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ABSTRACT

Computer assisted instruction (CAI) in Biology and Developmental Reading was administered at two junior high schools and two senior high schools in Philadelphia. The achievement of the students in CAI was compared with comparable students in traditionally instructed classes. The results of the standardized tests were equivocal. In Reading, the CAI classes performed significantly better than comparable students in traditional classes. Differences in achievement were not obtained between the CAI and traditional Biology classes. This was attributed to computer down time and a lack of sufficient content validity in the standardized Biology test. An attitude survey constructed for the project indicated that the pupils liked working with the machines, but were frustrated when the system did not function properly. A discussion of the project, including the results of unstandardized achievement tests, and an analysis of the pupils' responses while interacting with the computer is included. Tables of statistical data supplement the report. The appendix contains a list of topics covered in the CAI units and samples of the student and teacher questionnaires. (Author/JY)

THE SCHOOL DISTRICT OF PHILADELPHIA

A REPORT ON PROJECT GROW: PHILADELPHIA'S EXPERIMENTAL PROGRAM IN COMPUTER ASSISTED INSTRUCTION

OFFICE OF RESEARCH AND EVALUATION

BOARD OF EDUCATION
THE SCHOOL DISTRICT OF PHILADELPHIA, PA.

A REPORT ON PROJECT GROW: PHILADELPHIA'S EXPERIMENTAL PROGRAM IN COMPUTER ASSISTED INSTRUCTION

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August, 1969

Preface:

The attached report covers the first full year of operation of Project GROW, the large Computer Assisted Instruction project of the Philadelphia Schools. Use of developmental research as a basis for decision making in Project GROW marks it as an unusual effort for a public school system, and we are very pleased that research results have been useful in helping to identify a number of needed program changes, and in answering certain basic questions. Answers to these questions were used in planning the GROW program for the coming year.

The report is quite frank, as a good research report must be, in discussing both strengths and weaknesses of the project. Overall, the results are quite promising and clearly suggest great potential for CAI, as it is being used in project GROW. We feel that good progress was made the first year, both in the program itself and in the related research design, and we look forward to even more meaningful results at the end of 1969-1970.

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Abstract:

Computer Assisted Instruction (CAI) in Biology and Developmental Reading was administered at two junior high schools and two senior high schools in Philadelphia.

The achievement of the students in CAI was compared with comparable students in traditionally instructed classes.

The results of the standardized tests were equivocal. In Reading, the CAI classes performed significantly better than comparable students in traditional classes. Differences in achievement were not obtained between the CAI and traditional Biology classes. This was attributed to computer downtime and a lack of sufficient content validity in the standardized Biology test.

An attitude survey constructed for the project indicated that the pupils liked working with the machines but were frustrated when the system did not function properly.

A discussion of the project including the results of unstandardized achievement tests and an analysis of the pupils' responses while interacting with the computer was included.

Introduction:

This report presents a summary of the Project Grow activities for the school year 1968-1969. The report is divided into five sections. The first deals with a description of the system and data relating student performance to some variables collected as part of the computer programs employed in Project Grow. We typically refer to these as "on-line" data.

The second section presents the results of the standardized achievement tests given in June, 1969 to the students participating in the project. Testing was done for both Project Grow curricula: Biology and Reading. For the purposes of comparison, we have also presented data in sections two and three for students in traditionally instructed classes.

Section three discusses the results of an attitude survey given to both students and teachers participating in the project. These data may indicate directions for subsequent research.

The fourth section discusses the results of achievement tests which have been constructed for use in the program. We have used the term "off-line" to designate these data.

Sections one through four include explanations and summaries. In addition, section five presents an overall summary and suggestions for the future.

