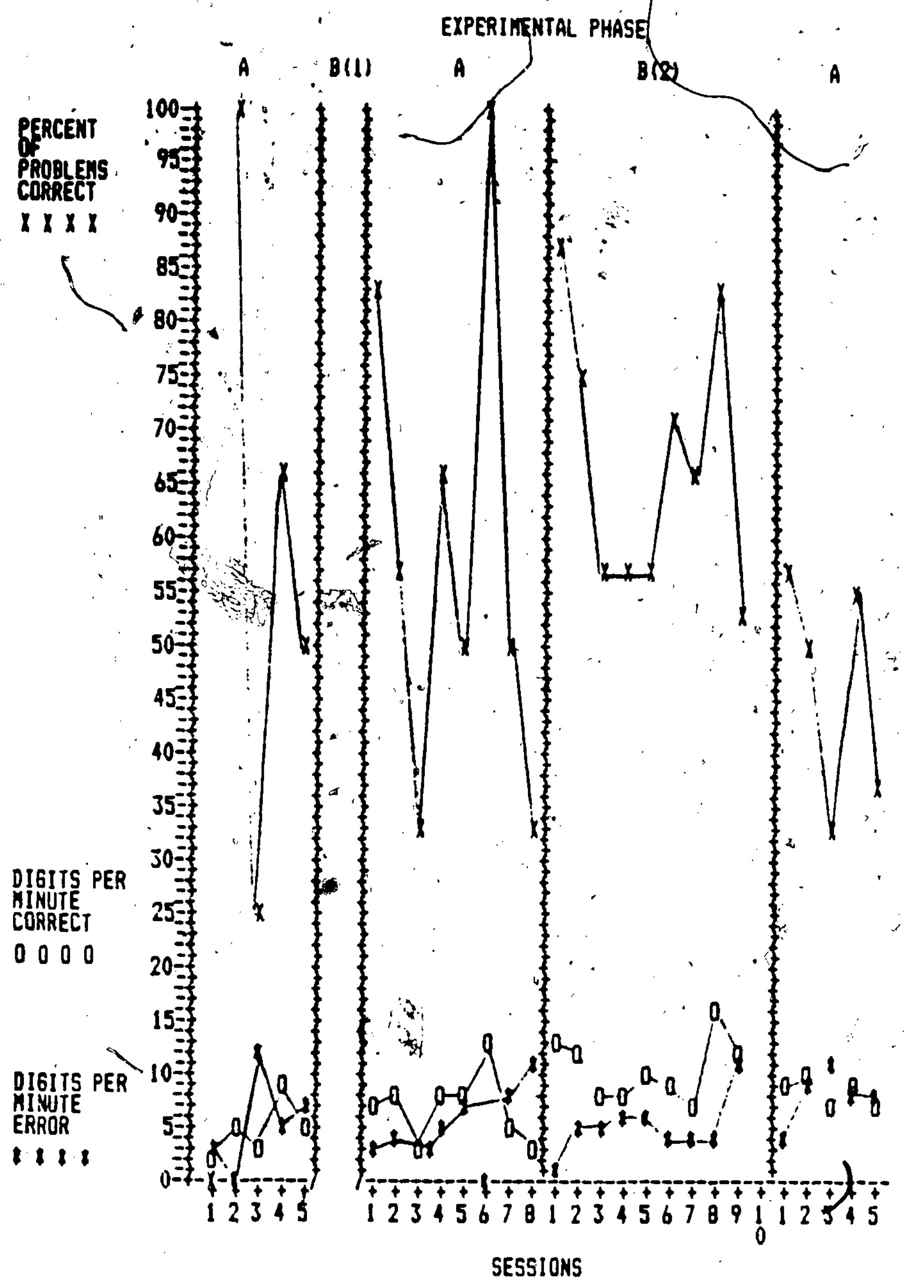

FIGURE 68 STUDENT A11
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = NO INSTRUCTION GIVEN
NO SUBTRACTION MEASURES TAKEN

B(2) = MEASURES IN SUBTRACTION WHILE
RECEIVING INSTRUCTION IN SUBTRACTION

Student A12

Student A12 was a male aged 15 years 4 months with a measured full scale WISC-R score of 52. This student was assigned to receive computer instruction during the first and second instructional phases in addition and subtraction respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Red Form this student obtained a standard grade equivalence score of 2.5 on the pretest and a 3.0 on the posttest. The positive change of .5 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation areas of addition and subtraction were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 41.

		Baseline Period		
Operation Area	Measure	1	2	3
Addition	DPMC	27.4	38.7	38.4
	DPME	.6	.2	.7
Subtraction	DPMC	10.2	14.5	18.4
	DPME	1.3	.8	.2

Table 41. Student A12 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Addition and Subtraction.

Student A12 received computer instruction in the operation area of addition during the first instructional phase. A comparison of his performance during the baseline periods pre and post to this instructional period show both an increase of 41% in his DPMC, from 27.4 during baseline one to 38.7 during baseline two, and a decrease in his DPME of 66%, from .6 to .2. During the instructional phase in which the student did not receive computer instruction in the operation area of addition an analysis of baselines two and three shows a slight decrease in DPMC performance of 1%, from 38.7 to 38.4. DPME performance during this period increased from .2 to .7.

This student received computer instruction in the operation area of subtraction during the second instructional phase. His performance during baselines two and three shows an increase of 27%, from 14.5 to 18.4 DPMC. During this same period his error rate decreased to .2 from .8 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows an increase in his performance on the DPMC measure of 42%, from 10.2 to 14.5. DPME performance decreased by 39% to .8 from 1.3.

Hypothesis 2 is accepted for both operation areas of addition and subtraction. Paper-and-pencil baseline measures taken pre and post to computer instruction show an increased performance.

Hypothesis 3 is accepted for the operation area of addition. Paper-and-pencil baseline measures taken pre and post to computer instruction show no change in performance.

Hypothesis 3 is rejected for the operation area of subtraction. Paper-and-pencil measures taken pre and post of the noninstruction phase show increased performance.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of addition and subtraction are shown below in figures 28 and 29 respectively. In the operation area of addition measures taken pre and post of instruction show an increase in performance from an average of 11.2 DPMC (s.d.= 1.8) during baseline one to 17.8 DPMC (s.d.= 2.1) during baseline two. During this same period his error rate decreased from an average of .2 (s.d.= 1.6) to 0.0 DPME. Measures taken before and after the noninstruction phase show a decrease in his performance from an average of 17.8 DPMC (s.d.= 2.1) in baseline two to 14.4 DPMC (s.d.= 2.3) in baseline three. Average DPME during this same period increased from 0.0 to 1.0 (s.d.= 1.2).

Baseline measures of student A12's performance taken pre and post to instruction in the operation area of subtraction (baselines two and three) show an increase in average DPMC from 10.4 (s.d.= 3.5) to 13.8 (s.d.= 1.3). Average DPME decreased from 3.3 (s.d.= 3.5) to 1.6 (s.d.= 1.3). Pre and postmeasures of the noninstructional phase show a slight increase in average DPMC, from 10.2 (s.d.= 1.9) during baseline one to 10.4 (s.d.= 3.5) in baseline two. Average DPME during this time increased from .8 (s.d.= 1.3) to 3.3 (s.d.= 3.5).

Student A12's performance in both the operation areas of addition and subtraction support an acceptance of hypothesis 4. Post instruction baseline computer measures reflect increased performance when compared to preinstruction measures.

Hypothesis 5 is accepted for the operation area of addition. Computer measures taken pre and post of the non instructional phase indicate no change in performance.

Hypothesis 5 is rejected for the operation area of subtraction. Computer measures taken pre and post of the noninstruction phase show decreased performance.

Figure 69

Figure 70

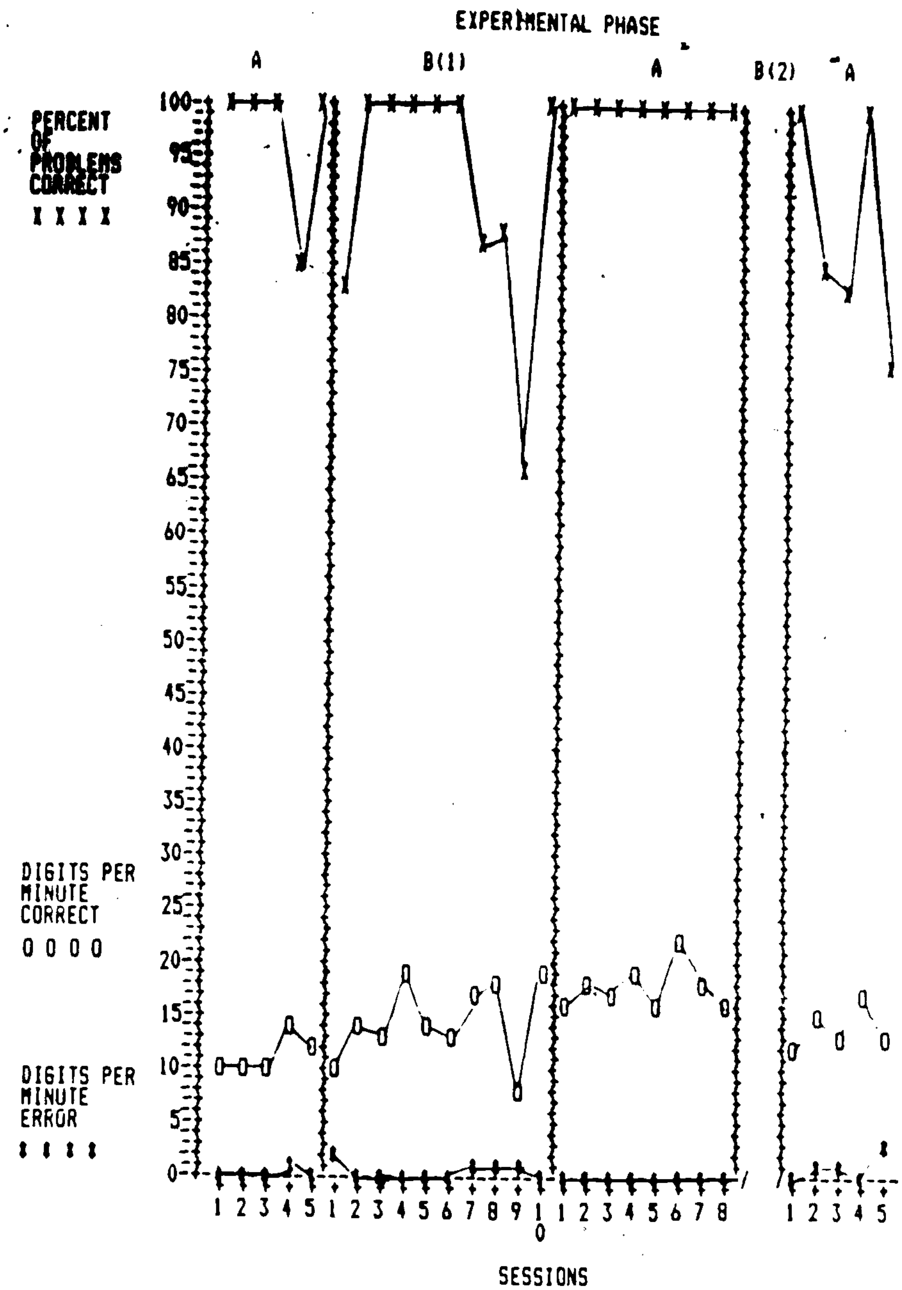

FIGURE 69 STUDENT A12
ADDITION PERFORMANCE

A = BASELINE MEASURES IN ADDITION

B(1) = MEASURES IN ADDITION WHILE
RECEIVING INSTRUCTION IN ADDITION

B(2) = INSTRUCTION IN SUBTRACTION
NO ADDITION MEASURES TAKEN

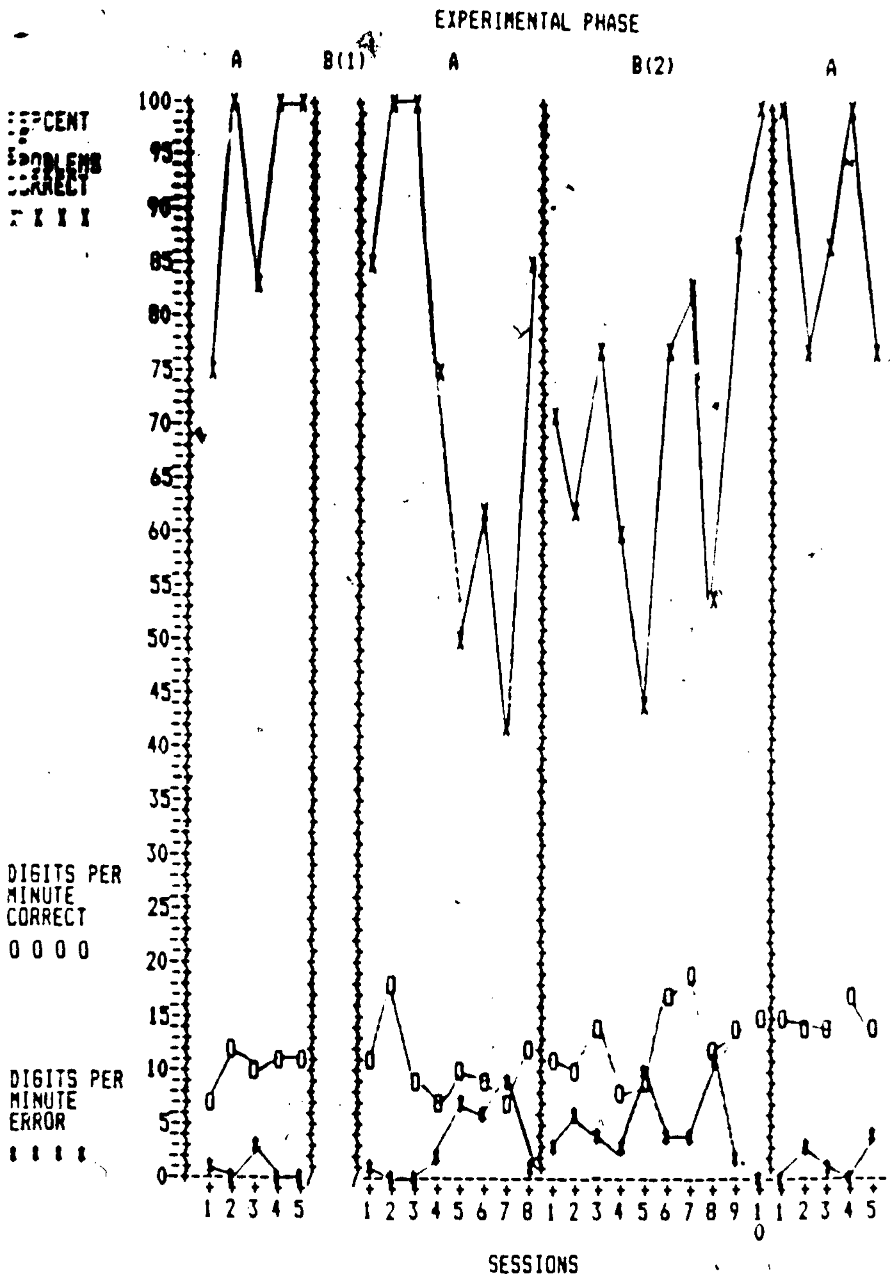

FIGURE 70 STUDENT A12
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = INSTRUCTION IN ADDITION
NO SUBTRACTION MEASURES TAKEN

B(2) = MEASURES IN SUBTRACTION WHILE
RECEIVING INSTRUCTION IN SUBTRACTION

Student A13

Student A13 was a male aged 12 years 1 month with a measured full scale WISC-R score of 65. This student was assigned to receive computer instruction during the first and second instructional phases in division and multiplication respectively. Unfortunately, due to excessive absence from school no instruction was provided in the operation area of division during the first instructional phase. Therefore, only performance in the operation area of multiplication will be reported.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Red Form this student obtained a standard grade equivalence score of 3.0 on the pretest and a 3.1 on the posttest. The positive change of .1 does not support an acceptance of hypothesis 1 in that posttest standardized measures were not higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation area of multiplication were taken three times during the course of this study. This student's performance in this operation area across each of the baseline periods is shown below in Table

Operation Area	Measure	Baseline Period 1	2	3
Multiplication	DPMC	12.7	21.3	32.0
	DPME	1.0	2.0	3.0

Table Student A13 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Area of Multiplication.

Student A13 received computer instruction in the operation area of multiplication during the second instructional phase. A comparison of his performance during the baseline periods pre and post to this instructional period shows an increase of 50% in his DPMC, from 21.3 during baseline two to 32.0 during baseline three. DPME increased during this period 50% from 2.0 to 3.0. During the instructional phase in which the student did not receive computer instruction in the operation area of multiplication, an analysis of baselines one and two shows an increase in DPMC performance of 68%, from 12.7 to 21.3. DPME performance during this period decreased from 10.0 to 2.0.

Hypothesis 2 is accepted for the operation area of multiplication. Paper-and-pencil measures taken pre and post to computer instruction in this operation area shows an increase in performance.

Hypothesis 3 is rejected for the operation area of multiplication. Paper-and-pencil measures taken pre and post to the noninstruction phase show an increase in performance.

Hypothesis 4 and 5. Computer baseline measures in the operation area of multiplication are shown below in figure 30. In the operation area of multiplication measures taken pre and post of instruction show an increase in performance from an average of 10.6 DPMC (s.d.= 4.4) during baseline two to 12.8 DPMC (s.d.= 1.7) during baseline three. During this same period his error rate decreased from an average of 8.8 (s.d.= 6.1) to 6.0 (s.d.= 4.2) DPME. Measures taken before and after the noninstruction phase show an increase in his performance from an average of 8.8 DPMC (s.d.= 2.2) in baseline one to 10.6 DPMC (s.d.= 4.4) in baseline two. Average DPME during this same period increased from 3.4 (s.d.= 3.1) to 8.8 (s.d.= 6.1).

Hypothesis 4 is accepted for the operation area of multiplication. Computer measures taken pre and post to instruction in this operation area show increased performance.

Hypothesis 5 is rejected for the operation area of multiplication. Computer measures taken pre and post to the noninstructional phase shows decreased performance.

Figure 71

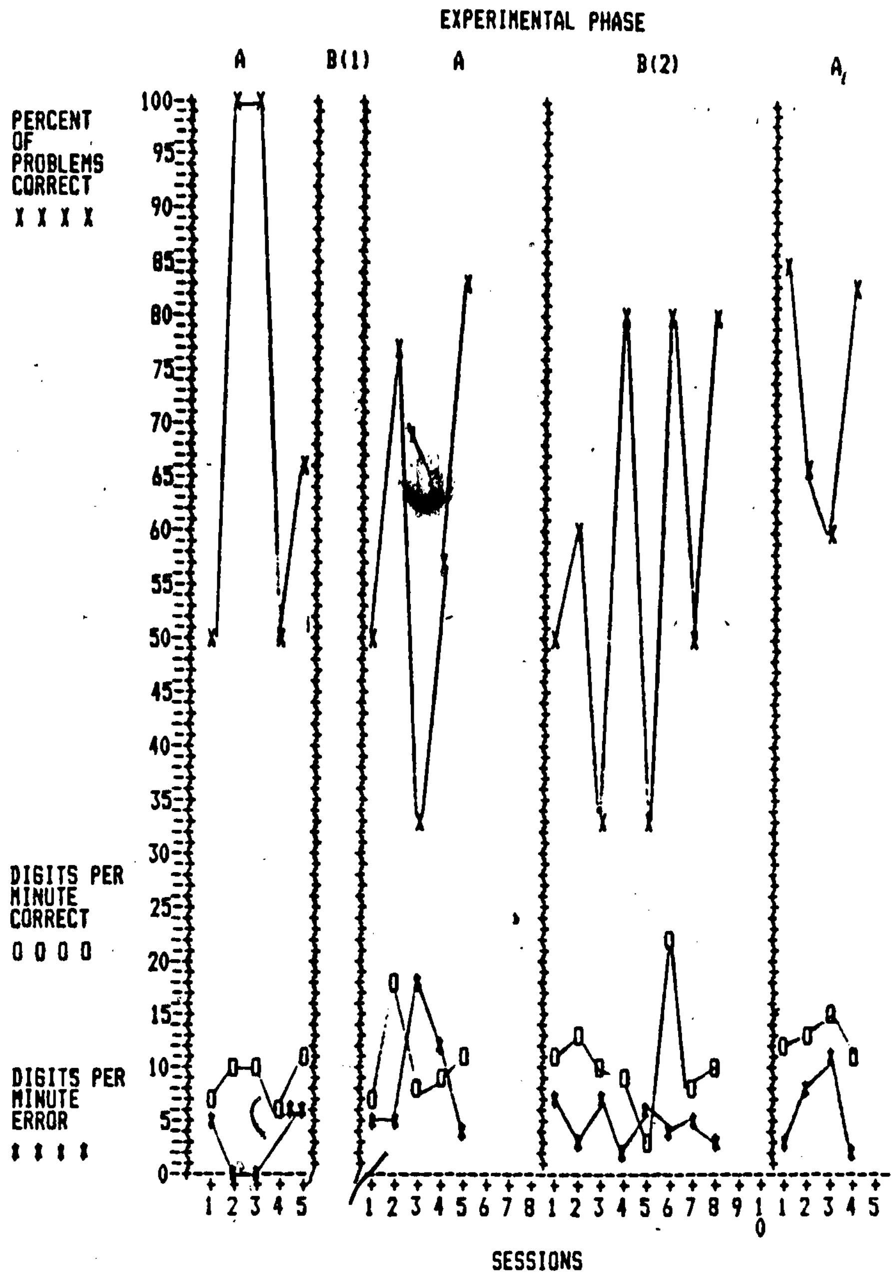

FIGURE 71 STUDENT A13
MULTIPLICATION PERFORMANCE

A = BASELINE MEASURES IN MULTIPLICATION

B(1) = NO INSTRUCTION GIVEN
NO MULTIPLICATION MEASURES TAKEN

B(2) = MEASURES IN MULTIPLICATION WHILE
RECEIVING INSTRUCTION IN MULTIPLICATION

Student A14

Student A14 was a female aged 13 years 2 months with a measured full scale WISC-R score of 70. This student was assigned to receive computer instruction during the first and second instructional phases in subtraction and division respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Green Form this student obtained a standard grade equivalence score of 4.4 on the pretest and a 4.7 on the posttest. The positive change of .3 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation area of subtraction and division were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 43.

		Baseline Period		
Operation Area	Measure	1	2	3
Subtraction	DPMC	11.0	18.3	19.8
	DPME	.5	.3	.2
Division	DPMC	10.0	13.0	14.0
	DPME	5.0	9.0	2.0

Table 43. Student A14 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Subtraction and Division.

Student A14 received computer instruction in the operation area of subtraction during the first instructional phase. A comparison of her performance during the baseline periods pre and post to this instructional period (baselines one and two) show both an increase of 66% in DPMC, from 11.6 to 18.3, and a decrease in DPME of 40%, from .5 to .3. During the instructional phase in which this student did not receive computer instruction in the operation area of subtraction an analysis of baselines two and three shows an increase in DPMC of 8%, from 18.3 to 19.8. DPME performance during this period decreased to .2 from .3.

This student received computer instruction in the operation area of division during the second instructional phase. Her performance during baselines two and three shows an increase of 8%, from 13.0 to 14.0 DPMC. During this same period her error rate decreased by 78%, from 9.0 to 2.0 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows an increase in her performance on the DPMC measure of 30%, from 10.0 to 13.0. DPME performance increased by 80% from 5.0 to 9.0.

Hypothesis 2 is accepted for both operation areas of subtraction and division. Paper-and-pencil measures taken pre and post of instruction show an increase in performance in both operation areas. Although DPMC did not increase significantly in the operation area of division from pre to post measurements the large decrease in DPME warrants an acceptance of hypothesis 2 for this operation area.

Hypothesis 3 is rejected for both operation areas of subtraction and division. Paper-and-pencil measures taken pre and post of the noninstructional phases show an increase in performance in both operation areas.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of subtraction and division are shown below in figures 31 and 32 respectively. In the operation area of subtraction measures taken pre and post of instruction show a slight increase in performance from an average of 8.2 DPMC (s.d.= 1.9) during baseline one to 8.6 DPMC (s.d.= 1.6) during baseline two. During this same period her error rate increased from an average of 1.0 (s.d.= 1.2) to 2.9 (s.d.= 1.6) DPME. Measures taken before and after the noninstruction phase shows an increase in her performance from an average of 8.6 DPMC (s.d.= 1.6) in baseline two to 12.4 DPMC (s.d.= 3.4) in baseline three. Average DPME during this same period decreased from 2.9 (s.d.= 1.6) to 2.0 (s.d.= 1.2).

Baseline measures of student A14's performance taken pre and post to instruction in the operation area of division (baselines two and three) show an increase in average DPMC from 7.8 (s.d.= 2.3) to 12.2 (s.d.= 1.8). Average DPME increased from 4.4 (s.d.= 1.4) to 5.4 (s.d.= 1.8) during this same period. Computer measures taken pre and post of the noninstructional phase shows a decrease in average DPMC from 9.0 (s.d.= 3.9) during baseline one to 7.8 (s.d.= 2.3) in baseline two. Average DPME during this time increased from 2.2 (s.d.= 1.1) to 4.4 (s.d.= 1.4).

Hypothesis 4 is rejected for the operation area of subtraction. Computer measures taken pre and post to instruction do not show an increase in performance.

Hypothesis 4 is accepted for the operation area of division. Computer measures taken pre and post to instruction shows an increase in performance.

Hypothesis 5 is rejected for both operation areas of subtraction and division. Computer measures taken pre and post of noninstructional phases show increased performance in each of these operation areas.

Figure 72

Figure 73

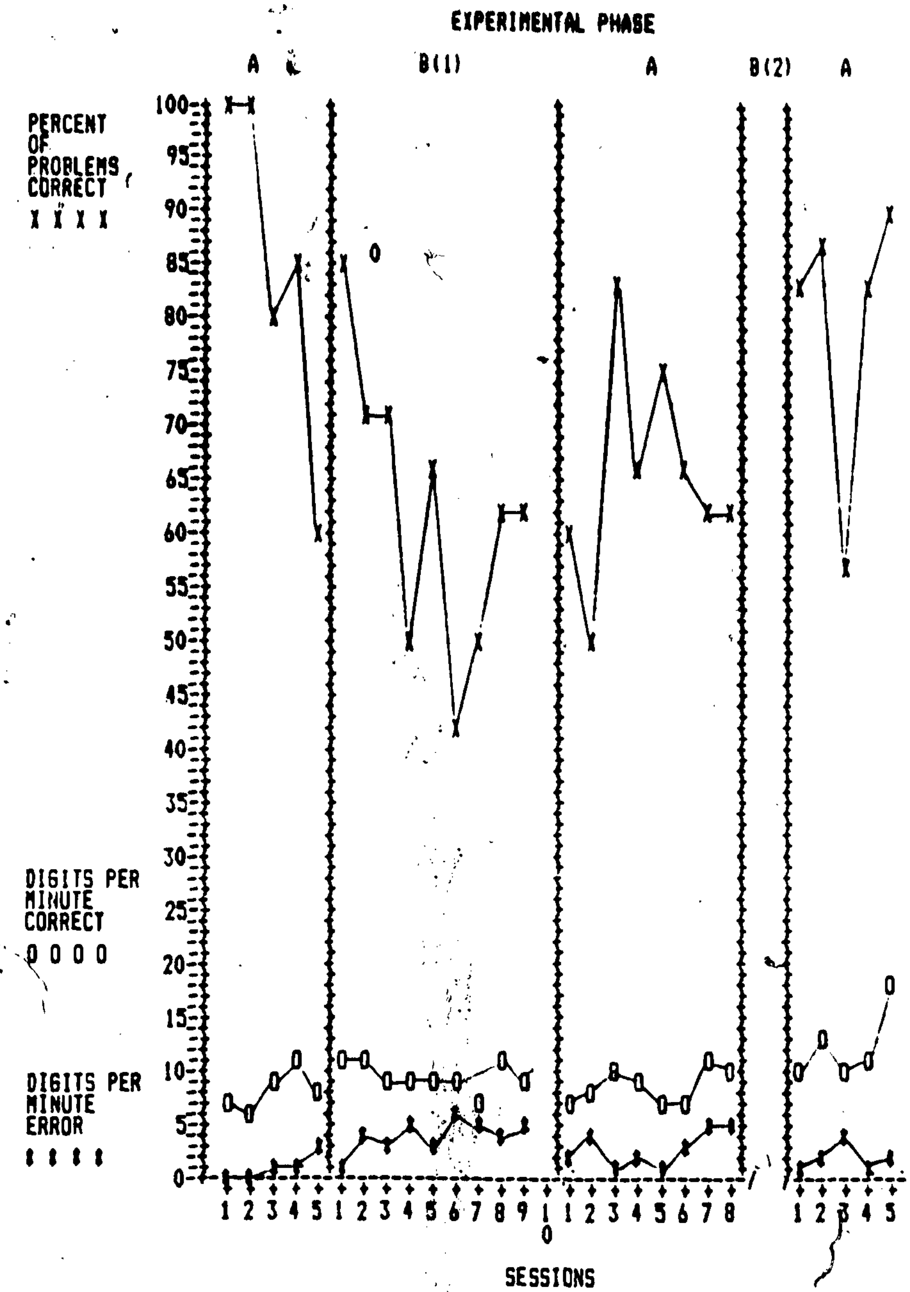

FIGURE 72 STUDENT A14
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = MEASURES IN SUBTRACTION WHILE
RECEIVING INSTRUCTION IN SUBTRACTION

B(2) = INSTRUCTION IN DIVISION
NO SUBTRACTION MEASURES TAKEN

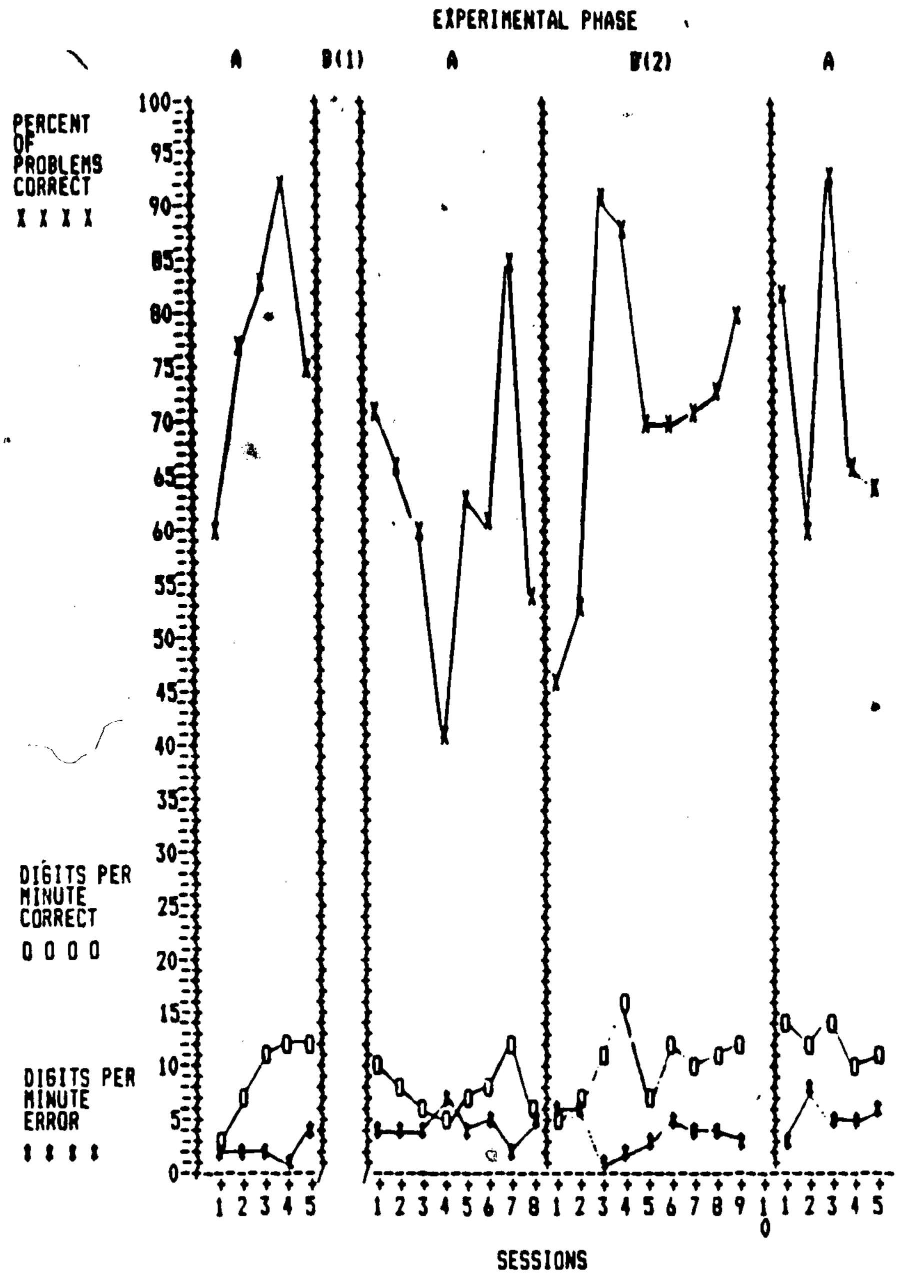

FIGURE 73 STUDENT A14
DIVISION PERFORMANCE

A = BASELINE MEASURES IN DIVISION

B(1) = INSTRUCTION IN SUBTRACTION
NO DIVISION MEASURES TAKEN

B(2) = MEASURES IN DIVISION WHILE
RECEIVING INSTRUCTION IN DIVISION

Student A15

Student A15 was a female aged 14 years 7 months with a measured full scale WISC-R score of 69. This student was assigned to receive computer instruction during the first and second instructional phases in division and subtraction respectively.

Hypothesis 1. Using the Stanford Diagnostic Math Test - Green Form this student obtained a standard grade equivalence score of 4.8 on the pretest and a 7.8 on the posttest. The positive change of 3.0 supports an acceptance of hypothesis 1 in that posttest standardized measures were higher than pretest measures.

Hypothesis 2 and Hypothesis 3. Paper-and-pencil measures of computation skill performance in the operation areas of division and subtraction were taken three times during the course of this study. This student's performance in each of these operation areas across each of the baseline periods is shown below in Table 44.

Operation Area	Measure	Baseline Period 1	2	3
Division	DPMC	17.0	26.0	17.0
	DPME	.5	.3	.2
Subtraction	DPMC	29.5	38.7	42.0
	DPME	1.5	.2	0.0

Table 44. Student A15 - Digits per Minute Correct (DPMC) and Digits per Minute Error (DPME) Baseline Paper-and-Pencil Measures in the Operation Areas of Division and Subtraction.

Student A15 received computer instruction in the operation area of division during the first instructional phase. A comparison of her performance during the baseline periods pre and post to this instructional period (baselines one and two) show both an increase of 53% in her DPMC, from 17.0 to 26.0, and a decrease in her DPME, from 1.0 to 0. During the instructional phase in which the student did not receive computer instruction in the operation area of division an analysis of baselines two and three shows DPMC decreased by 35%, from 26.0 to 17.0. DPME performance during this period remained at 0.

This student received computer instruction in the operation area of subtraction during the second instructional phase. Her performance during baselines two and three shows an increase of 9%, from 38.7 to 42.0 DPMC. During this same period her error rate decreased, from .2 to 0 DPME. No computer instruction was received in this operation area during the first instructional period. An analysis of performance during baseline periods one and two shows a an increase in her performance on the DPMC measure of 31%, from 29.5 to 38.7. DPME performance decreased by 87%, from 1.5 to .2.

Hypothesis 2 is accepted for the operation area of division. Paper-and-pencil measures taken pre and post of instruction show increased performance.

Hypothesis 2 is rejected for the operation area of subtraction. Paper-and-pencil measures taken pre and post of instruction show no change in performance.

Hypothesis 3 is rejected for both operation areas of division and subtraction. Paper-and-pencil measures taken pre and post of noninstruction phases show decreased performance in the operation area of division and increased performance in the operation area of subtraction.

Hypothesis 4 and 5. Computer baseline measures in the operation areas of division and subtraction are shown below in figures 33 and 34 respectively. In the operation area of division measures taken pre and post of instruction show an increase in performance from an average of 15.2 DPMC (s.d.= 3.0) during baseline one to 20.0 DPMC (s.d.= 3.2) during baseline two. During this same period her error rate increased from an average of 1.2 (s.d.= .7) to 1.5 (s.d.= .8) DPME. Measures taken before and after the noninstruction phase shows a slight decrease in her performance from an average of 20.0 DPMC (s.d.= 3.2) in baseline two to 20.6 DPMC (s.d.= 1.7) in baseline three. Average DPME during this same period decreased from 1.5 (s.d.= .8) to .6 (s.d.= .9).

Baseline measures of student A15's performance taken pre and post to instruction in the operation area of subtraction (baselines two and three) show an increase in average DPMC from 21.1 (s.d.= 1.7) to 26.6 (s.d.= 1.3). Average DPME increased from .3 (s.d.= .5) to .8 (s.d.= .8) during this same period. Computer measures taken pre and post of the noninstructional phase show an increase in average DPMC from 14.0 (s.d.= 6.0) during baseline one to 21.1 (s.d.= 1.7) in baseline two. Average DPME during this time increased, from 0 to .3 (s.d.= .5).

Student A15's performance in both operation areas of division and subtraction support an acceptance of hypothesis 4. Post instruction computer measures reflect increases in performance when compared to preinstruction measures.

Hypothesis 5 is accepted for the operation area of division. Computer measures taken pre an post of the non-instructional phase show no change in performance.

Hypotheis 5 is rejected for the operation area of subtraction. Computer measures taken pre and post of the noninstruction phase show incresed performance.