Before presenting the data from the past months' activities, a very important caveat needs to be included. We in Philadelphia have what is probably the most sophisticated Computer Assisted Instruction system in the country. This sophistication can only be achieved by manipulating a highly complex system of computer hardware, software, and peripheral equipment such as teletypes. What has happened this past year is that, partly because of the experimental nature of the program and partly because of the complexity of the system, there has been a great deal of so-called "down-time." That is, there have been times when

the system has not functioned properly. Therefore, we have only partial data in many areas and frequently have been able to ask more questions than we have answered. In fact, there is almost no data from Wanamaker Junior High School because of a very late start in Computer Assisted Instruction and because of resulting "down-time." Problem areas such as this are to be expected during the implementation of a new system. We must caution the reader not to dismiss the concept of CAI based upon the results of a few months with an experimental program. This would be a great disservice to the pupils and teachers involved.

We believe that our general feeling concerning CAI can be summarized by quoting one of the teachers participating in Project Grow. As he said:

"Advertise (if advertise you must):

a) that the program is experimental.

b) that there are 'bugs,' and that debugging will take place in due time.

c) that units of work are constantly revised as the need arises.

d) that the work will be adapted to a changing school population as we find changes in attitude, approach, method, material, and evaluation are needed.

e) above all, stress the CAI aspect of the program - Computer Assisted Instruction - that the system in no way is intended to supplant the teacher - that the human brain in no instance is meant to be replaced by an electronic brain.

f) that teacher attitude can affect the success of the CAI program. Teachers need to be patient, need to believe in the program, need to grow into the program, which is an evolving one.

g) that we are 'pioneering' and have only begun to scratch the surface. We look forward hopefully to mastering techniques and processes that will demonstrate the increasing value of CAI instruction."

Finally, the reader needs to be aware of an event which took place during February, 1969. At that time the Central Processor, which had been at the Philco-Ford plant in Willow Grove was moved into a building shared by the Pennsylvania Advancement School at 5th and Luzerne Streets. In addition, the sophistication of the system was increased through the incorporation of a different computer as the Central Processor. The results of this change in hardware and location have been as indicated above. Our data are preliminary. They are tentative. They need to be considered as only a starting point toward future experimentation.

Section One

Description of the system:

The CAI system in Philadelphia currently employs two curricula: Biology and Reading. In the future, Mathematics will be added. Four schools are involved in the project, two high schools and two junior high schools. The majority of the high school students who participate in the project are in the tenth grade while the typical junior high student is an eighth or ninth grader.

In each school there are eight so-called SAVI units. SAVI stands for student-audio-visual interface. The interfaces are integrated system elements containing both visual receiving equipment and keyboard transmitting equipment. Through these devices, students are presented with alphanumeric or graphic information in visual form. The keyboard provides the facility for typing responses into the system. In addition, the student may use a light pen to simply point at appropriate information as another method of responding. At each school there is also a cluster processor which is made up of computing and control elements, a magnetic core memory, and a mass memory in which the curriculum programs are entered and stored.

The outermost element of the system, the Central Processor, is a large scale computer with extensive magnetic core and mass storage facilities. The Central Processor is designed to handle large amounts of intricate data, to do statistical analyses and to solve mathematical problems. In our system, the curriculum is developed in the Central Processor and stored there for later distribution to the schools as required throughout the day.

At both the schools and the Central Processor, there is the necessary peripheral equipment such as teletypes, punched card handlers, and printers, plus

other devices necessary to the development, entry, storage, and retrieval of the curriculum material.

The programming language used in the CAI system is referred to as the INFORM author language. Using this language, the authors have taken the curriculum material and translated it into a form which can be stored in the computer. Each topic in the curriculum is a collection of concepts. We can think of a concept as a small instructional group which gets united with other concepts to form a topic. Each concept includes instructional material with which the student interacts. The computer then monitors the results of that interaction, noting such information as how long a student took to respond, whether he was right or wrong, and so on. The students' responses are examined according to a set of categories. For example, a student's response will be classified as Correct, Incorrect, Anticipated Wrong (this means the curriculum writers inserted answers which were neither right nor wrong but which they anticipated the students would give. When finding one of these Anticipated Wrong answers, the computer might then branch the student into a specific remedial path), Time-up (the student did not respond in the specified time, usually five minutes), Unrecognized Wrong Answer (not a response which fell into the previous categories but it was not a recognizable one either), or Inclusive (none of the above).