Figure 74

Figure 75

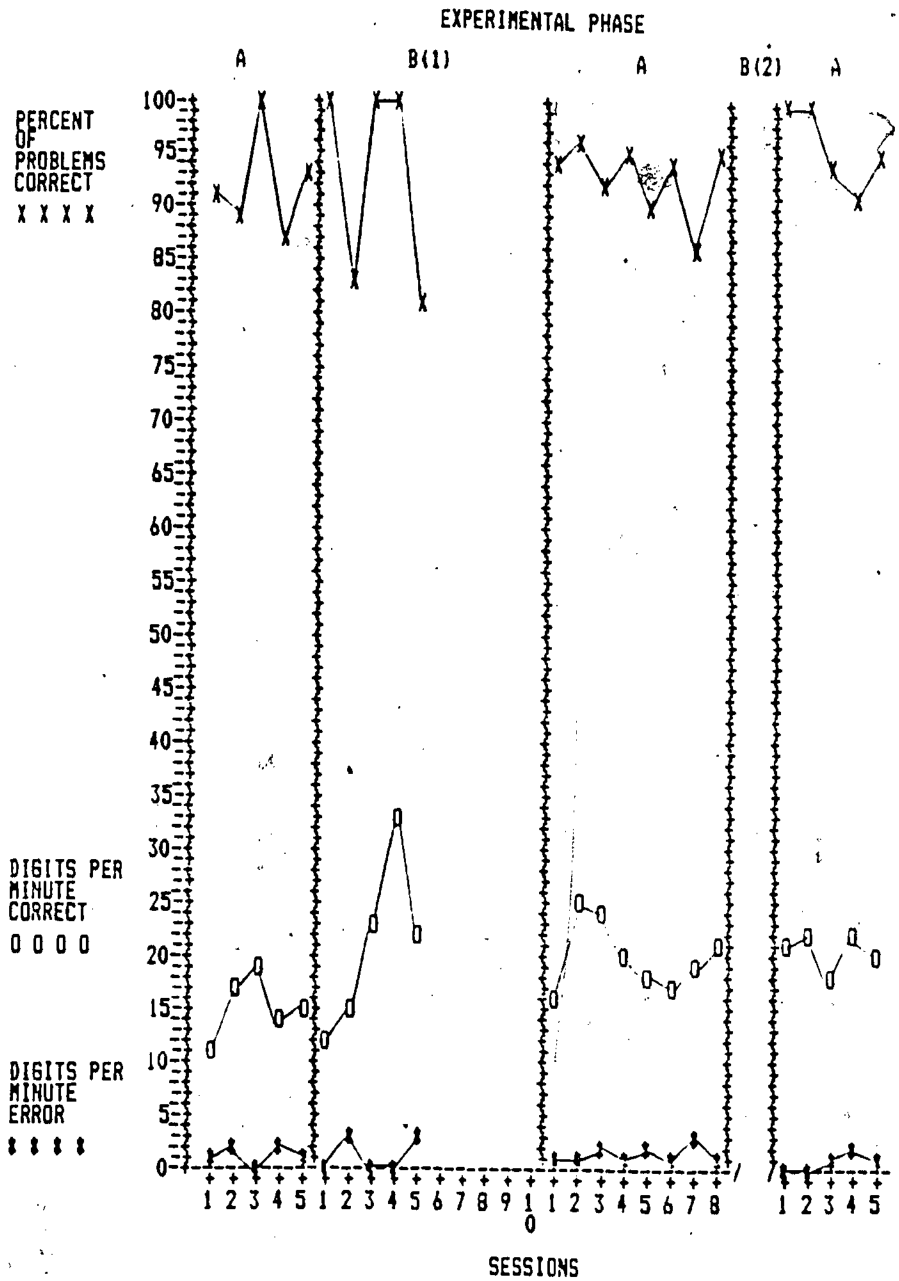

FIGURE 74 STUDENT A15
DIVISION PERFORMANCE

A = BASELINE MEASURES IN DIVISION

B(1) = MEASURES IN DIVISION WHILE RECEIVING INSTRUCTION IN DIVISION

B(2) = INSTRUCTION IN SUBTRACTION NO DIVISION MEASURES TAKEN

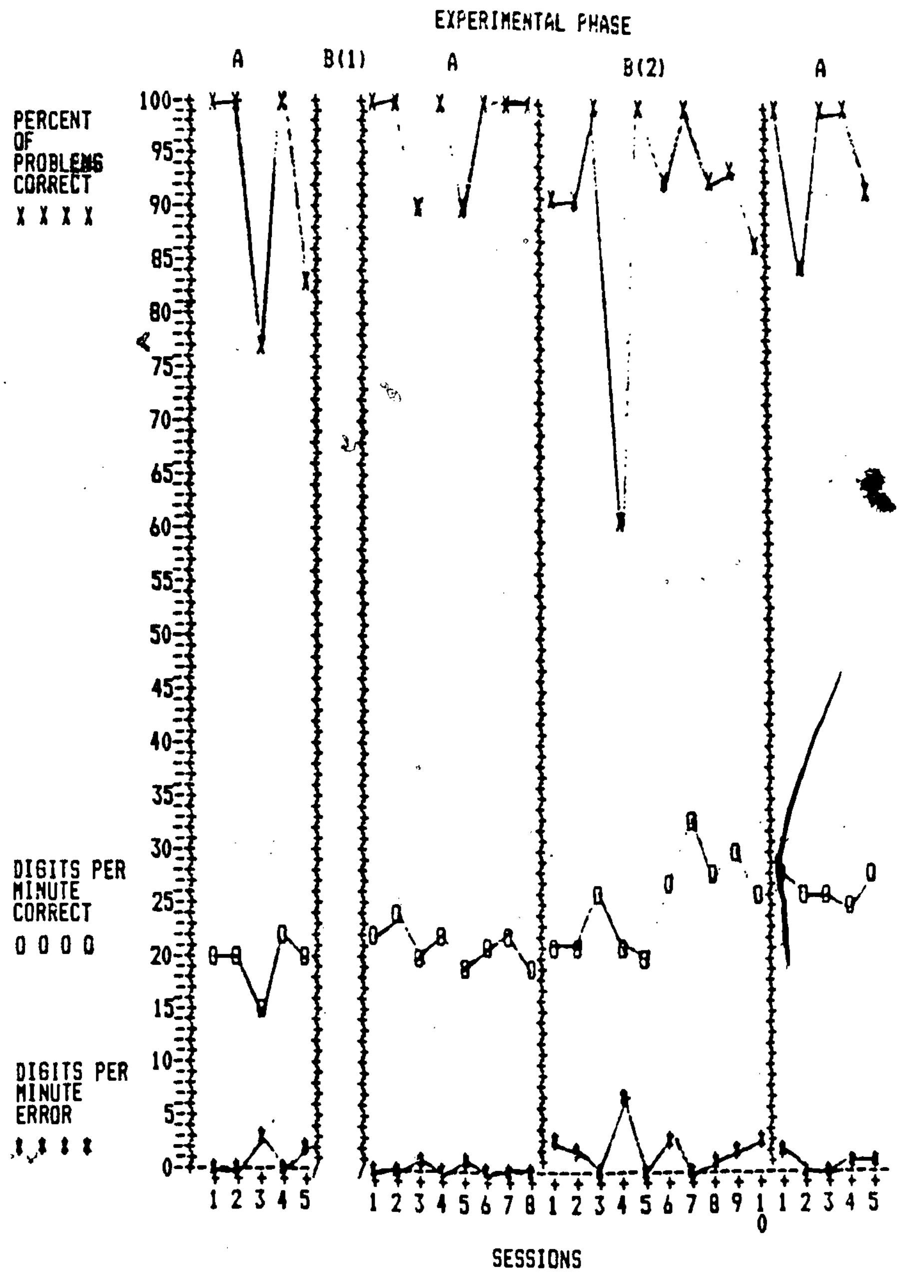

FIGURE 75 STUDENT A15
SUBTRACTION PERFORMANCE

A = BASELINE MEASURES IN SUBTRACTION

B(1) = INSTRUCTION IN DIVISION
NO SUBTRACTION MEASURES TAKEN

B(2) = MEASURES IN SUBTRACTION WHILE
RECEIVING INSTRUCTION IN SUBTRACTION

Section II - Group Analysis

The following section will present the results of this study using group analysis procedures. Since this study was primarily designed to test the effectiveness of a computer-based instructional program using single-subject design procedures (Baer et al., 1968; Kratochwill, 1978) the following analysis will by necessity be limited to intra-group repeated measures procedures (Winer, 1971).

Hypothesis 1 - Standardized Posttest Measures Will Be Higher than Pretest Measures

Individual student pre, post, and change standardized grade equivalence scores obtained on the Stanford Diagnostic Math Test - Computation Subtest (SDMT) (Beatty, et al., 1976) are listed below in Table 45.

A one-factor repeated-measures analysis of variance technique (Winer, 1971) was used to determine if student posttest scores were significantly higher than pretest scores. Results from this analysis (see Figure 76) support an acceptance of hypothesis 1 in that posttest scores were significantly ($F(1,13)= 10.23$, $p.< .01$) higher than pretest scores.

Student	Pre Measure	Post Measure	Change
A1	5.6	6.1	.5
A2	4.8	6.1	1.3
A3	3.6	4.5	.9
A5	2.6	5.4	2.8
A6	2.4	2.6	.2
A7	4.7	5.1	.4
A8	4.5	5.1	.6
A9	5.9	6.1	.2
A10	4.7	5.1	.4
A11	3.8	3.9	.1
A12	2.5	3.0	.5
A13	3.0	3.1	.1
A14	4.4	4.7	.3
A15	4.8	7.8	3.0
Mean	4.09	4.90	.81
s.d.	1.13	1.43	.94

Table Pre, Post, and Change Grade Eqivalence Scores Obtained on the Stanford Diagnostic Math Test - Computation Subtest

Source	SS	DF	MS	F
Between Students	37.33	13		
Within Students	10.36	14		
Time	4.56	1	4.56	10.23 **
Residual	5.80	13	.45	
Total	47.69	27		

* p.< .05
** p.< .01

Figure 76. Repeated, Measures Analysis of Variance of Pre and Post Stanford Diagnostic Math Test - Computation Subtest Scores.

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Hypothesis 2 - Paper-and-Pencil Posttest Scores Will Be Higher than Pretest Scores After Computer Instruction.

In this study there were two instructional periods, B(1) and B(2). During each of these periods students were instructed in one of two individually-assigned math operation areas. Math computation abilities in each of the assigned operation areas were measured pre and post of each instructional period. Therefore, three measures were obtained for each of the two assigned operation areas for each student, pre and post of instruction and pre and post of noninstruction. Individual student performance scores are shown below in Table 46.

	Instruction during period B(1)					Instruction during period B(2)				
	Experimental Periods					Experimental Periods				
Student	A	B (1)	A	B (2)	A	A	B (1)	A	B (2)	A
A1	22.5		33.5		29.2	24.7		24.0		26.7
A2	26.7		32.3		29.7	14.0		18.0		23.0
A3	16.6		19.3		26.0	16.0		27.7		36.3
A5	21.7		30.7		40.4	14.3		21.3		30.0
A6	7.7		16.7		16.7	21.3		32.1		30.4
A7	10.2		17.8		16.0	15.0		19.0		19.0
A8	24.6		32.7		36.0	20.2		30.7		27.0
A9	15.7		29.7		27.5	31.3		29.0		44.0
A10	20.6		19.0		22.3	15.0		13.0		7.0
A11						11.8		18.5		19.5
A12	27.4		38.7		38.4	10.2		14.5		18.4
A13						12.7		21.3		32.0
A14	11.0		18.3		19.8	10.0		13.0		14.0
A15	17.0		26.0		17.0	29.5		38.7		42.0
Mean	18.5		26.2		26.6	17.6		22.9		26.4
s.d.	6.5		7.7		8.5	6.9		7.8		10.5

Table 46. Paper-and-Pencil Baseline Measures Taken Pre and Post of Instruction and Non-Instruction. Digits per Minute Correct (DPMC).

Two one-factor repeated-measures analysis of variance procedures were used to test the effect of instruction on student paper-and-pencil performance. The measure used was digits per minute correct (DPMC). The first analysis used the pre and post measures for the first instructional period, B(1), and the second used the pre and post measures for the second instructional period, B(2). Orthogonal planned comparisons were used to test mean differences across repeated-measures. These results are presented in figures 77 and 78 respectively.

Source	SS	DF	MS	F
Between Students	1667.20	11		
Within Students	753.37	24		
Time	503.73	2	251.87	22.20 **
Residual	249.63	22	11.35	
Total	2420.57	35		

Planned Comparisons

Time 1 vs. Time 2	$F(1,22)$ =	31.76 **
1 vs. 3	=	34.76 **
2 vs. 3	=	.07

* $p < .05$
** $p < .01$

Figure 77. Repeated Measures Analysis of Variance of Paper-and-Pencil Performance in the Operation Area In Which Instruction Occured During Instructional Phase B(1). Digits Per Minute Correct.

Source	SS	DF	MS	F
Between Students	2343.98	13		
Within Students	1024.29	28		
Time	551.21	2	275.60	15.15 **
Residual	473.08	26	18.20	
Total	3368.26	41		

Planned Comparisons

Time 1 vs. Time 2	$F(1,26)$ =	10.98 **
1 3	=	29.84 **
2 3	=	4.62 *

* $p < .05$
** $p < .01$

Figure 78. Repeated Measures Analysis of Variance of Paper-and-Pencil Performance in the Operation Area In Which Instruction Occured During Instructional Phase B(2). Digits Per Minute Correct.

Hypothesis 2 is accepted. Pre and post instruction measures taken across two instructional periods support an acceptance of this hypothesis.

For the operation area in which instruction occured during the first instructional phase average post measures of 26.23 DPMC (s.d.= 7.65) were significantly higher ($F(1,22)= 31.76$, $p < .01$) than average pre instruction measures of 18.48 DPMC (s.d.= 6.54).

Analysis of student performance in the operation area in which instruction occured during the second instructional phase show similar results to those reported above. Average post measures of 26.38 DPMC (s.d.= 10.45) were significantly higher ($F(1,26)= 4.62$, $p < .05$) than pre measures of 22.91 DPMC (s.d.= 7.78).

Hypothesis 3 - Paper-and-Pencil Posttest Scores will be the Same as Pretest Scores After No Computer Instruction

The planned comparisons, of student performance over periods of noninstruction (reported above in Figures 36 and 37) show conflicting results. Measures taken pre and post of noninstruction for the operation area in which instruction occured during phase B(1) support this hypothesis. The mean score of 26.58 (s.d.= 8.54) obtained as a post measure was not significantly different ($F(1,22)= .07$, $p.> .05$) than the pre measure mean score of 26.23 (s.d.= 7.65).

For the measures taken pre and post of the noninstructional phase of the operation area in which instruction occured during instructional phase B(2), significant differences were found ($F(1,26)= 10.98$, $p.< .01$). The premeasure mean was 17.57 (s.d.= 6.85) and the postmeasure mean was 22.91 (s.d.= 7.78).

Therefore, hypothesis 3 is rejected.

Hypothesis 4 - Computer Posttest Scores Will Be Higher than Pretest Scores After Computer Instruction

Computer measures taken during the three baseline periods on each of the two math operation areas in which students received instruction in are shown below in Table 47.

Student	Instruction during period B(1): Experimental Periods A	B (1) A	B (2) A	Instruction during period B(2): Experimental Periods A	B (1) A	B (2) A
A1	10.0	17.2	15.5	11.8	12.5	22.3
A2	14.6	19.1	17.6	8.4	12.9	15.6
A3	9.0	12.8	14.7	15.0	15.8	21.4
A5	9.2	15.5	15.0	6.6	9.1	8.8
A6	7.0	11.3	10.7	15.4	16.1	19.4
A7	5.8	12.3	9.0	12.0	13.4	16.2
A8	9.2	15.1	23.2	9.5	10.8	22.8
A9	11.8	12.7	16.8	20.6	22.0	29.4
A10	13.8	22.9	21.4	6.2	8.3	14.4
A11				4.8	6.9	8.4
A12	11.2	17.8	14.4	10.2	10.9	13.8
A13				8.8	10.6	12.8
A14	8.2	8.6	12.4	9.0	7.8	12.2
A15	15.2	20.0	20.6	19.4	21.1	26.5
Mean	10.4	15.4	15.9	11.3	12.7	17.4
s.d.	2.98	4.12	4.27	4.79	4.66	6.39

Table 47. Computer Measures Taken Pre and Post of Instruction and Non-Instuction. Digits per Minute Correct (DPMC).

Two one-factor repeated-measures analysis of variance procedures were used to test the effect of instruction on student computer performance. The measure used was digits per minute correct (DPMC). The first analysis used the pre and post measures for the first instructional period, B(1), and the second used the pre and post measures for the second instructional period, B(2). Orthogonal planned comparisons were used to test mean differences across repeated-measures. These results are presented in figures 79 and 80 respectively.

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Source	SS	DF	MS	F
Between Students	386.41	11		
Within Students	322.85	24		
Time	224.10	2	112.05	24.96 **
Residual	98.75	22	4.49	
Total	709.25	35		

Planned Comparisons

Time 1 vs. Time 2	$F(1,22)$ = 33.75	**
1 3	= 40.81	**
2 3	= .33	

* $p. < .05$
** $p. < .01$

Figure 79. Repeated Measures Analysis of Variance of Computer Performance in the Operation Area In Which Instruction Occured During Instructional Phase B(1). Digits Per Minute Correct.

Hypothesis 4 is accepted. Pre and post instruction measures taken across two instructional periods support an acceptance of this hypothesis.

For the operation area in which instruction occurred during the first instructional phase, average post measures of 15.44 DPMC (s.d.= 4.12) were significantly higher ($F(1,22)$= 33.75, $p. < .01$) than average pre instruction measures of 10.42 DPMC (s.d.= 2.98).

Source	SS	DF	MS	F
Between Students	1012.30	13		
Within Students	391.67	28		
Time	292.23	2	146.12	38.21 **
Residual	99.44	26	3.82	
Total	1403.97	41		

Planned Comparisons

Time 1 vs. Time 2	F(1,26) =	3.74
1	3	= 69.71 **
2	3	= 41.17 **

* p.< .05
** p.< .01

Figure 80. Repeated Measures Analysis of Variance of Computer Performance in the Operation Area In Which Instruction Occured During Instructional Phase B(2). Digits Per Minute Correct.

Analysis of student performance in the operation area in which instruction occurred during the second instructional phase show similar results to those reported above. Average post measures of 17.44 DPMC (s.d.= 6.39) were significantly higher (F(1,26)= 41.17, p.< .01) than pre measures of 12.69 DPMC (s.d.= 4.66).

Hypothesis 5 - Computer Posttest Scores Will Be the Same as Pretest Scores After No Computer Instruction

The planned comparisons of student performance over periods of noninstruction (reported in Figures 79 and 80) support an acceptance of this hypothesis. Measures taken pre and post of non-instruction for the operation area in which instruction occurred during instructional phase B(1) show a mean posttest score of 15.94 (s.d.= 4.27) obtained as a post measure not significantly different (F(1,22)= .33, p.> .05) than the pre measure mean of 15.44 (s.d.= 4.12).

Pre and post measures of noninstruction taken on the operation area in in which instruction occurred during instructional phase B(2) were also non significant (F(1,26)= 3.74, p.> .05.). The mean for the pre measure was 11.26 (s.d.= 4.79) while the post measure mean was 12.69 (s.d.= 4.66)

Hypothesis 6- Pre-Post Change Scores Will Correlate Highly With Total Time of Computer-Instruction

During this study a total of 50 minutes was allocated to each student for computer instruction in each operation area assigned to them. Due to school absences, scheduling difficulties, and other (unknown) reasons all students did not participate in computer instruction for the entire time allocated. Total student instruction time ranged from 25 to 100 minutes with a mean of 82.5 (s.d.= 18.25). The wide range in total time is largely accounted for by the two students who did not participate in computer instruction during the first instructional phase. Across instructional phases average student time spent receiving instruction were fairly equivalent, with an average of 40.42 (s.d.= 8.38) minutes during instructional phase B(1) and 47.86 (s.d.= 3.78) minutes during instructional phase B(2).

Tables 48 and 49 list the total time each student received computer instruction as well as change scores for each of the major measures used during instructional phases B(1) and B(2) respectively.

Hypothesis 6 is rejected. Results of correlations of Digits per Minute Correct (DPMC) change scores and computer instructional time are shown below in table 50.

Correlations of student perforamance change scores on each of two measures used in this study were essentially 0 during the first instructional phase. During the second instructional phase correlations were negative for both the DPMC paper-and-pencil and DPMC computer performance measures.

Student	Instruction Time	DPMC Change Score: Computer	DPMC Change Score: Paper & Pencil
A1	35	7.2	11.0
A2	45	4.5	5.6
A4	45	3.8	2.7
A5	50	6.3	9.0
A6	40	4.3	9.0
A7	50	6.5	7.6
A8	30	5.9	8.1
A9	35	.9	14.0
A10	35	9.1	-1.6
A12	50	6.6	11.3
A14	45	.4	7.3
A15	25	4.8	9.0
Mean	40.42	5.03	7.75
s.d.	8.38	2.51	4.10

Table 50. Average Time Received Computer Instruction and Digit per Minute Correct (DPMC) Change Scores for Instructional Phase B(1).

Student	Instruction Time	DPMC Change Score	
		Computer	Paper & Pencil
A1	40	9.8	2.7
A2	50	2.7	5.0
A4	50	5.6	8.6
A5	50	-.3	8.7
A6	50	3.3	-1.7
A7	50	2.8	.0
A8	50	12.0	-3.7
A9	45	7.4	15.0
A10	50	6.1	-6.0
A11	50	3.4	1.0
A12	40	2.2	13.9
A13	45	4.4	10.7
A14	50	5.5	1.0
A15	50	1.5	3.3
Mean	47.86	4.60	3.46
s.d.	3.78	3.45	5.78

Table 48. Average Time Received Computer Instruction and Digit per Minute Correct (DPMC) Change Scores for Instructional Phase B(2).

DPMC Measure	Instructional Phase B(1)	Instructional Phase B(2)
Paper-and-Pencil	.04	-.32
Computer	.02	-.24

Table 49. Correlations of Digit per Minute Correct (DPMC) Paper-and-Pencil and Computer Change Scores With Number of Minutes of Computer Instruction During Each of Two Instructional Phases.

DISCUSSION

Summary of Results

Student data were analyzed individually and as a group. The following discussion will delineate the degree of correspondence between these two methods of analysis. Within this discussion findings for each hypothesis proposed in this study will be reviewed and summarized. In addition, an attempt will be made to reconcile conflicting results where they occur.

Hypothesis 1. Analysis of individual student performance shows that standardized posttest measures were higher than pretest measures for 12 out of the 14 subjects. The 2 students for whom hypothesis 1 was not accepted completed only 1 out of the 2 instructional phases, e.g., they received only half of the assigned instruction.

The criterion for acceptance of this hypothesis was that the student must have attained a minimal gain of .2 grade levels (2 months) over the course of the study. This would be an expected gain for normal children. The students in this study, however, ranged from 3-5 years below grade level in math computation skills. Performance at expectancy level is thus for them a dramatic gain on this measure. In addition, since all students in this study demonstrated increased performance on this measure the possible confounding influence of the SEM associated with this measure is decreased. These data indicate that the math remediation instructional package designed for this research was effective in raising standardized test scores for the mildly mentally handicapped junior high school students included in this study.

A repeated measures analysis of variance on group pre and post standardized test scores supported the finding of the summative analysis of individual performance. That is, significant gains in scores were found.

Hypothesis 2. An analysis of individual student performance on paper-and-pencil posttest scores after receiving computer instruction shows that 12 of the 14 students completed two instructional phases, producing 24 trials or possibilities for performance gains for this hypothesis. The remaining 2 students completed only one instructional phase each, adding 2 additional trials. Hypothesis 2 was accepted in 20 out of the 26 trials and rejected for the remaining 6 trials. These data suggest that for most of the students, the instruction was effective in the operation areas for which instruction was provided. It further suggests that the computer-based instruction generalized to the paper-and-pencil medium. Differences in significance levels for the group data across instructional phases is congruent with the summative individual results, both show a stronger positive gain for the first instructional phase.

Of the 6 rejections of this hypothesis, 5 occurred during analysis of instructional effect on the operation area taught during the second instructional phase. Of these

5, 4 of the students demonstrated high gains in their second operation area during the first instructional phase, when they were receiving instruction in a different operation area. These data suggest that there may be a generalization of skill acquisition across operation areas. That is, while being taught one operation area another improves simultaneously. An additional possibility is that the frequent assessment necessitated by the study's design had an instructional effect and could account for at least part of the gain before instruction in the second operation area.

A third explanation of the differences in effectiveness of the computer instruction across instructional periods may be found in an analysis of individual performance within specific operation areas in which instruction occurred. Correlations of computer measures with paper-and-pencil measures (see Table 49 - Appendix D) for each student in the operation area for which instruction occurred indicates that student performance seems to have generalized from computer instruction to paper-and-pencil measures highly when the operation area in which instruction occurred was subtraction, addition, or multiplication. When students received instruction in the operation area of division, however, the correspondence between measures was consistently low. Since the majority of students received instruction in division during the second instructional phase and the group based statistical analysis did not control for differences in operation areas, differences in individual student correlations between computer and paper and pencil measures may be a function of difficulty level of the instructional content rather than time in instruction.

Hypothesis 3. Following the first instructional phase, posttest paper-and-pencil measures indicated no change in student performance from pretest paper-and-pencil measures in the operation area in which no instruction was received. Following the second instructional phase, significant differences were found in the noninstruction operation area. These data are congruent with the results discussed for Hypothesis 2.

Hypothesis 4. Results evaluating hypothesis 4 suggest that the computer instructional program was effective in producing computer performance gains for the students included in the study. Group-based analysis of variance was significant for each instructional phase at the .01 level. These results are congruent with the summative individual data for this hypothesis: 12 students completed two instructional phases and 2 completed only one phase, making a total of 26 trials for this hypothesis. Out of these 26 trials, the hypothesis was accepted for 23, rejected for only 3.

Hypothesis 5. Analysis of individual student data resulted in the rejection of hypothesis 5 for 21 out of the possible 26 trials. Computer posttest scores were not the same a computer pretest scores when instruction was not received. Eight of the rejections of this hypothesis occurred during the first instructional phase, 13 during the second. Of the rejections which occurred during the second instructional phase, 9 were rejected for performance gains and 4 for performance decreases. Group-based analysis of variance results for Hypothesis 5 show no significant difference for noninstructional phases.

This conflict in results is probably indicative of the variance in the individual data. Since this hypothesis was not directional, predicting neither gains or losses, individual student analysis was more conservative than group based analysis. That is, the individual student analyses rejected this hypothesis because of both gains and losses while the group based statistic may have been influenced by a "regression to the mean" effect, or a leveling of data due to inconsistency in the direction of individual deviation scores.

Hypothesis 6. Analysis of group data indicate that posttest change scores did not correlate highly with total time of computer instruction. Hypothesis 6 was rejected. Negligible correlations were obtained for both paper-and-pencil and computer measures for the first instructional phase. Strong negative correlations of .32 and .24 were obtained on the measures for the second instructional phase. Thus, this analysis seems to provide evidence for the fatigue effect discussed in hypothesis 2. The negative correlations for the second instructional phase could also be, however, to variance in the effectiveness of the

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instructional phase itself as indicated by the relatively high standard deviation obtained on the mean change scores. In addition, the relatively small amount of variance in instructional time across subjects during the B(2) phase make correlational analysis highly susceptible to error when those scores are correlated with scores with a small standard deviation.

Problems in the Measures

Computer Measures. The computer measures consisted of a random selection of problems which represented those in the operation clusters and skills. In this study the computer measures were taken for one minute at a time. During the course of one minute, an adequate sample of problems may not have been generated. This problem may have caused some of the variance in daily scores obtained during baseline periods.

In addition, each of the one minute baseline tests were made up of a random sample of problems selected from all skill clusters within the tested operation area. This study provided instruction in two operation areas for a maximum of 50 minutes in each. Student performance during instruction may not have allowed them to receive instruction in higher level skill clusters since progression was entirely dependent on performance during instruction. Although the magnitude of change scores was highly variable, the overall positive direction of change across students suggests a highly effective instructional program.

Pencil-and-Paper Measures. The paper-and-pencil measures consisted of one-minute tests for each operation cluster. The score used for analysis of operation area performance was the average of all of the cluster tests from that operation area. (The number of clusters varied across operation areas.) Student gains within individual clusters may not have been reflected adequately in the average scores. Again, as noted above, opportunity for instruction in higher level skill clusters was dependent upon performance during instruction which was highly variable across students.

In summary, problems in measurement can be classified into three distinct areas: practice effect; skill sampling; and across student variance in opportunity to learn. The practice effect problem is primarily a feature of the research design used in this study. Future investigations should limit opportunities for students to practice operation area skills during times they are not receiving instruction in that skill.

Possible skill sampling problems during computer tests can be controlled by two different methods. First, the testing session can be extended to a time limit longer than one-minute. This would allow more opportunities for the randomization of problems presented to sample all inclusive skills. Second, instead of determining the rate measure by holding time constant with the number of problems attempted varying, which would limit the number of opportunites to respond, the number of problems could be held constant while time for completion varied. This would assure adequate representation of skills during each test.

The computer-based math remediation program developed for this study seemed to be effective for most students. The wide variance in student gains would seem to suggest a differential effectiveness of the program with children of varying instructional needs and entry levels. Unfortunately the demographic variables collected on the students in this study were not predictive at all of performance. Table 21 (see Appendix D) summarizes correlational analyses calculated using performance change scores with student I.Q. scores and standardized entry level skills.

These results indicate that the differential effect of the computer instruction cannot be accounted for by entry skills and abilities measured in this study. Individual student measured intelligence as well as entry level math grade equivalence scores are not predictive of success in the computer instructional program.

Future Research Implications

Overall, the program was highly effective with a group of students who had demonstrated difficulty in the math operation areas of the instructional package. This success is dramatic when considered against the students' previous failure to learn over a period of years. These data suggest tremendous potential for computer instruction for exceptional children.

The computer-managed instruction literature demonstrates the capability of the computer to perform a variety of instructional tasks effectively. It also demonstrates the effectiveness in CMI of individual learning principles outlined by Carr and others. The literature does not, however, examine the effectiveness of Carr's learning principles when combined as a cohesive model of instruction, e.g., no previous CMI package has incorporated these principles and tested the effectiveness of the model as a whole. This was the goal of this pilot study.

This research has demonstrated the effectiveness of the math remediation instructional package developed for it. Now that the model as a whole has been evaluated successfully, the instructional variables within the model can be systematically varied to test for and optimize their effectiveness. The interrelationships between variables can also be tested. The following variables can be varied to test the components of the instructional program designed for this research.

Organization of Content. This instructional package essentially used Crowder's "scrambled book" approach for organization of assessment and remediation. The linear approach was used for assessment; the branched model was used for remediation. Although comparisons of linear and branched programmed learning experiments using books and mechanical teaching machines have been made, no comparable research comparing these methodologies has been reported using computer-based instruction. The "scrambled book" approach has been demonstrated in this pilot to be effective. The instructional program used in this study was designed to allow the "branching" procedure to be not used. If this option is used, the program will instruct students using a pure "linear" model. That is, all students will have to demonstrate proficiency in each of the skills. No cluster assessment or error diagnosis would occur. Would this be more effective? Or is the individualization of remediation in the branched model more efficient?

<u>Analysis of Error Patterns</u>. After this package has been tested on more subjects, a considerable data bank of error patterns in arithmetic problems could be collated and analysed. This analysis might yield areas in which many children have common problems. For example, many children might find multiplying by 8 especially problematic. Remediation in these identified problem areas could then be emphasized in the instructional package. Are there generalized areas of difficulty across students? Would such information and subsequent "forced" remediation make the package more effective with more children? Or is branching into individualized remediation most effective?

<u>Feedback</u>. Carr posits that immediate knowledge of results for each response and frequent knowledge of results keeps students working (Principles 3 and 5). Previous research has demonstrated the effectiveness of feedback in computer-based instruction. The three kinds of feedback used in this research were: immediate knowledge of results,

end of session summary of results, and a cumulative record of performance. Would deletion of any or all three of these kinds of feedback affect performance?

The immediate feedback in this research consisted of a 2-second visual display. Would varying the length of presentation affect effectiveness? Would a longer presentation, for example, be more effective with mildly mentally handicapped students and a shorter presentation more effective with higher-functioning students?

Are there effective patterns of varying duration of feedback? For example, would short bursts of feedback during a unit be more effective if followed by a longer, more detailed presentation of results?

Computer-based instructional programs may be used with a wide range of students, especially in special education classrooms. Individualization of feedback patterns might be most effective when working with exceptional students. If so, would teacher control of feedback duration and frequency allow the optimal feedback flexibility? Or would it offer little or no advantage over preset patterns?

Setting Criterion Levels in Student Assessment. The use of criterion levels for student performance assessment has been used quite extensively in computer-based instruction. Unfortunately, a rationale or reason for choosing criterion levels is conspicuously missing in every computer-based instruction study reviewed. In this research, criterion levels were set arbitrarily according to performance levels on standardized test measures. The next research step would be to randomly assign criterion levels to students with equivalent entry skills.

External Contingencies. Much of the computer-managed instruction literature does not specify whether or not external contingencies were used. None were set for this study. This lack of external accountability may account in part for the wide fluctuations in daily performance. Would the use of external contingencies such as grades decrease this fluctuation? Would they help to optimize effectiveness of the program?

Time on Machine. The computer-managed instruction literature does not address the question of how long students should work on the computer at any given session. The five-minute sessions used for this study appeared to be effective. Would ten-minute sessions increase learning? Should younger students work for shorter sessions than older ones? Should length of time on the machine vary for exceptionality types?

Modeling of Correct Response. In this study, a modeling of the correct response was presented after a student missed a problem twice. Would it be more effective to model the correct response after 1 error?

SUMMARY AND CONCLUSIONS

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The purpose of this project was to develop, implement and evaluate efficient and systematic data management and information systems utilizing microcomputers to provide resource room teachers of mildly handicapped secondary school pupils with up-to-date daily records of appropriateness of instruction and the progress of individual students to facilitate instructional decision-making. The project attempted to develop a low cost method of collecting, summarizing, and storing data necessary for fulfilling requirements of special education practices mandated by 94-142. It was hypothesized that if teachers were supplied with necessary microcomputer hardware and software and provides with appropriate training in their application that this would enable them to improve their planning and decision-making in programming students. It was also anticipated that the microcomputer technology would avail more time for teachers to provide direct instructional time to student's academic learning time.

To meet the objectives of the project, several microcomputer software systems developed earlier were employed. One (CIMS) involved a microcomputer-based IEP system that housed each student's individual instructional objectives and enough memory to allow teachers to make daily entries regarding the progress of students on these. This program was designed to serve as a daily prompt to teachers to focus upon using student performance data for evaluating their progress relative to stipulated long-range and short-range educational objectives. Teachers had only to enter student's daily progress data (e.g., scores on papers, results from tests, grades on materials, rates on criterion-referenced exams) into the machine regarding each short-range objective and the instructional materials used in order to maintain computer records--the information and effort required was no more than that ordinarily recorded by traditional pencil and paper methods. Demographic and test information on each student was also stored on the machine to further simplify record-keeping by the teacher. Printed summaries of all records were available to the teachers. Moreover, to avoid duplication of efforts on standard written forms, these records served as the standard IEP for the project teachers. In short, every effort was made to shape teacher behavior to use the computer for daily lesson planning, to review and evaluate computer-compiled data on student performance, to base programming decisions upon computer-based data, and to use the computer for updating IEP's.

In addition to the IEP system, teachers were also given access and trained to use two academic software programs: a reading assessment and progress evaluation program (CIRIS) and a math assessment and tutorial program (CMMRS). Both of these programs automatically collected and summarized student assessment and progress information in reading and math and provided hard copy output for incorporation into IEP's. Teachers were given training in the interpretation of data generated from these programs for planning and decision-making.

Teachers were also given and trained to use a computer-based readability indexing system (CRIS) that enabled them to provide a quick method of determining the reading level and appropriateness of reading assignments for their students. This program was also interfaced with the reading assessment (CIRIS) program to allow teachers to develop their own computer-based reading assessment and student monitoring programs.

Another major goal of the project thus involved determining the extent to which teachers would use these programs and, ultimately, the effect the program would have on changing teacher practices and improving student's achievement scores.

The data collected during the first year of the project clearly indicated that teachers can use the microcomputer to record, and monitor student academic performances and to use these data for planning instructional programs. More importantly, in classrooms where teachers performed these tasks and used the microcomputer for providing instruction resulted in significant gains in student achievement. However, incorporating microcomputer technology into special education practices appears no simple matter. In the school system where microcomputer-based IEP's were adopted as a system-wide practice, teachers were able to use this technology for meeting goals outlined in the project. Replication of procedures and attempted adaptation of the system to other school districts, however, indicated that the teacher's sustained use of the microcomputer technology may be affected by variables other than mere availability and training.

Informal observation and interview data collected from teachers who volunteered during the second and third year of the project indicated that they made daily programming decisions rapidly, based upon random observations of student performance. For the most part, they did not evaluate student progress on educational objectives on a regular basis or have a systematic plan for instructional short-range objectives. From interviews and informal observations we conclude that teachers typically based their evaluations of student's progress on instructional objectives primarily upon the passage of time rather than upon student performance. For example, we found that teachers consistently placed students in increasingly difficult academic material regardless of whether the students had mastered the preceeding content. Once an instructional material was selected, the teachers typically had the student proceed sequentially through the material regardless of student's performance. This pattern of haphazard planning continued when the teachers began using CIMS. We found, however, that when video screen prompts, which informed teachers of student failure to meet mastery criteria and inquired also whether the teachers wanted to assign alternative activities and materials before proceeding to more difficult material, were added to the software, some teachers began to use student performance data to develop suceeding lessons. The data also indicated that teachers who worked in school districts that did not require systematic record keeping and student districts that did not require systematic record keeping and student performance monitoring, were not motivated to use CIMS, software for planning and for tracking student's academic progress primarily because of the time required and the lack of interest in data-based decision making on behalf of Case Conference Coordinators and Administrators. They therefore discontinued using CIMS once they had initially tried it.

This finding was not unexpected. Since none of the four participating school districts initially required teachers to maintain systematic records of student academic performance and since the CIMS required teachers to allocate time to record and to monitor student performance, this activity was more an unrewarded onus than a boon to efficiency. Because teachers volunteered to participate in the project, they were willing to reallocate their time to trying the CIMS program. When they began using CIMS, they reorganized their planning periods and some after school hours to perform the data entry and planning activities. However, at the end of the school year when they interviewed, they candidly admitted that there was no recognition nor incentives provided by the school system for engaging in these additional activities. While they admitted that the program appeared beneficial, it was not worth the additional time and effort since it was not included among the school district's required activities and since they already had no direct experience indicating that these practices resulted in student gains.

Once the school system adopted CIMS as part of their data management regimen, the teachers complied with the request to use the system. Two school districts which participated in this project were sufficiently experimental to perceive the benefits of the systems and to adopt them. Once the systems opted to adopt the system, the frequency of teacher use increased. This type of commitment appears essential if teachers are to collect and use data for instructional decision-making. In both cases, the school systems underscored their commitments by purchasing hardware so that teachers had adequate access to the machines and provided appropriate inservice training programs to train teachers specifically to use CIMS and to demonstrate how such record keeping systems could enhance the efficacy of instruction and streamline the record keeping requirements during the second and third year of the project.