By using the data in these categories and other information, the computer generates reports which can indicate the learning patterns of a particular student or groups of students.

Five types of reports can be generated. They are typically referred to as off-line reports and are outlined below.

The off-line reports include:

a. Trace--Detailed student activity reports produced by special request
b. Question Summary--Author report for question validation and analysis
c. Student Summary--Teacher report on cumulative student progress

d. Topic Summary--Author report for topic analysis and validation
e. Weekly Summary--Teacher report on student progress prepared weekly
f. Daily Schedule--System schedule report prepared daily for operations use

a. Trace Report

This report is a highly detailed research-type report which specifies each curriculum question label and response recorded and evaluated by the system. The report may be used to determine exactly how a specified student answered every question within a specified curriculum segment as recorded on the Student History File. Data described in the Trace includes:

(1) Heading Data--Report number, title and student ID number, and requestor's name.
(2) Concept Labels--Concept number, major and minor label numbers
(3) Response Time--Latency time in seconds for each question (label) answered by the student
(4) Input Mode--Answer type: K for keyboard or L for Lightpen
(5) Examine Mode--Indicates whether Key Group (K) or Specific Order (O) options were specified for question's Examine command
(6) Response Code--Specifies which answer command was accessed by the student (C, W, A, T, U or X). Answer numbers and answer part numbers or each C, W, or A answer matches are printed. If an unrecognized (U or X) answer is given, the actual wrong typed response or lightpen coordinates are printed.

b. Question Summary Report

This is an author report which indicates how a particular question was answered by all students to date. It provides the following data:

(1) Number of students answering the question
(2) Number of attempts (responses) to the question
(3) Number of students correct on first attempt
(4) Average response (latency) time in seconds. Longest and shortest latency time in seconds
(5) The number and percentage of each answer type given by all students sampled is printed (correct, wrong, anticipated, time-up, unrecognized and inclusive X path answers)
(6) Unrecognized wrong answers are printed with frequency data for each
(7) Long form (optional) summaries additionally provide a detailed answer frequency matrix chart. This option is recommended only for complex multi-part questions with a large variety of possible answers

c. Student Summary Report

This is a teacher report providing cumulative student progress data. A picture of each student's activity for the term is presented with average scores, latencies and topic times. The report consists of the following:

(1) Heading data: Report title, student name and ID number, request name and report date
(2) Number of topics completed to date
(3) Average number of responses (per topic)
(4) Average latency time in seconds (for each question answered)
(5) Average topic time in hours and minutes
(6) Average scores are given as follows:

Number and percentage	Correct	(C)
" " "	Wrong	(W)
" " "	Anticipated	(A)
" " "	Time-Up	(T)
" " "	Unrecognized	(U)
" " "	Inclusive	(X)

(7) Counter totals (cumulative) for all topics are also given

c. Topic Summary Report

This is mainly an author report which is useful in determining overall student success in handling a particular topic or test. The report specifies the same type of data items as the Student Summary, but for all students recorded to date rather than one specific student.

Data includes:

(1) Heading data--Report title, topic name, requestor's name, report date
(2) Number of students completing the topic
(3) Average number of responses
(4) Topic time in hours and minutes
(5) Average latency time per response in seconds
(6) Cumulative counter totals

e. Weekly Summary Report

This report is prepared and distributed weekly for all teachers and is the most important off-line prepared teacher report. The report is formatted with a separate detailed report for each student assigned to a particular teacher, sequenced by teacher ID and student ID for each teacher's class.

Data includes:

(1) Heading data--Report title, teacher name, report date (week beginning)
(2) Student data includes: Student ID number, name and Topic name and statistical topic data for each topic completed
(3) Topic data includes: number of responses, topic time in hours and minutes, average latency time in seconds, number and percentage of each type of answer given (C, W, A, T, U, X)
(4) Optional counter print-outs can also be requested (long form) but are not recommended.

f. Daily System Schedule Report

This report is prepared daily and is designed for central operations control usage. A list of all students scheduled that day is given by school cluster and period. Data includes: student ID number, student name and current concept number. A duplicate of this report is automatically transmitted to each GROW school cluster and printed on the cluster ASR teletypewriter each morning on startup.