On the other hand, teachers much more readily accepted and used CMMRS, CIRIS. The CMMRS and CIRIS programs required simply that the teachers turn on the microcomputers and schedule students. These software programs administered, scored, and prepared reports of student performance. Thus, these were low effort programs that freed the teacher to interact more freely with other students while the computer tutored the student and kept copious records of student performance. The CRIS allowed teachers to determine the reading level for their students, and thus select appropriate instructional materials.

During the course of the project, we systematically studied the effects of CMMRS on student achievement. We found basically that although the CMMRS was the most used program, teachers for the most part made little use of it. During the second year, one teacher who attempted to use the program actually had children using the machine an average of one minute per day over the school year. For the third year, children used the machine an average of only five hours per year per classroom. These results gave far too little data to draw any conclusions regarding teacher use of microcomputer software. To more intensively evaluate the effects of computer software, we conducted an intensive study to analyze the impact of CMMRS on the math achievement. This study involved a sample of mildly handicapped middle school students who were between 3 and 5 years below grade level in their math computation skills. We found that when the program was assiduously implemented, it contributed to significant increases in student achievement as measured by computer and paper and pencil norm criterion referenced measures.

While analyzing the data, we also found that postest change scores on the norm-referenced measures did not correlate highly with the total time spent on the computer-based instruction. In addition, we found virtually the same low order correlation between student achievement and time on computer when we analyzed the data collected by the Monroe County Teachers during the second and third years. These data suggest the need for additional studies designed to identify optimal amounts of instructional time that correlate highly with student success. On the surface, they suggest that the extra time spent using the microcomputer may not necessarily produce corresponding student academic growth. The second year data collected at Edgewood Middle School demonstrated clearly that time spent on additional drill and practice by students who have learned certain higher level math skills correlates negatively with student achievement. However, as previously indicated, the lack of the teacher utilization of the program does not allow us to clearly evaluate the effectiveness of microcomputer software.

Our data indicate several paradoxes. While considerable discourse has been conducted concerning the potential effectiveness of microcomputers for several education classrooms, and despite the enthusiasm of our teachers related to the use of microcomputers, and although we made available microcomputer hardware and software, we were not able to promote teacher use of the machine or to sustain the use of student instruction to any significant degree. This was in part due to the limited amount of software to which the teachers had access. Specifically, the teachers only had access to the four pieces of software evaluated during the project. A factor that undoubtedly limited overall use. Such limited data tend to question the myth of the microcomputer as an instructional panacea. As with any type of instruction, the microcomputer must be used judiciously. In cases where teachers use it as an electronic worksheet whose content is clearly below the academic functioning level of the student, results appear similar to those found with students assigned to inappropriate paper and pencil tasks. Informal observations suggest that this may ve a widespread abuse of the microcomputer.

On the other hand, data collected indicate that when the teacher carefully uses the CMMRS assessment data and develops an appropriate program that includes the microcomputer-based instructional programs in the overall math instructional program, student achievement increases quite rapidly. A primary example was found in results from the program at Arlington High School. In this program, the teacher systematically assessed the students and carefully planned amath program that featured computer-based and teacher and paper and pencil instruction for qualified students. The pre-post test comparisons show clearly that the students made statistically significant achievement ganins.

The CIRIS Program was used extensively by teachers at first to screen student reading assignments. These data were then used for planning student instructional programs. They were also useful in informing the teacher of the students general level of reading proficiency so that they could place the students appropriately in the texts for other subject areas. This was also a low response cost program since the teacher simply had to turn on the machine, provide the student with a disc. The software did the rest including administering the informal reading inventory and comprehension items, scoring and profiling the student response patterns, and preparing the report.

As with CMMRS, however, the CRIS program was used selectively by the teachers. In many cases, this program was used extensively by other teachers housed in the building with special education teachers. For example, in one building, the program was used extensively by a librarian so that she could provide handicapped children with interesting books that they could read. In contrast, the data indicate that teachers reported that they used the data to monitor the readability of materials assigned to handicapped students. In addition, given the highly variable nature of the readability of sections of the multiple texts assignd to handicapped students, teachers face a formidable task of compiling the readability data necessary to analyze the myriad of texts which are assigned to the students.

The project also produced a telephone-based data transmission scheme. The system involved using on-site microcomputer systems to provide the primary interactive user interfact for the daily collection and retrieval of teacher and student data. The centrally located time-sharing computer system provided the facility with storage of large masses of IEP objectives. Such a central storage facility allows periodic transfer of collected data from each microcomputer site and permites project access into an integrated database for overall data analysis and summary evaluation requirements. Such a prototype possesses vast potential for school systems wanting to establish integrated instructional and data-based managment systems. Stand-alone microcomputer systems will not enable school systems to accomplish this necessary task. They must establish more sophisticated systems that allow for networking capability.

To a large extent, this project has succeeded in generating more research questions than it has answered. However, it is apparent that some of the findings are important since they support some of the utilitarian functions of microcomputer as data management and instructional devices. The data also suggest that we must proceed carefully since the indiscriminant use of microcomputers may not improve instruction and, in some cases, it may inhibit student achievement. In addition, the findings from this project suggest that placing microcomputer software in special education classrooms and providing training to teachers in the use of these does not necessarily ensure that this technology will be used for providing student instruction. The infusion of microcomputer technology into special education practices appear to require careful attention and planning, staff training and modification of administrative practices and expectancies before it can be expected to be adopted by teachers. The computer must be integrated into an appropriate instructional program that is built upon ongoing academic assessment and instruction programs that optimize the amount of academic learning time provided to students must be carefully developed.

This project also revealed that additional research is needed to explore the efficacy of educational software. We must identify ways of incorporating pedagogically sound learning principles into the development of software. It is imperative to identify the contextual variables related to the effective use of the microcomputer in the classroom. Some questions that urgently need to be addressed are:

--What type of training is required to enable teachers effectively use and intergrate comuters into their instructional program?

--Are lab arrangements better than placing machines in individual classrooms?

--How much time should be allocated per student for computer-based instruction?

--How must the classroom ecology be altered to efficiently integrate computers into the classroom.

These represent just a few of the important questions that must be answered as we move into the technology era that is marked by the proliferation of computers in classrooms. While indoubtedly the movement toward the utilization of microcomputers in the schools will continue to be fueled by pressure from business and parent groups, it is important that research on the most appropriate applications of this technology be continued in order to avoid further corresponding problems of educational efficiency.

DISSEMINATION ACTIVITIES

The project staff made a concerted effort to disseminate project products and the research data. The following section provides a listing and brief description of the dissemination activities accomplished.

Product Adaption

1. The Indianapolis Public Schools adopted a modified version of the CIMS system to monitor student IEP's in all ten city high schools. The computer software was customized to meet their needs for a data-based management system to record and monitor student progress toward meeting preprogrammed minimal instructional objectives developed for each grade level. Under the terms of a concensus agreement between the administration and the teachers, all teachers were required to enter and monitor student progress data at least once a week. In addition, the school system has adopted the CMMRS, CIRIS and CRIS programs for use in junior and senior high schools.
2. A pencil and paper version of SAMS was adopted by the Washington Township Public Schools as the standard method of recording daily student academic performance data in all middle and high school programs for the handicapped.
3. Teachers in the Monroe County Special Education Cooperative have adopted the CMMRS, CRIS, and CIRIS programs as integral parts of their academic programs.
4. Principally as a result of presentations at professional meetings, the CIMS, CMMRS, CRIS and CIRIS programs have been requested for use in approximately 100 systems nationally.

Professional Presentations

1. Project activities, results, and products were disseminated at the California Special Education Area Administrators Conference in Santa Barbara, California.

2. The project staff were featured invited speakers at the annual meeting of the Indiana Association of Children with Learning Disabilities.

3. An overview of project activities was presented at the annual meeting of the North Central States Association of School Psychologists.

4. Project activities, findings and products were presented at the annual meeting of the Assosiation for Behavior Analysis.

5. A workshop describing software developed and/or field tested under the auspices of the project were represented at the International Association of School Psychologist's Convention.

6. A workshop which featured project activities was presented at the last two Annual Meetings of the Association of Teacher Educators of Children with Severe Behavior Disorders.

7. Presentations were made during the last three years at the annual meeting of the Indiana Federation of the Council for Exceptional Children.

8. The project was described in a presentation made to the annual meeting of Council for Children with Behavior Disorders, Programming for the Developmental Needs of Adolescents with Behavior Disorders.

9. Project data were presented at the annual Henry Lester Smith Research Conference.

10. Project activities were described during a presentation at the

annual meeting of the American Educational Research Assosiation.

11. The project was described at the annual meeting of Kentucky Council for Exceptional Children.

12. Summary data were presented at the Council for Exceptional Children's National Topical Conference in the Use of Microcomputers in Special Education.

13. The project was described at the annual meeting of the Teacher Education Division of the Council for Exceptional Children.

14. Preliminary data were presented at the International Council for Exceptional Children Convention.

Publications

A majority of the publications based upon the project are still in preparation however

1. An article entitled Use of Microcomputers in Training Special Education Teachers has been accepted by the Peabody Journal of Education and is currently in press.

2. An article entitled Using Microcomputers to Instruct Mildly Handicapped Secondary School Students has been submitted to the Journal of Special Education Technology.

Adoptions

The following school systems have adoped materials developed and/or evaluated on this grant:

1. Indianapolis Public Schools, Indianapolis, Indiana
2. Washington Township Public Schools, Indianapolis Indiana
3. Monroe County Schools, Bloomington, Indiana

4. Spencer-Owen County Schools, Spencer, Indiana

5. Tuscon Public Schools, Tuscon, Arizona

Software Distribution Requests

The following is a listing of only a few school systems that have requested the software:

1. Flowing Wells School System, Tucson, Arizona

2. Meade County School System, Brandenburg, Kentucky

3. Saddle Brook School System, Saddle Brook, New Jersey

4. St. Mary's School for the Deaf, Buffalo, New York

5. San Juan Unified School District, Carmicheal, California

APPENDICES

APPENDIX A

CIRIS AND CIMS PROGRAMS

CIRIS

Computer-Based Informal Reading Inventory System

(c)1983 Center for Innovation in Teaching the Handicapped

Smith Research Center / Indiana University

>>>> Report Command Processor <<<<

<1> REPORT READING INVENTORY Program DATA
<2> ACCESS READING INVENTORY Achievement CRITERIA
<3> ACCESS Student NAMES/NUMBERS File
<4> ACCESS STORIES, QUESTIONS, and ANSWERS
<5> CONVERT a CRIS Passage to a CIRIS Story
<6> HELP
<7> EXIT

MCCSC NO.	TEACHER	CITH LC	OBJECTIVE
ALPHABET			
REB 15	2		- Given a list of the letters of the entire alphabet presented randomly - S will write both the letter that preceeds and succeeds given letters (e.g., _ b _, _ r _) - 100% accuracy
REB 25	1		- Given a written array of upper case letters of the alphabet in random order - S can orally identify the upper case letters of the alphabet out of sequence - 100% accuracy
ORAL EXPRESSION			
REC 18	2		- Given a selected reading 1-minute passage at S's reading level - S will respond appropriately to commas when reading by showing appropriate pauses - 70% accuracy
REC 36	2		- Given one-minute long reading selections taken from S's reading assignments at grade level - S will read and decrease the number of mispronunciations in oral reading - Reductions in oral reading rate on 50% reduction in oral reading errors in 10 samples - Given and required to read for one minute
REC 44	2		- Given a selected reading passage (at grade level) taken from S's reading assignment - S will use good expression in oral reading (not word by word or monotone) - Teacher judgment
WORD ATTACK			
RED 09	2		- Given two to four sounds to be blended in a ten word sample - S will orally blend individual sounds into words - 70% accuracy

RED 16	2	- Given ten words containing various beginning consonants - S will identify orally beginning consonants - 90% accuracy
RED 18	2	- Given ten words containing various ending consonants - S will identify orally ending consonants - 90% accuracy
RED 19	1 2	- Given ten randomly selected words taken from S's reading assignments with missing consonants - S can supply missing consonant sounds orally or in writing to make a word - 90% accuracy
RED 20	2	- Given a list of five beginning and five ending consonant substitutions and five of words with beginning and ending consonant sounds - S can form (write) new words using beginning and ending consonant substitutions - 70% accuracy
RED 21	2	- Given five sentences containing unknown words with beginning and ending consonants - S will make consonant sounds to unknown word - 90% accuracy
RED 22	2	- Given ten words containing beginning and ending consonants in a list - S will supply (write) correct consonant sounds to unknown words in isolation - 90% accuracy
RED 23	2	- Given a list of all beginning word blends - S can correctly pronounce all blends in two trials - 100% accuracy
RED 25	2	- Given ten words each with missing consonant blends - S will supply (write) missing consonant blends to make the word - 80% accuracy

RED 2[illegible]	1-2	- Given unknown words (S cannot pronounce within 1") in ten sentences to be read - S can pronounce consonant blends orally in unknown words in context - 80% accuracy
RED 29	2	- Given words with silent consonants kn, gh, mb, and wr (in a list of ten words) - S can identify (underline) silent consonants - 80% accuracy
RED 30	2	- Given a list of ten words without silent consonants - S will supply missing silent consonant sounds to pronounce a word - 80% accuracy
RED 31	1 2	- Given five sentences containing unknown words with silent consonants - S will pronounce correct silent consonants to unknown word in context - 70% accuracy
RED 37	2	- Given ten words with missing consonant digraphs - S will supply (write) missing consonant digraphs to make a word - 90% accuracy
RED 39	2	- Given five sentences with unknown words containing consonant digraphs - S will apply (pronounce) correct consonant digraphs to unknown [illegible] context - 70% accuracy
RED 43	2	- Given a list of ten familiar words containing short vowel forms - S can identify (mark) whether short vowels in a word - 100% accuracy
RED 44	2	- Given a list of ten familiar words containing long vowel forms - S can identify (mark) whether long vowels in a word - 100% accuracy
RED 47	2	- Given ten sentences containing unknown words with vowel sounds - S will apply (pronounce) correct vowel sounds to unknown word in context

RED 53	2	- Given a list of 10 vowel digraphs (i.e., ea, oa, etc.) in isolation - S will pronounce vowel digraphs - 90% accuracy
RED 56	2	- Given five sentences containing unknown words with vowel digraphs - S will apply (pronounce) correct vowel digraphs to unknown word in context - 70% accuracy
RED 57	2	- Given a list of ten words with unknown words in isolation containing vowel digraphs - S will apply (pronounce) vowel digraphs to unknown word in isolation - 70% accuracy
RED 58	2	- Given a list of ten selected vowel dipthongs (oi, oo, ow, etc.) - S can pronounce vowel dipthongs - 70% accuracy
RED 59	2	- Given a list of ten words each containing vowel dipthongs - S can identify (underline) vowel dipthongs in the word - 70% accuracy
RED 61		- Given a list of five sentences containing unknown words with vowel digraphs - S can apply (pronounce) correct vowel digraph to unknown words
RED 64	2	- Given a list of five words with murmer dipthongs missing - S will supply murmer dipthongs to make a word - 80% accuracy
RED 68	1 2	- Given ten words taken from S's reading assignments containing all five vowels in long and short sounds - S can pronounce words correctly and state whether the vowels are long or short - 90% accuracy
RED 69	22	- Given a list of ten unknown multisyllabic words - S will identify compound words in writing contained in larger words - 70% accuracy

RED 70	1	- Given a list of 20 simple and compound words taken from S's reading, spelling, or vocabulary assignments containing two or more syllables - S can identify the compound words - 100% accuracy
RED 72	1 2	- Given a list of ten common words to be converted to contractions taken from S's assignments - S can produce and read common contractions - 90% accuracy
RED 73	2	- Given a selected list of ten common nouns and pronouns - S can produce and read common possessives - 80% accuracy
RED 75	2	- Given a list of two to five multi-syllabic words common - S can count (write) the number of syllables in words - 80% accuracy
RED 77	2	- Given a list of syllables and ten root words taken from S's reading assignment - S can synthesize syllables into a word - 80% accuracy
RED 78	1 2	- Given a list of ten words missing appropriate prefixes taken from S's assignments and prefixes displayed in random order - S can produce (match) common prefixes to root word and read word correctly - 80% accuracy
RED 79	1 2	- Given a list of ten words missing suffixes taken from S's assignments and appropriate suffixes displayed in random order - S can produce (match) common suffixes to root word and read word correctly - 80% accuracy
RED 80	1 2	- Given an unknown word (that S cannot pronounce in 4 ") - S can list three methods to use in solving for unknown word (e.g., breaking into syllables, identifying from context, looking up word in dictionary) - 100% accuracy on teacher checklist

REE 08	1	- Given five standard written instructions taken from S's assignments in various areas - S can read and follow written directions at instructional level - 100% accuracy
REE 12	1	- Given five sentences taken from S's reading assignments containing one piece of information to be identified - S can locate (underline) the word in a sentence which answers a specific question - 100% accuracy
REE 13	1 2	- Given a paragraph taken from S's reading assignments containing factual information - S can locate (underline) the sentence in a paragraph which answers a specific question - 100% accuracy
REE 14	1 2	- Given an oral or tape recorded short story at S's reading level - S can answer (orally) comprehension questions after listening to the story selection - 90% accuracy
REE 15	1	- Given a reading selection at S's grade-level and five specific facts to identify - S can name (or write) the specific facts contained in a given reading selection - 90% accuracy on checklist
REE 16	1 2	- Given a reading selection at S's grade-level and request to list five specific facts in the story passage - S can list the specific facts contained in a given reading selection - 90% accuracy on checklist
REE 17	1 2	- Given a reading selection at grade-level - S can write answers to five comprehension questions of various types - 80% accuracy
REE 18	1 2	- Given ten sentences missing words of various types (i.e., nouns, verbs, adjectives, pronouns, adverbs) - S can use the context of a sentence to determine a missing word - 80% accuracy

REE 19	1 2	- Given ten sentences taken from S's assignments containing words unknown to S (cannot pronounce in 4") - S will use the context of the sentence to determine a word's meaning and offer an oral or select a written definition of a word - 70% accuracy
REE 20	1 2	- Given a selected reading passage at S's grade-level - S will name (write) relevant information from the reading selection - 80% accuracy
REE 21	2	- Given a selected reading passage at S's grade-level - S will read and list (in order) the relevant information from a reading selection - 70% accuracy
REE 22	1 2	- Given ten sentences taken from S's reading assignment - S will state or write the main idea of sentennces - 80% accuracy
REE 23	1 2	- Given a paragraph selected from S's reading assignment - S will summarize in writing the paragraph and state the main idea in writing - 100% accuracy on checklist
REE 24	2	- Given a paragraph read as S's reading assignment that has not been titled and a list of 5 titles - S will select the best title from the list - 80% accuracy
REE 25	1 2	- Given a paragraph selected from S's reading assignment and the main idea of the paragraph in written form - S will identify (write) two to three details that support the main idea - 100% accuracy
REE 26	1 2	- Given a reading selection at S's grade-level - S will read selection and list the main events in correct order as they appear - [illegible] on checklist

REE 27	1½	- Given a reading selection at S's grade-level to read and a list of 5 to 10 details in random order - S will read selection and place sequence details in correct order as they appeared in selection - 90% accuracy on checklist
REE 29	2	- Given a selected reading passage at S's grade-level without a conclusion included - S will predict a logical outcome for a given story - 70% accuracy on checklist
REE 30	1½	- Given three reading selections at S's grade-level with conclusions missing and a list of five possible conclusions each - S will select conclusion which best predicts a story's ending - 100% accuracy
REE 31	1½	- Given a reading selection at S's grade-level - S will read the selection and write a summary of the events and actions of main characters of the story (plot) - 90% accuracy
REE 32	1½	- Given a reading selection at S's grade-level and a list of (three to five) cause statements and five to 10 effect statements - S can read the story and match cause statements with corresponding effect statements - 80% accuracy
REE 33	1	- Given a fictional or biographical reading selection at S's grade-level - S can locate (underline) words in the story which identify a main character's feelings - 80% accuracy
REE 37	1	- Given a newspaper or magazine article at S's reading level - S can outline (list in writing) main topics of the article - 80% accuracy