Three ASR Teletype reports are also generated.

The on-line ASR reports are constantly being printed on the ASR teletype associated with each cluster computer system. These reports include the

(a) Daily Cluster Schedule Report
(b) Student Sign-Off Report
(c) Student Topic Report

a. Daily Cluster Schedule Report

This report is identical to the off-line printed schedule report but with data for that particular school cluster. The report lists the period, scheduled student ID numbers, student names and current concept numbers for all students scheduled for terminal activity that day.

b. Sign-Off Report

This report is printed as soon as each student signs-off from the terminal. The report includes:

(1) Student ID number, name and date
(2) Time on and off the terminal in 2400 hour clock time.
(3) Number of responses made
(4) Ending concept and label number

c. Student Topic Report

This report is printed each time each student completes a different topic unit or topic test. The report includes:

(1) Student name and report date
(2) Name of current topic completed (or test)
(3) Topic completion time in hours and minutes
(4) Number of responses
(5) Number of correct answers and percentage correct

The language and the majority of the hardware used in the project have been developed and produced by the Philco-Ford Corporation. Much of this description can be found in the Project Grow Author Reference Manual which was prepared for the School District by Philco-Ford. Figure 1 shows a schematic of the system.

Each CAI class consists of approximately 16 students. During each class period, which lasts roughly 45 minutes, the student spends half his time at the SAVI unit and half his time at a central table with the teacher and the other students not at the consoles. The teacher typically does not interact with the students at the SAVI console so he can devote more of his time to each individual pupil at the central table where appropriate materials are provided to supplement the console curriculum. Since each student progresses at his own rate, each class may have students who are at widely disparate points in the curriculum. This situation can be handled by the computer and at present has not been a problem for the teachers.

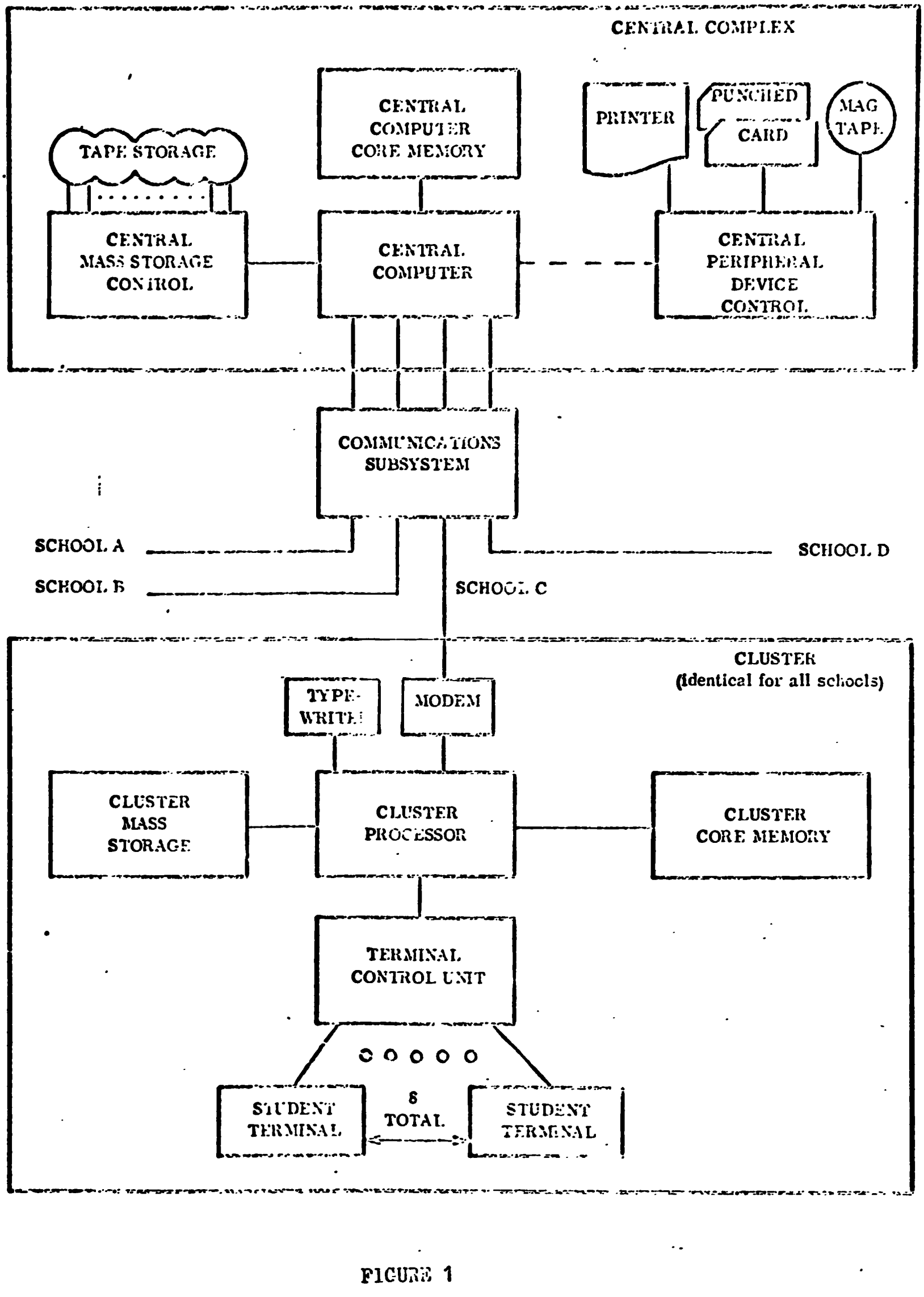
CENTRAL COMPLEX
CENTRAL COMPUTER CORE MEMORY
PRINTER
PUNCHED CARD
MAG TAPE
TAPE STORAGE
CENTRAL MASS STORAGE CONTROL
CENTRAL COMPUTER
CENTRAL PERIPHERAL DEVICE CONTROL
COMMUNICATIONS SUBSYSTEM
SCHOOL A
SCHOOL B
SCHOOL C
SCHOOL D
CLUSTER
(identical for all schools)
TYPE-WRITER
MODEM
CLUSTER MASS STORAGE
CLUSTER PROCESSOR
CLUSTER CORE MEMORY
TERMINAL CONTROL UNIT
8 TOTAL
STUDENT TERMINAL
STUDENT TERMINAL

FIGURE 1

Analysis of the Relationship between Curriculum-Related Variables and Unit Achievement in CAI Biology

This section of the report describes the results of an analysis done to determine the relationship between a student's performance during a unit or topic of instruction and his final achievement on that unit. The variables included in this analyisis were those that were collected as part of the weekly summary reports generated by the Philco-Ford CAI system. Briefly, these summaries show the topics and topic tests completed by each student in any one week. Report (e) described on page 1-4 was used for this analysis. Also included were data on variables which were hypothesized to be related to test performance and would therefore be relevant in differentiating among the various students in the CAI classes. These curriculum-related variables were:

1. Sex of student: Sex is not a curriculum-related variable but was included in this analysis.

2. Time on Unit: This is the time it took the student to complete the unit, in minutes.

3. The average time it took a student to answer each question in the unit, in tenths of a second.

4. The number of correct answers given in a unit.

5. The number of wrong answers given in a unit. These are actual wrong answers and omitted answers.

6. The number of answers that were not correct, wrong, or omitted. This would include the number of times a student failed to answer a question in the specified time limit or failed to ever give a recognizable answer, i.e., recognizable to the computer.

7. The time to complete the unit achievement test, in minutes.

8. The average time it took the student to answer the questions on the unit achievement test, in tenths of a second.

9. The dependent variable in this analysis was the number of correct answers to the topic achievement test.

The model used for data analysis was multiple linear regression. The dependent variable was the number right in the unit achievement test and the predictor variables were the first eight variables listed on page 1 - 9 of this report. Since these variables are collected as a matter of routine and since the analysis was not intended to help decide which should be collected in the future, all variables were included rather than doing the analysis in a stepwise fashion where only some would be. Our basic purpose was to determine whether the data now being gathered could be used to predict achievement. If so, this will help us to understand the student-curriculum-computer interaction.