REE 41	1	- Given a reading selection at S's grade-level and a listing of five pieces of relevant and five irrelevant pieces of information - S can discriminate (select) relevant from irrelevant information in a reading selection - 80% accuracy on checklist
REE 42	1	- Given a list of ten sentences taken from S's reading assignments - S can identify which sentences are fact and which are based on opinion - 90% accuracy
REE 43	1	- Given a factual reading passage at S's reading level - S will read and state opinion of author regarding a selected issue - 100% accuracy on checklist
REE 48	1	- Given an informal observation situation - S will demonstrate interest in reading books by selecting, reading, or possessing non-academic books - Teacher observation
REE 49	1	- Given a reading instructional situation - S will participate in learning activities to increase reading ability - 80% on task without complaint
REE 50	1	- Given a choice of two or more methods of obtaining knowledge about a particular topic, one of which involves reading - S will use reading as a means of deriving knowledge (rather than asking another) - Teacher observation
REE 51	1	- Given a reading passage at S's grade-level or above and a list of 3 pieces of information - S can describe and demonstrate use of skimming to locate information - Teacher observation
REE 52	1	- Given a choice of activities in a free-time situation one of which includes reading - S will engage in recreational reading when faced with a number of alternatives for use of leisure time - Teacher observation

REE 53	1 2	- Given selected assignments in outside content areas (science, math, etc.) - S will demonstrate comprehension of this material - 50-60% accuracy on comprehension questions asked by teacher

SIGHT VOCABULARY

REF 19	2	- Given stories made from experience written in own words by the teacher - S will read personal experience stories - Teacher judgement
REF 20	1 2	- Given a reading passage constructed from S's own words as told to teacher - Teacher judgement
REF 25	2	- Given a selected list of 20 number words from one to one-hundred - S will read number words one to one-hundred - 90% accuracy
REF 53	1	- Given a list of ten new sight words each week taken from S's reading assignment - S will read more than then to 20 sight words each week three times - Teacher judgement
REF 55	1	- Given a list of more than ten new sight words each months taken from S's reading assignments - Student will read more than ten to twenty new sight words each month three times - Teacher judgement
REF 58	1	- Given a list of 5 new vocabulary words taken from S's reading assignment each day - S will state meaning for 5 new vocabulary words each day - 80% accuarcy
REF 60	2	- Given a list of 5 new vocabulary words taken from S's reading assignment each month - S will state meaning for 5 new vocabulary words each month - 80% accuracy
REF 63	1	- Given a list of 10 new vocabulary words taken from S's reading assignment each week - S will state meaning for 10 new vocabulary words each week - 80% accuracy

REF 64	1	- Given a list of more than 10 new vocabulary words taken from S's [illegible]ading assignment each week - S will state meaning for for more than ten new vocabulary words each week - 80% accuracy
REF 70	1 2	- Given a list of 5 new vocabulary words to learn each week - S will write meaning for 5 new vocabulary words each week - 100% accuracy
REF 71	2	- Give[illegible] list of 5 new vocabulary words to [illegible] each month - S [illegible]te meaning for 5 new vocabulary wo[illegible] month - 10[illegible]uracy
REF 72	1	- [illegible] list of 10 new vocabulary words to learn each day - [illegible]ent will write meaning for 10 new voc[illegible]lary words each day - [illegible]0% accuracy
REF 73	1	- Given a list of 10 new vocabulary words to learn each week - S will write meaning for 10 new vocabulary words each week - 100% accuracy
REF 76	1	- Given a list of more than 10 vocabulary words to learn each month - S will write the meaning for more than 10 new vocabulary words each month - 100% accuracy
REF 77	1 2	- Given a list of basic sight vocabulary words for outside content areas such as science, math, etc. - S will define, learn and be able to provide an oral definition of each vocabulary word - Five words each day
REF 78	1	- Given a list of basic sight vocabulary words taken from a State Driver's Manual - S can read basic sight vocabulary of Driver's Manual at a rate of five words per day - 100% accuracy on first trial

MCCSC NO.	Teachers	CITH LC	Objective
NUMERATION			
MAAA 21	2		- Given numerals shown in sequence - S can verbally identify numerals 1 to 10 when shown in sequence - 100% accuracy
MAAA 67	2		- Given orally presented digits randomly selected - S can write dictated numbers up to 4 digits - 100% accuracy
MAAA 70	2		- Given 20 written number words randomly selected from 1 to 100 - S can write corresponding numerals - 100% accuracy
MAAA 73	2		- Given 20 written number words randomly selected from 1 to 100 - S can read number words - 100% accuracy
MAAA 86	2		- Given a written model 4 digit number - S can circle or write the place value (ones, tens, hundreds, thousands) of each numeral - 100% accuracy
ADDITION			
MAAB 30	2 3		- Given 10 randomly selected 3-digit addition problems without regrouping, not involving zero, - S can correctly add numbers - Rate = 35 digits/min.
MAAB 35	2		- Given 10 randomly selected 4-digit addition problems with regrouping, involving zero - S can add numbers correctly - Rate = 35 digits/min.
MAAC 19	3		- Given 10 randomly selected 2-digit subtraction problems with regrouping, involving zero - S will correctly subtract numbers - Rate = 35 digits/min.

MAAC 23	1 2	- Given 10 randomly selected 3-digit problems with regrouping, involving zero - S will accurately subtract numbers - Rate = 35 digits/min.
MAAC 25	2	- Given 10 randomly selected 3 digit subtraction problems without regrouping, involving zero - S will correctly subtract numbers - Rate = 35 dpm.
MAAC 27	23 3	- Given five randomly selected 4-digit subtraction problems with regrouping, involving zero - S will correctly subtract numbers - Rate = 35 dpm
MAAC 29	2	- Given five randomly selected 4-digit subtraction problems without regrouping, involving zero - S will correctly subtract numbers - Rate = 35 dpm.
MAAC 30	3	- Given five randomly selected 4-digit subtraction problems without regrouping, not involving zero - S will correctly subtract numbers - Rate = 35 dpm.
MAAC 39	3	- Given five randomly selected 3-digit subtraction problems written horizontally - S can correctly subtract numbers - Rate = 35 dpm.

MULTIPLICATION

MAAD 10	3	- Given verbal request to recite 10 multiplication question facts 1-5 - S can recite from memory facts through 5's - 90% accuracy
MAAD 11	1 2 3	- Given verbal request to recite 10 multiplication facts 1-9 - S will recite from memory facts through 9's - 90% accuracy

MAAD 15	1 2 3	- Given ten randomly selected multiplication problems with regrouping, involving zero - S will multiply by a 1-digit number - 100% accuracy
MAAD 16	2	- Given ten randomly selected multiplication problems involving zero - S will multiply by a 1-digit number - Rate = 35 cdpm.
MAAD 17	2	- Given ten randomly selected multiplication problems without regrouping involving zero - S will multiply by a 1-digit number - Rate = 35 cdpm.
MAAD 19	1 2 3	- Given ten randomly selected multiplication problems with regrouping, involving zero - S will multiply by a 2-digit number - Rate = 35 cdpm.
MAAD 20	23	- Given ten randomly selected multiplication problems with regrouping, not involving zero - S will multiply by a 2-digit number - Rate = 35 cdpm.
MAAD 22	1	- Given ten randomly selected 2-digit numbers multiplication problems, without regrouping, not involving zero - S will multiply by a 2-digit number - Rate = 35 cdpm.
MAAD 23	1 2 3	- Given five randomly selected multiplication problems with regrouping, involving zero - S will multiply by a 3-digit number - Rate = 35 cdpm.
MAAD 26	1	- Given five randomly selected multiplication problems without regrouping, not involving zero - S will multiply by a 3-digit number - Rate = 35 cdpm.
MAAD 30	1	- Given five randomly selected multiplication problems presented horizontally with regrouping - S can multiply by a 1-digit number - Rate 35 cdpm.

DIVISION

MAAE 06	3	- Given ten division facts through 9 and a counting device or table - S will compute division facts - 100% accuracy
MAAE 11	1 2 3	- Given a verbal request - S will recite from memory division facts through 9's - 100% accuracy
MAAE 13	2 3	- Given a verbal or written request - S will write from memory division facts through 9's - 100% accuracy
MAAE 15	1 2 3	- Given ten randomly selected division problems with remainders, involving zero - S will divide by a 1-digit divisor - Rate = 35 cdpm.
MAAE 16	2 3	- Given ten randomly selected division problems with remainders, not involving zero - S will divide by a 1-digit divisor - Rate = 35 cdpm.
MAAE 17	3	- Given ten randomly selected division problems without remainders, involving zero - S will divide by a 1-digit divisor - Rate = 35 cdpm.
MAAE 19	1 2 3	- Given ten randomly selected division problems with remainders, involving zero - S will divide by a 2-digit divisor - Rate = 35 cdpm.
MAAE 20	1	- Given ten randomly selected division problems with remainders, not involving zero - S will divide by a 2-digit division - Rate = 35 cdpm.
MAAE 21	1 3	- Given ten randomly selected division problems without remainders, involving zero - S will divide by a 2-digit divisor - Rate = 35 cdpm.

MAAE 22	1 3	- Given ten randomly selected division problems without remainders, not involving zero - S will divide by a 2-digit divisor - Rate = 35 cdpm.
MAAE 23	1 2	- Given five randomly selected division problems with remainders, involving zero - S will divide by a 3-digit divisor - Rate = 35 cdpm.
MAAE 24	1	- Given five randomly selected division problems with remainders, not involving zero - S will divide by a 3-digit divisor - Rate = 35 cdpm.

FRACTIONS

MAAF 05	3	- Given a written model of the symbols 1/2, 1/3, 1/4, 1/8, 1/16 - S will correctly name the symbols - 100% accuracy
MAAF 10	2 3	- Given various figures representing wholes, halves, thirds, quarters, eighths and sixteenths - S will name or match appropriate fraction - 100% accuracy
MAAF 15	1 2 3	- Given a list of five randomly selected numbers - S can name or write common factors - 90% accuracy
MAAF 20	1 2 3	- Given ten randomly selected proper and improper fractions - S can change fractions to higher terms and state the rule - 100% accuracy
MAAF 25	1 2 3	- Given ten randomly selected improper fractions - S can change improper fractions into mixed numbers and state the rule - 90% accuracy
MAAF 30	1 2	- Given ten randomly selected mixed numbers - S can changed mixed numbers into proper fractions and state the rule - 90% accuracy

MAAF 35	1 2	- Given ten randomly selected like fractions with regrouping - S will add correctly - Rate = 35 cpm
MAAF 36	P 3	- Given ten randomly selected like fractions with regrouping - S will add correctly - Rate = 35 cpm.

MAAF 37	1 2 3	-Given Ten randomly selected problems with unlike fractions requiring regrouping. -S will add unlike fractions with regrouping. -Rate = 35 cdpm.
MAAF 38	1 2	-Given ten randomly selected problems with unlike fractions not requiring regrouping. -S will add unlike fractions without regrouping. -Rate = 35 cdpm.
MAAF 39	1 2	-Given ten randomly selected problems with like fractions requiring regrouping. -S will subtract like fractions with regrouping. -Rate = 35 cdpm.
MAAF 40	1 3	-Given ten randomly selected problems with like fractions requiring no regrouping. -S will subtract like fractions without regrouping -Rate = 35 cdpm.
MAAF 41	1 2 3	-Given ten randomly selected problems with unlike fractions requiring regrouping. -S will subtract unlike fractions with regrouping -Rate = 35 cdpm.
MAAF 45	2	-Given ten randomly selected problems with like mixed numbers requiring regrouping. -S will add like mixed numbers with regrouping. -Rate = 35 cdpm.
MAAF 47	1 2	-Given ten randomly selected problems with unlike mixed fractions requiring regrouping. -S will add unlike mixed numbers with regrouping. -Rate = 35 cdpm.
MAAF 50	2	-Given ten randomly selected problems with like mixed numbers not requiring regrouping. -S will subtract like mixed numbers without regrouping.
MAAF 51	1 2	-Given five randomly selected problems with unlike mixed numbers requiring regrouping. -S will subtract unlike mixed numbers with regrouping. -Rate = 35 cdpm.

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MAAF 55		- Given ten randomly selected problems using regrouping - S will multiply fractions with regrouping - Rate = 35 cdpm.
MAAF 56	1	- Given ten randomly selected problems using fractions without regrouping - S will multiply fractions without regrouping - Rate = 35 cdpm.
MAAF 57	1 2 3	- Given ten randomly selected division problems using fractions requiring regrouping - S will divide fractions with regrouping - Rate = 35 cdpm.
MAAF 60	2	- Given ten randomly selected multiplication problems using mixed numbers - S will multiply mixed numbers - Rate = 35 cdpm.
MAAF 61	2	- Given ten randomly selected division problems using mixed numbers - S will divide mixed numbers - Rate = 35 cdpm.
MAAF 70	2	- Given ten randomly selected common fractions (1/2, 1/3, 1/4, 1/5, 1/8, 1/10, 3/4, etc.) - S will change fractions to their decimal equivalents - 90% accuracy

DECIMALS

MAAG 08	1	- Given ten randomly selected problems requiring regrouping through the 1st decimal place - S will add unlike decimals without regrouping through the 1st place - Rate = 35 cdpm.
MAAG 11	1	- Given ten randomly selected problems using decimals with regrouping - S will subtract unlike decimals to the 1st place with regrouping - Rate = 35 cdpm.
MAAG 21	1 2	- Given ten randomly selected problems using decimals to the 2nd place with regrouping - S will add like decimals with regrouping through the 2nd place - Rate = 35 cdpm.

MAAG 25	1 2	- Given ten randomly selected problems using like decimals to the 2nd place requiring regrouping to the 2nd place - S will subtract like decimals with regrouping to the 2nd place - Rate = 35 cdpm
MAAG 27	2	- Given ten randomly selected problems using unlike decimals to the 2nd place requiring regrouping - S will subtract unlike decimals with regrouping through the 2nd place
MAAG 31	1	- Given ten randomly selected problems using unlike decimals to the 2nd place requiring regrouping - S will multiply unlike decimals with regrouping through the 2nd place - Rate = 35 cdpm
MAAG 32	1	- Given ten randomly selected problems using unlike decimals to the 2nd place not requiring regrouping - S will multiply unlike decimals without regrouping through the 2nd place - Rate = 35 cdpm
MAAG 35	1	- Given ten randomly selected problems using unlike decimals to the 3rd place requiring regrouping - S will add unlike decimals with regrouping through the 3rd place - Rate 35 cdpm.
MAAG 39 2	1	- Given ten randomly selected problems using unlike decimals to the 3rd place requiring regrouping - S will add unlike decimals with regrouping through the 3rd place - Rate = 35 cdpm.
MAAG 43	1	- Given ten randomly selected problems using unlike decimals to the 3rd place requiring regrouping - S will subtract unlike decimals with regrouping to the 3rd place - Rate = 35 cdpm.
MAAG 45	2	- Given ten randomly selected problems using like decimals to the 3rd place requiring regrouping - S will multiply like decimals with regrouping through the 3rd place - Rate = 35 cdpm.

MAAG 47	1 3		- Given ten randomly selected problems using unlike decimals to the 3rd place requiring regrouping - S will multiply unlike decimals with regrouping through the 3rd place - Rate = 35 cdpm
MAAG 55	1 2		- Given ten pairs of assorted decimals of 1 to 4 digits long - S can line up decimal numbers correctly for addition and state the rule - 100% accuracy
MAAG 56	2		- Given ten pairs of assorted decimals of 1 to 4 digits long - S can line up decimal numbers correctly for subtraction and state the rule - 100% accuracy
MAAG 57	1 2		- Given ten pairs of assorted decimals of 1 to 4 digits long - S can line up decimal numbers correctly for multiplication and state the rule - 100% accuracy
MAAG 58	1 2		- Given ten pairs of assorted decimals of 1 to 4 digits long - S can line up decimal numbers correctly for division and state the rule - 100% accuracy
MAAG 75	1		- Given ten randomly selected even whole numbers below 100 - S can write common percentages (e.g., 25%, 33%, 50%, 68%, 75%, 80%, 90%) - 90% accuracy

COMPREHENSION

MAAH 12	2	b	- Given five one-step story problems involving addition or subtraction - S can write the equation that will solve a story problem - 90% accuracy
MAAH 14	2		- Given three 2-step story problems presented orally using addition - S can solve story problem - 68% accuracy

MAAH 22	3	- Given three written 2-step story problems using addition - S can read problem and write answer to 2-step problems - 100% accuracy
MAAH 24	3	- Given three written 2-step story problems using subtraction - S can read problems and write answers - 100% accuracy
MAAH 26	2 3	- Given three written 2-step story problems using multiplication - S can read problems and write answers - 100% accuracy
MAAH 28	1 2 3	- Given three written 2-step story problems using division - S can read problems and write answers - 100% accuracy
MAAH 32	2	- Given two 3-step orally presented story problems using subtraction - S will say answer - 100% accuracy
MAAH 44	1	- Given two three-step story problems using addition - S can read problem and write answer - 90% accuracy
MAAH 46	1	- Given two three-step story problems using division - S can read problems and write answers - 90% accuracy
MAAH 48	2	- Given two three-step story problems using two or more mathematical functions - S can read problems and write answers - 90% accuracy

TIME

MABA 01	2	- Given oral or written request to tell what yesterday, tomorrow, and tomorrow night - S will demonstrate understanding of concepts by defining them in own words - 100% accuracy

MABA 10	3	- Given five written or oral requests to tell the time of day and tell if it is a.m. or p.m. - S can discriminate time as a.m. or p.m. by writing appropriate abbreviation after correct time - 100% accuracy
MABA 15	3	- Given an actual clock with hour and minute hands or reproduction or drawing, - S can identify the hour hand on the clock - 100% accuracy for five trials with hands in various positions
MABA 16	3	- Given an actual clock with hour and minute hands or reporduction or drawing, - S can identify the minute hand on the clock - 100% accuracy for five trials with hands in various positions
MABA 21	3	- Given an actual clock face or appropriate reproduction and asked to count minutes in a clockwise direction - S can count in a clockwise motion the marks on the face of a clock
MABA 28	3	- Given an actual clock face or appropriate reproduction with hands in various positions - S can state time to the nearest five minute interval - 90% accuracy for 5 trials
MABA 29	1 2 3	- Given an actual clock face or appropriate reproduction with hands in various positions - S can state time to the nearest minute - 90% accuracy for 5 trials

CALENDAR

MABB 20	3	- Given two problems with a verbal or written request to name the months of year in order - S says or writes the months of the year in correct sequence - 100% accuracy on two trials
MAAB 61	1 2	- Given two problems with a verbal or written request to name the various months in Winter, Spring, Summer and Fall - S can write the months in each season - 100% accuracy on two trials

MAAB 65	1	- Given a verbal or written request [illegible] identify one major holiday i[illegible]ason of the year - S can name or write a major holiday in each season - 100% accuracy

MEASUREMENT: LIQUID & DRY (VOLUME)

MACB 05	2	- Given an array of standard containers for various liquids (e.g., half-gallon, quart, half-pint, 250 milliter, liter, cup, 1/2 cup, 1/4 cup) - S can orally identify standard liquid measure containers - 90% accuracy
MACB 10	2	- Given an array of standard utensils for measuring dry volume (cup, 1/2 cup, 1/3 cup, 1/4 cup, tablespoon, teaspoon, 1/2 teaspoon) in random order - S will orally identify utensil - 90% accuracy

LINEAR

MACC 10	2	- Given a standard ruler without increment symbols (i.e., 1/2, 1/4, etc.) - S can identify the segments on a ruler to 1/16th marks - 80% accuracy on five trials
MACC 25	1	- Given appropriate measuring devices and three lengths (lines, walls, containers, etc.) - S will measure a length in inches, feet, yards, centimeters, and meters to the nearest inch or centimeter - 80% accuracy
MAAC 26	1	- Given three lengths to measure (e.g., lines, walls, containers) and appropriate measuring device - S will measure lengths in inches, feet, yards, centimeters, meters to the nearest 1/2 inch or milimeter - 80% accuracy

MACC 27	1 2 3	- Given three lengths to measure (e.g., lines, walls, containers) and appropriate - S will measure lengths (in inches, feet, yards, centimeters, meters) to the nearest 1/4 inch or milimeter - 90% accuracy
MACC 28	1 2	- Given three lengths to measure (e.g., lines, walls, containers) and appropriate measuring device - S will measure lengths (in inches, feet, yards, centimeters, meters) to the nearest 1/8 inch or millimeter - 90% accuracy
MACC 29	1	- Given three lengths to measure (e.g., lines, walls, containers) and appropriate measuring device - S will measure lengths (in inches, feet, yards, centimeters, meters) to the nearest 1/16 inch. - 90% accuracy
MACC 75	1	- Given three representative story problems involving measurements - S can compute and write answers to 3-step story problems involving measurements - 80% accuracy

CONSUMER: MONEY

MADA 13	2	- Given three groups of coins with three or more denominations - S will tell or write which coins in each group of coins has a higher value when compared with others by rank ordering the coins - 100% accuracy
MADA 14	1	- Given three lists of at least three different money amounts with "$" and "¢" designating values (i.e., $5, $.05, $5.00) - S can name the money signs and tell their meaning in terms of money value. - 100% accuracy on three trials
MADA 39	1	- Given five written problems requiring sums for values up to $100.00 - S can add amounts of money up to $100.00 - 90% accuracy

MADA 43	2	- Given five written problems requiring differences in money values up to $10.00 - S can subtract amounts of money up to $10.00 - 90% accuracy
MADA 49	1	- Given five written problems requiring multiplication of even amounts of money (e.g., $25 x 2, $10 x 5, $5 x 4) - S will multiply amounts of money up to 100.00 - 100% accuracy
MADA 53	1	- Given five written problems requiring division of even amounts of money (e.g., $6 ÷ 3, $4 ÷ 2, etc.) - S can divide amounts of money up to 10.00 - 100% accuracy
MADA 55	1	- Given five written problems requiring division of even amounts of money (e.g., $1000 ÷ 4, $500 ÷ 5, $300 ÷ 3, etc.) - S will divide amounts of money up to 1,000.00 - 100% accuracy
MADA 63	1 2 3	- Given five problems using various amounts of change in dollars and cents with sham money - S will count change (add bills) up to $10.00 - 100% accuracy
MADA 73	3	- Given an array of money (graphic, sham, real) and written or oral request to compute change in five different problems - S can compute change up to $1.00 and provide an oral or written answer - 90% accuracy
MADA 75	2	- Given an array of money (graphic, sham, or real) in five different problems and a written or oral request to compute change for selected amounts - S can compute change up to $10.00 by selecting appropriate sums or - 90% accuracy
MADA 76	1	- Given an array of money (graphic, sham, or real) in five different problems and a written or oral request to compute change for selected amounts - S can compute change up to $20.00 by selecting appropriate sums or - 90% accuracy

MADA 91	3	- Given five different problems requiring exact change to $.50 (either graphic or actual) - **S can give exact change for a selected price using mixed coins to $.50** - 100% accuracy
MADA 96	2	- Given five real life simulations using sham money requiring various amounts of change from $.01 to $1.00 - S can select the correct coins for real life situations such as purchases from vending machines, etc. - 90% accuracy
MADA 99	2	- Given three story problems using money in amounts from $1.00 to $50.00 - S will read problem and solve (write answer) story problems using money - 90% accuracy

BANKING

MADB 05	1 2	- Given 3 bank forms from [illegible] banks for savings deposits, checking deposits, money orders and specified amounts of money between $5 and $100 including cents - S can fill out bank forms for savings, checking, and money orders - 100% accuracy
MADB 10	1	- Given five problems using a standard check form and different amounts of money from $3 to $500, including cents - S can write checks for correct amounts - 100% accuracy
MADB 35	2	- Given an oral or written request to explain differences between checking and savings accounts - S can say or write differences between a checking and a savings account and reason for maintaining each - 100% accuracy
MADD 30	2	- Given three different problems involving credit purchases and interest charges (in terms of percentage rate per month on unpaid balance) - S can compute total amount to be repaid for credit purchases from 2 months to one year - 90% accuracy

MADD 68	2	- Given three different real-life situations presented (orally or written) involving purchases of faulty or unsatisfactory merchandise - S will list three alternatives each to deal with unsatisfactory merchandise - 90% accuracy on checklist
MADD 20	1	- Given details in terms of income and expenditures per month - S can make a budget for monthly expenses based on job income - $100% accuracy on teacher prepared checklist

MCCSC No.	Teacher	CITH Lc.	Objective
LAA 64	3		- Given a live or recorded presentation - S will listen to a short story or musical piece - For 20 minutes with at least 80% on-task behavior
LAB 06	3		- Given a typed example of his home address - S will trace address with teacher assistance - Readable by an independent observer
LAB 09	3		- Given a typed, hand printed, cursive or handwritten copy of his home address as a model - S will write the address - 90% correct and legible
LAB 17	3		- Given a written or verbal request to write name, address, telephone number, age, place of birth, and birthdate, height and weight - S will write personal data words - 100% accurate and legible
LAB 19	1		- Given a written or verbal request to list the names of immediate family members - S can write the first and last names of ten relatives or friends - 90% accurate and legible
LAB 22	3		- Given a written or verbal request - S can write the name of his current school ~~ten times~~ - 100% accuracy
LAB 27	1		- Given appropriate instructions - S will write name, date, subject and period of day on 10 assignments - 90% accurate and legible
LAB 28	1		- Given five different types of school and job application forms from five local businesses - S will fill out school forms and job application blanks unassisted - 90% accurate and legible
LAB 29	1,3		- Given five different types of school forms and job application forms from five local businesses - S will fill out school forms and job application blanks assisted - 90% accurate, legible, requires teacher aid no more than once per each form.

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LAB 34	1	- Given ten various forms to complete (catalog order blanks, subscription requests, medical questionnaire, etc.) - **S will be able to copy personal phone number onto blanks on forms with teacher assistance** - **100% accuracy; legible no more than one teacher aid per each form.**
LAB 37	1	- Given request and pertinent personal, biographic, and employment history and a standard format - S will write a personal resume for use in obtaining employment - 90% accuracy on checklist comparison
LAB 38	1	- Given ten groups of words containing complete and incomplete sentences - S will identify groups of words that are not complete sentences. - 90% accuracy
LAB 41	1,3	- Given a request to construct a complete sentence using ten of S's own words - S can construct a complete sentence with correct capitalization and punctuation - 100% accuracy
LAB 43	1,3	- Given a list of words taken from spelling assignments - S can compose and write [redacted] sentences 5 ~~10-20~~ words long with correct grammar, capitalization, and punctuation. - 80% accuracy on teacher checklist
LAB 44	1,3	- Given a list of vocabulary words taken from S's texts - S can compose sentences 5- 10-15 words long with correct grammar, capitalization and punctuation - 80% accuracy on teacher checklist
LAB 46	1,3	- Given three sentences in random order - S will sequence three sentences in proper order to make a paragraph - 100% accuracy
LAB 47	1	- Given five sentences in random order S can sequence five sentences in proper order to make a paragraph - 80% accuracy

LAB 48	3	- Given seven sentences in random order - S will sequence the seven sentences in proper order - 80% accuracy
LAB 50	1,3	- Given selected topic of interest - S will write a three-sentence paragraph with correct capitalization and punctuation - 100% accuracy
LAB 51	1 3	- Given a selected topic - S will write a five-sentence paragraph with correct grammar, capitalization and punctuation - 90% accuracy
LAB 52	1	- Given a selected topic - S will write a seven sentence paragraph with correct grammar, capitalization and punctuation - 80% accuracy
LAB 53	1 3	- Given a selected topic - S will write a nine-sentence paragraph with with correct grammar, capitalization and punctuation - 80% accuracy
LAB 54	1, 3	- Given a selected topic - S will write two paragraphs (at least ten sentences in length) with correct grammar, capitalization and punctuation about a topic - 80% accuracy
LAB 55	1	- Given a selected topic - S will write a four paragraph about the topic using correct grammar, capitalization, and punctuation - ~~75%~~ accuracy 80%
LAB 56	1 3	- Given a selected topic or asked to supply a topic - S will write a short story (10 to 20) paragraphs using appropriate form, correct grammar, capitalization, and punctuation - 75% accuracy on capitalization and punctuation; 90% accuracy on form checklist
LAB 57	1	- Given a short written article or story, or other piece of (300-1000 words) - S will paraphrase the information in the article by writing the main ideas and at least five major details in own words - 80% accuracy on checklist

LAB 58	1 3	- Given a short story and/or article 500-2000 words in length - S will read and write a summary of the selection using own words using correct grammar, capitalization, punctuation, and including the major points and details - 80% accuracy on checklist
LAB 59	1 3	- Given an appropriate format and - After reading a book 100-500 pages long - S will write a book report using correct grammar, ~~spelling~~, capitalization, and punctuation following a standard form - 75% accuracy on English usage, capitalization; 90% accurate on format checklist
LAB 60	1 3	- Given a selected topic and appropriate format - S will write a business letter (4-8 paragraphs) using correct grammer, capitalization and punctuation and following appropriate form - 75% accuracy on English usage - 90% accuracy on format checklist
LAB 61	1 3	- Given a selected topic and an appropriate format - S will write a personal letter using correct grammar, spelling, capitalization, and punctuation - 75% accuracy on English usage - 90% accuarcy on format checklist
LAB 62	1 3	- Given an appropriate format - S will address a letter using correct spelling, capitalization, and punctuation - 90% accuracy on English usage and format
LAB 65	1	- Given a written factual article - S will write five statements from an article to a friend or relative - 80% accuracy on English usage
LAB 67	1	- Given a familiar location - S will accurately write directions for someone to interpret and follow on a map - 100% accuracy

LAC 03	3	- Given ten sentences and appropriate infinitives - **S will write correct verb forms in sentences** - **90% accuracy**
LAC 04	1 3	- Given ten sentences containing common and proper nouns - S will identify the nouns in the sentences - 90% accuracy
LAC 05	1 3	- Given ten sentences containing active, passive and helping verbs - S will identify the main verbs in the sentences - 90% accuracy
LAC 06	1 3	- Given ten sentences containing various adjectives - S will identify the adjectives in sentences - 80% accuracy
LAC 07	1 3	- Given ten sentences containing various adverbs - S will identify the adverbs in sentences - 80% accuracy
LAC 17	1	- Given five sentences and appropriate infinitives - S will write correct verb forms for past, present and future tenses of each verb - 80% accuracy
LAC 18	1 3	- Given ten sentences with proper, common and pronouns as subjects with and without introductory clauses and phrases - S will identify the subjects in the sentences - 80% accuracy
LAC 22	1	- Given a list of ten common contractions and ten words to be written in contraction form - S will write contractions and word combinations for contractions - 90% accuracy
LAC 23	1	- Given a list of five common contractions and five words to be written in contraction form - S will read contractions and identify word combinations for which they stand - 100% accuracy

LAC 26	1 3	- Given a list of ten common abbreviations - S will write words for which they stand - 90% accuracy
LAC 29	1	- Given ten sentences with standard "AB" form - S will identify predicate - 100% accuracy
LAC 30	3	- Given a list of ten words taken from S's reading or other assignments and containing a list of 20 words of similar and other meaning - S will correctly identify appropriate synonyms and verbally tell what a synonym is - 80% accuracy
LAC 32	3	- Given a list of five words taken from S's reading or other assignments - S will correctly identify appropriate antonyms for given words and verbally define "antonyms" - 90% accuracy
LAC 34	3	- Given a list of ten words taken from S's reading or other assignments - S will correctly identify appropriate homonyms and define "homonyms" - 80% accuracy
LAC 38	1 3	- Given five words with a combination of denotations taken from instructional material - S will state meanings of multiple meaning words - 80% accuracy
LAC 54	3	- Given five-word sentences without appropriate capitalization - S will capitalize letters at the beginning of each sentence and state the rule - 100% accuracy
LAC 58	1 3	- Given a paragraph of 100 words without appropriate capitalization - S will captialize necessary words in the paragraph - 90% accuracy
LAC 59	1 3	- Given ten sentences without appropriate capitalization - S will capitalize necessary words in each sentence - 80% accuracy

LAC 66	1 3	- Given a paragraph of 100 words without appropriate punctuation - S will insert proper punctuation in the paragraph - 80% accuracy
LAC 70	1 3	- Given a writing assignment of 100 words or more - S will use proper punctuation in written work - 80% accuracy
LAC 71	3	- Given a writing assignment of 100 words or more - S will use commas where appropriate in written work - 80% accuracy
LAC 74	1	- Given a writing assignment of 100 words or more - S will use quotation marks where appropriate in written work - 80% accuracy

INFORMATION RETRIEVAL AND PROCESSING

LAD 03	3	- Given a list of ten words in random order - S will alphabetize words to the third letter - 80% accuracy
LAD 13	3	- Given a dictionary and a list of ten words - S will locate definitions of words in a dictionary giving correct page number - 100% accuracy
LAD 15	1	- Given a name, subject, or topic to locate in a file, telephone book, index, or encyclopedia - S will locate the word without assistance and specify the page number and words before and after - 90% accuracy
LAD 19	3	- Given a page from a standard dictionary - S will identify in writing the dictionary guide words for a particular word and verbally explain how to use guide words - 100% accuracy
LAD 25	3	- Given access to a set of encyclopedias and a selected topic - S will locate the information for a particular topic in an encyclopedia and write down major points - 90% accuracy on location

LAD 64	1	- Given a local telephone book and instructions to identify emergency numbers (fire station, police, ambulance, physician) - S can locate and write emergency telephone numbers - 100% accuracy
LAD 65	1	- Given five various information guides (menues, TV listings, directories, etc.) - S will demonstrate how to use information guides by locating a specified piece of information from each - 90% accuracy
LAD 66	1	- Given a 500 word reading passage or a list of items containing 5 pieces of factual information on a topic - S will demonstrate the use of skimming to locate information - 90% accuracy in five minutes
SPELLING		
LAE 07	1 3	- Given a list of ten spelling words taken from S's reading, vocabulary, or spelling spellers - S will spell ten new words each week - 90% accuracy
LAE 09	1 3	- Given a list of fifteen spelling words taken from S's reading, vocabulary, or spelling spellers - S will spell fifteen new words each week - 90% accuracy
LAE 11	1 3	- Given a list of more than fifteen spelling words taken from S's reading, vocabulary, or spelling spellers - S will spell more than fifteen new words each week - 90% accuracy
LAE 15	1 3	- Given verbal or written instructions - S will spell the days of the week - 90% accuracy and legible
LAE 20		- Given verbal or written instructions - S will spell the months of the year - 90% accuracy and legible

LAA 14	2	-Given questions beginning with who, what, where, why and when. -S can answer questions with a 3tc 5 word as response. -90% accuracy.
LAA 27.	2	-Given words presented on flashcards or list. -S can call the words, increasing vocabulary by five words each month. -100% accuracy on three trials in succession.
LAA 41	2	-Given an opportunity to participate in a group or individual discussion. -S will make contributions to the discussion which are clear and to the point. -Does not require questions from others for clarification.
LAA 43	2	-Given a selected topic for group discussion. -S can orally express own ideas. -Adds contribution to discussion that is different from others.
LAA 54	2	-Given a five frame picture story in random order. -S can sequence pictures in proper order and tell the story without teacher assistance. -100% accuracy on both pictures and story.
LAB 25	2	-Given a verbal or written request to write the current date, yesterdays date, and tomorrows date. -S can sequence pictures, in proper order and tell the story without teacher assistance. -100% accuracy on both pictures and story.
LAB 36	2	-Given five different standard forms containing blanks for personal data with explanation by teacher. -S will copy name, address, and telephone number onto appropriate blanks on forms. -100% accuracy.
LAB 64	2	-Given a short tape recorded message 5" to 30" long. -S can record telephone messages. -100% accuracy on information given.

LAC 02	2	-Given ten sentences, appropriate infinitives and teacher assistance. -S will write correct verb forms for sentences. -90% accuracy.
LAC 12	2	-Given ten sentences selected from reading assignments with common nouns missing. -S will write nouns in sentences. -90% accuracy.
LAC 13	3	-Given five sentences selected from reading assignments with 2 adjectives missing. -S will write appropriate adjectives in sentences. -90% accuracy.
LAC 16	2	-Given ten sentences selected from reading assignments with appropriate verbs missing. -S will write some form of the appropriate verb in sentence. -90% accuracy.
LAC 52	2	-Given ten sentences 5 to 10 words each selected from reading assignment. -S will identify the beginning and end of a sentence -100% accuracy.
LAC 68	2	-Given ten sentences selected from reading assignments requiring either an exclamation mark, question mark, or period -S will use the 3 forms of sentence punctuation. -90% accuracy.
LAD 16	2	-Given five unknown words with appropriate dictionary markings and the pronunciation key. -S will say correct pronunciation. -80% accuracy.
LAD 45	2	-Given table of contents and an index from a selected book and five information topics to locate. -S will write the correct page(s) on which specific information can be found. -90% accuracy.

LAD 56	2	-Given an appropriate form for inquiry (e.g. introduction, statement of interest, brief qualifications and inquiry) and a help wanted ad related to a preferred job from the local newspaper. -S will demonstrate the appropriate use of the telephone to answer a newspaper about a job. -90% accuracy on checklist.
LAE 27	2	-Given five randomly selected number words from one to twenty presented orally. -S will spell orally or in writing number of words correct. -90% accuracy and legible.
LAE 29	2	-Given ten randomly selected number words from one to fifty. -S will write number words correctly from one to fifty. -90% accuracy and legible.

CIMS

Computer-Based IEP Management System

Version 6.0

Smith Research Center / Indiana University

IEP SUBSYSTEM Executive

<1> ACCESS Student IEP
<2> REPORT Student IEP
<3> REPORT Student IEP Progress
<4> ACCESS Student Profile
<5> HELP
<6> EXIT

ress the <KEY> for the FUNCTION you desire.

Computer-Based IEP Management System / Version 6.0
ACCESS Student IEP

Student Number? (0-99) 1

IEP Number? (1 or 2) 1

RIGHT-ARROW>=Select Field, <LEFT-ARROW>=Backspace,
DOWN-ARROW>=Continue, <UP-ARROW>=Exit, <CLEAR>=Clear Field

Computer-Based IEP Management System / Version 6.0
ACCESS Student IEP

1> UPDATE Objective(s) Status
2> ADD Objective(s)
3> EDIT Objective(s)
4> DELETE Objective(s)
5> EXIT
ress the <KEY> for the FUNCTION you desire.

tudent Number: 3066841361/01 - SAMPLE STUDENT
EP Number: 1 has 19 objectives.