Multiple regression analyses were done for those units where sufficient subjects were available. The number of subjects for whom data were available varied because the pupils progressed at different rates. In addition, the data were collected before the system was moved. Nevertheless, we were able to obtain adequate data for some of the beginning Biology Units. These units were: Cells, Energy and Life, Elements and Compounds, and Chemical Symbols. The reader can consult Appendix 1 for a complete list of the CAI Biology topics. The regression analysis for each Biology Unit is reported below.

For the four units, we have calculated the multiple correlation showing the relationship between the scores on variables 1 through 8 and the criterion variable of unit achievement. We reported whether each of these correlations could be considered statistically different from zero. In essence we are trying to determine whether we can predict student achievement more accurately using these eight variables than we could by guessing pupil achievement by some random method.

The table accompanying each unit's results shows the raw score and standard score weights. We can use these weights to judge which variables make the greatest contribution to the correlation. The variables whose weights are the closest to zero make the least contribution. Each table also includes the average score (MEAN) and the standard deviation (SIGMA) for each variable.

Cells:

Thirty-seven subjects had complete data on Cells. The multiple correlation for predicting unit achievement was 0.736 which was significantly different from zero at the .05 level. Table 1 shows the raw score and standard score regression weights, and the means and standard deviations of the variables involved in the regression analysis. The numbers of the variables correspond to those used on page 1 - 9 of this report.

TABLE 1

REGRESSION WEIGHTS, MEANS, AND STANDARD DEVIATIONS FOR THE VARIABLES USED IN THE REGRESSION ANALYSIS OF CELLS DATA

VARIABLE	RAW SCORE WEIGHT	STANDARD SCORE WEIGHT	MEAN	SIGMA
1	-1.5721	-0.2165	1.5946*	0.4977
2	0.0046	0.0137	41.7297	10.8388
3	-0.0133	-0.0901	133.4324	24.5917
4	0.1376	0.1198	51.1351	3.1461
5	-0.0997	-0.1875	7.7027	6.7981
6	-0.2133	-0.4488	19.2162	7.6053
7	0.0282	0.0140	4.5946	1.8022
8	0.0034	0.0316	104.3784	33.1975
9			12.3514$	3.6149

RAW SCORE INTERCEPT = 13.7763

*MALE = 1; FEMALE = 2

$The test on Cells had 19 items.

Energy and Life:

Twenty-one subjects had complete data on the unit Energy and Life. The achievement criterion was again the number right on a unit test given at the SAVI console after instruction. The same eight variables as listed page 1-9 of this report were the predictors. The multiple-correlation for these data was 0.582 which was not significantly different from zero at the .05 level. Table 2 shows the raw score and standard score regression weights and the means and standard deviations of the variables involved in the regression analysis.

TABLE 2

REGRESSION WEIGHTS, MEANS, AND STANDARD DEVIATIONS FOR THE VARIABLES USED IN THE REGRESSION ANALYSIS OF ENERGY AND LIFE DATA

VARIABLE	RAW SCORE WEIGHT	STANDARD SCORE WEIGHT	MEAN	SIGMA
1	1.9128	0.4520	1.5238*	0.5518
2	0.0544	0.1914	30.0000	7.6223
3	0.0217	0.4599	127.2381	45.9499
4	0.3313	0.2805	43.5238	1.8335
5	0.1636	0.4443	5.9048	5.8814
6	0.1746	0.3881	12.9048	4.8156
7	-0.1021	-0.0434	1.9524	0.9207
8	-0.0216	-0.3617	94.2857	36.2742
9			6.0952$	2.1658

RAW SCORE INTERCEPT = 16.5565

*MALE = 1; FEMALE = 2

$The test on Energy and Life had 10 items.