Computer-Based IEP Management System / Version 6.0
ACCESS Student IEP <1> UPDATE Objective(s) Status

tudent Number: 3066841361/01 - SAMPLE STUDENT
EP Number: 1 has 19 objectives.
Code:A001 LRO: 1.0 SRO: 1.0
001:This is the second course.
RO Desc.: THIS IS WHERE THE DESCTIPTION FOR LONG-RANGE OBJECTIVE NUMBER 1.0 WOULD APPEAR.
RO Desc.: THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 1.0 (UNDER LRO 1.0) WOULD APPEAR.
RO Criterion: 95 percent
tatus: INCOMPLETE
s SRO COMPLETED? <Y/N> Yes
ercentage Correct?, 98

Computer-Based IEP Management System / Version 6.0
REPORT Student IEP

'itle for IEP Report(s)
ANYCITY PUBLIC SCHOOLS SPECIAL EDUCATION DEPT..........

LEFT-ARROW>=Backspace,
DOWN-ARROW>=Continue, <UP-ARROW>=Exit, <CLEAR>=Clear Field

Computer-Based IEP Management System / Version 6.0
REPORT Student IEP

tudent Number? (0-99) 1
EP Number? (1 or 2) 1

LEFT-ARROW>=Backspace,
DOWN-ARROW>=Continue, <UP-ARROW>=Exit, <CLEAR>=Clear Field

Individualized Educational Program (NOT a Contract)
ANYCITY PUBLIC SCHOOLS SPECIAL EDUCATION DEPT.

Student Number/IEP Number/Name: 3066841361-01/1/ SAMPLE STUDENT
Address: 219 ANY STREET, ANYCITY, IN 47401
School: DYER JR. HIGH
Grade: 8
Program/Service: LD/FT
Date of Last Psychological Test: 01/01/81

Current Mathematics Instructional Level: ....

Current Reading Instructional Level: ....

The courses/areas and related objectives in this student's individualized education program have been developed specifically for pupils formally in the above listed special education area (Mildly Mentally Handicapped, Learning Disabled, Visually Handicapped, etc.).

At the end of the semester, the teacher will indicate which of the objectives have been mastered in a report which will be included in the pupil records. This achievement report will reflect not only the student's individual achievement in the course/area, but will also be utilized to plan his/her future course/area objective assignments.

It also should be noted that the teacher of each course/area may assign additional objectives, should student progress warrant it.

The achievement of the objectives shall be determined

by: ....

Person(s) attending Case Conference:

....

....

....

....

....

....

....

....

CIMS 6.0 Student IEP Report

Individualized Educational Program (NOT a Contract)

ANYCITY PUBLIC SCHOOLS SPECIAL EDUCATION DEPT.

Student Number/IEP Number/Name: 3066841361-01/1/ SAMPLE STUDENT

A000: THIS IS THE FIRST COURSE :

LRO: 1.0 THIS IS WHERE THE DESCRIPTION FOR LONG-RANGE OBJECTIVE NUMBER 1.0 WOULD APPEAR

SRO: 1.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 1.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 80 percent

SRO: 2.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 2.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 95 percent

SRO: 3.0 THIS IS WHERE THE DESCRIPTION OF SHORT-RANGE OBJECTIVE NUMBER 3.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 100 percent

SRO: 4.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 4.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 95 percent

LRO: 2.0 THIS IS WHERE THE DESCRIPTION FOR LONG-RANGE OBJECTIVE NUMBER 2.0 WOULD APPEAR.

SRO: 1.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 1.0 (UNDER LRO 2.0) WOULD APPEAR.
Criterion: 100 percent

SRO: 2.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 2.0 (UNDER LRO 2.0) WOULD APPEAR.
Criterion: 100 percent

SRO: 3.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 3.0 (UNDER LRO 2.0) WOULD APPEAR.
Criterion: 95 percent

A001: This is the second course. :

LRO: 1.0 THIS IS WHERE THE DESCTIPTION FOR LONG-RANGE OBJECTIVE NUMBER 1.0 WOULD APPEAR.

SRO: 1.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 1.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 95 percent

SRO: 2.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 2.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 95 percent

SRO: 3.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 3.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 100 percent

A002: This is the third course :

LRO: 1.0 THIS IS WHERE THE DESCRIPTION FOR LONG-RANGE OBJECTIVE NUMBER 1.0 WOULD APPEAR

SRO: 1.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 1.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 90 percent

Student Number/IEP Number/Name: 3066841361-01/1/ SAMPLE STUDENT

SRO: 2.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 2.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 100 percent

SRO: 3.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 3.0 (UNDER LRO 1.0) WOULD APPEAR.
Criterion: 95 percent

LRO: 2.0 THIS IS WHERE THE DESCRIPTION FOR LONG-RANGE OBJECTIVE NUMBER 2.0 WOULD APPEAR.

SRO: 1.0 THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE OBJECTIVE NUMBER 1.0 (UNDER LRO 2.0) WOULD APPEAR.
Criterion: 95 percent

Computer-Based IEP Management System / Version 6.0
REPORT Student IEP Progress

itle for IEP Progress Report(s)?
ANYCITY PUBLIC SCHOOLS SPECIAL EDUCATION DEPT..........

LEFT-ARROW>=Backspace,
DOWN-ARROW>=Continue, <UP-ARROW>=Exit, <CLEAR>=Clear Field

Computer-Based IEP Management System / Version 6.0
REPORT Student IEP Progress

Student Number? (0-99) 1

IEP Number? (1 or 2) 1

<LEFT-ARROW>=Backspace,
<DOWN-ARROW>=Continue, <UP-ARROW>=Exit, <CLEAR>=Clear Field

IMS 6.0 Student IEP Progress Report Page 1
ndividualized Educational Program (NOT a Contract)
NYCITY PUBLIC SCHOOLS SPECIAL EDUCATION DEPT.

tudent Number/IEP Number/Name: 3066841361-01/1/ SAMPLE STUDENT
ddress: 219 ANY STREET, ANYCITY, IN 47401
chool: DYER JR. HIGH
rade: 8
rogram/Service: LD/FT
ate of Last Psychological Test: 01/01/81

urrent Mathematics Instructional Level: ....

urrent Reading Instructional Level: ....

The courses/areas and related objectives in this student's individualized ducation program have been developed specifically for pupils formally in the bove listed special education area (Mildly Mentally Handicapped, Learning isabled, Visually Handicapped, etc.).

At the end of the semester, the teacher will indicate which of the bjectives have been mastered in a report which will be included in the pupil's ecords. This achievement report will reflect not only the student's individual chievement in the course/area, but will also be utilized to plan his/her future ourse/area objective assignments.

It also should be noted that the teacher of each course/area may assign dditional objectives, should student progress warrant it.

he achievement of the objectives shall be determined

y: ....

erson(s) attending Case Conference:

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==========================================================================
IMS 6.0 Student IEP Progress Report                              Page 1
ndividualized Educational Program (NOT a Contract)
NYCITY PUBLIC SCHOOLS SPECIAL EDUCATION DEPT.
==========================================================================
tudent Number/IEP Number/Name: 3066841361-01/1/ SAMPLE STUDENT
==========================================================================
==========================================================================
000:THIS IS THE FIRST COURSE                                :
RO:  1.0   THIS IS WHERE THE DESCRIPTION FOR LONG-RANGE
           OBJECTIVE NUMBER 1.0 WOULD APPEAR
           SRO:   1.0   THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE
                        OBJECTIVE NUMBER 1.0 (UNDER LRO 1.0) WOULD APPEAR.
       * COMPLETED * Criterion:  80 percent - Score:  97 percent
>>>  25 % of the SROs for LRO  1.0 have been COMPLETED.
RO:  2.0   THIS IS WHERE THE DESCRIPTION FOR LONG-RANGE
           OBJECTIVE NUMBER 2.0 WOULD APPEAR.
           SRO:   1.0   THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE
                        OBJECTIVE NUMBER 1.0 (UNDER LRO 2.0) WOULD APPEAR.
       * COMPLETED * Criterion: 100 percent - Score: 100 percent
>>>  33 % of the SROs for LRO  2.0 have been COMPLETED.
>>>  29 % of the SROs for A000 have been COMPLETED.
==========================================================================
001:This is the second course.                              :
RO:  1.0   THIS IS WHERE THE DESCTIPTION FOR LONG-RANGE
           OBJECTIVE NUMBER 1.0 WOULD APPEAR.
           SRO:   1.0   THIS IS WHERE THE DESCRIPTION FOR SHORT-RANGE
                        OBJECTIVE NUMBER 1.0 (UNDER LRO 1.0) WOULD APPEAR.
       * COMPLETED * Criterion:  95 percent - Score:  98 percent
>>>  33 % of the SROs for LRO  1.0 have been COMPLETED.
>>>  33 % of the SROs for A001 have been COMPLETED.
==========================================================================
002:This is the third course                                :
RO:  1.0   THIS IS WHERE THE DESCRIPTION FOR LONG-RANGE
           OBJECTIVE NUMBER 1.0 WOULD APPEAR
>>>  0 % of the SROs for LRO  1.0 have been COMPLETED.
RO:  2.0   THIS IS WHERE THE DESCRIPTION FOR LONG-RANGE
           OBJECTIVE NUMBER 2.0 WOULD APPEAR.
>>>  0 % of the SROs for LRO  2.0 have been COMPLETED.
>>>  0 % of the SROs for A002 have been COMPLETED.
```

Computer-Based IEP Management System / Version 6.0
ACCESS Student Profile

tudent Number? (0-99) 1

LEFT-ARROW>=Backspace,
DOWN-ARROW>=Continue, <UP-ARROW>=Exit, <CLEAR>=Clear Field

ACCESS Student Profile / HELP

Use the <UP-ARROW> and <DOWN-ARROW> keys to move the pointer to the item to be changed.
Press the <SHIFT> and <*> keys together before changing the item indicated by the pointer.

Press the <P> key to PRINT the Student Profile.
Press the <K> key to see the codes allowed for items marked: (see key)

Press the <E> key to EXIT and UPDATE the Student Profile.
Press the <?> key to EXIT and NOT UPDATE the Student Profile.
Press the <SPACE BAR> when READY

IMS 6.0 Student Profile as of 10/18/83

tudent Code Number:	3066841361/01
ame:	SAMPLE STUDENT
arent or Guardian:	MR. AND MRS. STUDENT
treet Address:	219 ANY STREET
ity and State:	ANYCITY, IN
ipcode:	47401
hone # (AAAEEENNNN):	812-555-1212
ex (M or F):	M
ace:	CAUCASIAN
irthdate (MMDDYY):	03/02/72
chool:	DYER JR. HIGH
rade:	8
rogram Code (see key):	LD
ervice Code (see key):	FT
ost Recent Psych. Test:	01/01/81

rogram Codes:
MR = Severely Mentally Retarded
OMH = Moderately Mentally Handicapped
MH = Mildly Mentally Handicapped
D = Learning Disabled
D = Emotionally Disturbed
H = Physically Handicapped
H = Visually Handicapped
H = Hearing Handicapped
H = Communications Handicapped
UT = Autistic

Service Codes:
FT = Full-Time
PT = Part-Time in:
1 = Social Science
2 = Science
3 = Language Arts
4 = Math
5 = P.V.E.
R = Resource

APPENDIX B

INFORMAL MATH INVENTORY

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

PROBE = 1

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

PROBE = 2

4 +8	8 +6	9 +7	3 +8	9 +9	7 +4
7 +7	9 +4	3 +9	6 +7	8 +6	9 +8
8 +8	4 +7	8 +8	3 +9	6 +7	7 +5
6 +9	9 +5	5 +7	9 +8	7 +9	3 +8
4 +7	3 +9	7 +6	8 +4	4 +7	9 +6
8 +4	9 +2	8 +4	6 +8	3 +9	8 +3
9 +2	7 +9	4 +7	8 +5	6 +8	9 +4
7 +9	9 +8	6 +9	9 +3	8 +9	7 +7
5 +8	6 +5	7 +7	5 +6	9 +4	3 +8
8 +7	9 +4	6 +6	8 +7	5 +9	8 +4

PROBE = 7

$4 - 2 =$ ___	$6 - 5 =$ ___	$9 - 4 =$ ___	$5 - 1 =$ ___	$8 - 7 =$ ___	$7 - 5 =$ ___
$6 - 1 =$ ___	$9 - 2 =$ ___	$4 - 3 =$ ___	$7 - 5 =$ ___	$9 - 2 =$ ___	$8 - 3 =$ ___
$9 - 2 =$ ___	$6 - 1 =$ ___	$7 - 4 =$ ___	$9 - 3 =$ ___	$3 - 1 =$ ___	$7 - 6 =$ ___
$8 - 5 =$ ___	$4 - 3 =$ ___	$9 - 2 =$ ___	$7 - 5 =$ ___	$8 - 4 =$ ___	$4 - 1 =$ ___
$6 - 1 =$ ___	$8 - 2 =$ ___	$5 - 3 =$ ___	$9 - 6 =$ ___	$7 - 1 =$ ___	$6 - 5 =$ ___
$8 - 4 =$ ___	$6 - 5 =$ ___	$9 - 6 =$ ___	$8 - 3 =$ ___	$3 - 2 =$ ___	$9 - 6 =$ ___
$3 - 2 =$ ___	$8 - 6 =$ ___	$7 - 1 =$ ___	$9 - 8 =$ ___	$5 - 3 =$ ___	$8 - 1 =$ ___
$6 - 3 =$ ___	$7 - 2 =$ ___	$8 - 6 =$ ___	$4 - 1 =$ ___	$6 - 2 =$ ___	$5 - 4 =$ ___
$8 - 4 =$ ___	$5 - 3 =$ ___	$9 - 8 =$ ___	$8 - 2 =$ ___	$5 - 3 =$ ___	$9 - 6 =$ ___
$4 - 2 =$ ___	$9 - 1 =$ ___	$8 - 4 =$ ___	$6 - 3 =$ ___	$7 - 1 =$ ___	$4 - 2 =$ ___

PROBE = 15

65 X3	54 X9	88 X3	38 X9	13 X6	54 X5
65 X2	68 X7	22 X5	39 X4	33 X8	85 X5
53 X5	42 X8	28 X5	49 X9	46 X3	18 X4
86 X4	33 X9	67 X8	45 X9	79 X8	17 X5
82 X9	57 X6	58 X9	35 X2	68 X6	54 X8
22 X8	27 X7	14 X9	19 X8	46 X5	84 X4
54 X7	34 X9	37 X7	33 X5	69 X7	53 X7
59 X2	79 X7	59 X5	76 X6	28 X2	27 X2
75 X3	33 X4	87 X5	65 X6	55 X7	79 X9
56 X8	64 X6	48 X8	67 X2	88 X7	28 X9

APPENDIX C

OPERATION, CLUSTER, AND SKILL LIST

ADDITION

Probe #1 - Addition Facts, 1 to 10 with sum < 11

Skill Levels	Sums to
1	1 (Addends = 1 through 10)
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10

	Add Facts
11	+1 (Maximum Sum = 10)
12	+2
13	+3
14	+4
15	+5
16	+6
17	+7
18	+8
19	+9

PROBE #2 - Addition Facts, 2 to 9 with sum > 10 < 19

Skill Levels	Sums to
20	11 (Single Digit Addend Only)
21	12
22	13
23	14
24	15
25	16
26	17
27	18

	Add Facts
28	+2 (Sum = 11 through 18, Single Digit Addend Only)
29	+3
30	+4
31	+5
32	+6
33	+7
34	+8
35	+9

PROBE #3 - Addition Facts,

Double Digit + Single Digit With No Carry

Skill Levels

36 Double Digit/Single Digit - No Carry
37 Double Digit on Top - Single on Bottom - No Carry
38 Double Digit on Bottom - Single on Top - No Carry

PROBE #4 - Addition Facts,

Double Digit + Single Digit With Carry

Skill Levels

39 Double Digit/Single Digit - With Carry
40 Double Digit on Top - Single on Bottom - With Carry
41 Double Digit on Bottom - Single on Top - With Carry

PROBE #5 - Addition Facts,

Double Digit + Double Digit With No Carry

Skill Levels

42 Double/Double + No Carry

PROBE #6 - Addition Facts

Double Digit + Double Digit With Carry

Skill Levels

43 Double/Double - With Carry

SUBTRACTION

PROBE #7 - Subtraction Facts, Single Digit - Single Digit

Skill Levels	Minuend
44	-1 (Single Digit Minuend and Subtrahend)
45	-2
46	-3
47	-4
48	-5
49	-6
50	-7
51	-8
52	-9

	Remainder
53	1 (Remainder < 10)
54	2
55	3
56	4
57	5
58	6
59	7
60	3
61	9

PROBE #8 - Subtraction Facts, Double Digit - Single Digit With No Borrow

Skill Levels	Subtrahend
62	-0 (Subtrahend < 10)
63	-1
64	-2
65	-3
66	-4
67	-5
68	-6
69	-7
70	-8
71	-9

PROBE #9 - Subtraction Facts,

Minuend > 9 < 19, Subtrahend 1 - 9 With Borrow

Skill Levels	Subtrahend
72	-1
73	-2
74	-3
75	-4
76	-5
77	-6
78	-7
79	-8
80	-9

PROBE #10 - Subtraction Facts,

Double Digit - Single Digit With Borrow

Skill Levels	Subtrahend
81	-1
82	-2
83	-3
84	-4
85	-5
86	-6
87	-7
88	-8
89	-9

PROBE #11 - Subtraction Facts,

Double Digit - Double Digit With No Borrow

Skill Levels

90

PROBE #12 - Subtraction Facts,

Double Digit - Double Digit With Borrow

Skill Levels

91

MULTIPLICATION

PROBE #13 - Multiplication Facts, Single Digit x Single Digit

Skill Levels	Multiplier
92	1x
93	2x
94	3x
95	4x
96	5x
97	6x
98	7x
99	8x
100	9x

PROBE #14, Multiplication Facts, Single Digit x Double Digit With No Carry

Skill Levels

101

PROBE #15, Multiplication Facts, Single Digit x Double Digit With Carry

Skill Levels

102

DIVISION

PROBE #16 - Division Facts, 1 - 9

Skill Levels	Answer
103	1
104	2
105	3
106	4
107	5
108	6
109	7
110	8
111	9
	(Divisor)
112	1
113	2
114	3
115	4
116	5
117	6
118	7
119	8
120	9

APPENDIX D

CORRELATIONS OF COMPUTER MEASURES WITH PAPER AND PENCIL MEASURES

	Instructional Phase			
	B(1)		B(2)	
Student	Operation Area	Corr.	Operation Area	Corr.
A1	Subt.	.99	Mult.	.95
A2	Mult.	.99	Subt.	.98
A3	Subt.	.91	Mult.	.88
A5	Add.	.82	Subt.	.77
A6	Subt.	.99	Mult.	.52
A7	Subt.	.95	Div.	.76
A8	Mult.	.95	Subt.	.26
A9	Subt.	.52	Mult.	.96
A10	Mult.	-.14	Div.	-.99
A11			Subt.	.95
A12	Add.	.87	Subt.	.88
A13			Mult.	.99
A14	Subt.	.70	Div.	.48
A15	Div.	.41	Subt.	.85

Table Correlations of Paper-and-Pencil and Computer Measures Across Three Baseline Periods for Each Student. Digits per Minute Correct.