Elements and Compounds:

Data were available from 42 CAI students for this unit. The dependent and independent variables were the same as those stated above. The multiple correlations for these data was 0.578 which did not differ significantly from zero at the .05 level. Table 3 shows the raw score and standard score regression weights and the means and standard deviations of the variables involved in the analysis. The numbers of the variables correspond to those used on page 1-9 of this report.

TABLE 3

REGRESSION WEIGHTS, MEANS, AND STANDARD DEVIATIONS FOR THE VARIABLES USED IN THE REGRESSION ANALYSIS OF ELEMENTS AND COMPOUNDS DATA

VARIABLE	RAW SCORE WEIGHT	STANDARD SCORE WEIGHT	MEAN	SIGMA
1	-0.4350	-0.0873	1.5714*	0.5999
2	0.0042	0.0214	49.1667	12.6778
3	0.0038	0.1045	115.6905	69.2061
4	0.0679	0.3217	73.9762	11.8352
5	-0.0092	-0.0479	12.7857	12.9380
6	-0.0654	-0.2703	19.6190	10.3121
7	-0.1640	-0.0726	2.7381	1.1036
8	-0.0083	-0.0899	63.9048	27.0481
9			13.7619$	2.4969

RAW SCORE INTERCEPT = 11.1632

*MALE = 1; FEMALE = 2

$The test on Elements and Compounds had 18 items.

Chemical Symbols:

The final unit for which sufficient data were available was Chemical Symbols. Twenty-nine subjects had complete data for the criterion variable and the eight predictors. The obtained multiple correlation was 0.832 which was significantly different from zero at the .05 level. Table 4 shows the raw score and standard score regression weights and the means and standard deviations of the variables used in the regression analysis.

TABLE 4

REGRESSION WEIGHTS, MEANS, AND STANDARD DEVIATIONS FOR THE VARIABLES USED IN THE REGRESSION ANALYSIS OF CHEMICAL SYMBOLS DATA

VARIABLES	RAW SCORE WEIGHT	STANDARD SCORE WEIGHT	MEAN	SIGMA
1	-0.7391	-0.1148	1.5172*	0.5085
2	0.0515	0.1504	32.5517	9.5528
3	-0.0118	-0.2101	74.6552	58.2570
4	0.0688	0.1957	54.1724	9.3046
5	0.0150	0.1196	17.6207	26.1662
6	-0.1767	-0.8534	15.1034	15.8076
7	-0.4242	-0.1693	4.2759	1.3065
8	0.0179	0.2980	70.0345	54.6400
9			13.0000$	3.2733

RAW SCORE INTERCEPT = 12.5656

*MALE = 1; FEMALE = 2

$The test on Chemical Symbols had 18 items.

Analysis of Reading Data:

We had anticipated that analyses similar to those done with the Biology data could be done in Reading. However, several factors prevented this. For one, the topics in Reading are much longer than those in Biology. Therefore, it takes a great deal of time to collect sufficient data so that a meaningful analysis can be performed.

As indicated elsewhere in this report, the weekly summary reports which generate the data for many of the Project Grow analyses had to be modified following the movement of the system to 5th and Luzerne Streets.

The result of these two factors has been that we did not have enough data to allow us to perform reliable analyses. Rather than doing calculations on data from a small number of students, we have decided to wait until next year when more substantial work can be done in this area, and more reliable results obtained. We do have data from standardized tests in Reading and from the teacher and student questionnaires. These Reading data are presented in the appropriate sections.

SUMMARY

The data clearly point to some degree of association between the criterion and predictor variables. The fact that some of the multiple correlations were not significantly different from zero is not disturbing. In reality the significance test may have little meaning for these data. The basic reason is that the students form whom complete data were available are very likely not a random sample from the CAI population in Philadelphia. To the extent that this is true, tests based upon errors of sampling such these need to be interpreted cautiously. If one would treat these results as descriptive of these pupils, then some conclusions can be drawn. We interpret the weights given in Tables 1 through 4 by looking at their value without regard to sign. The variables making the least contribution to the multiple correlation are those whose weights are close to zero.

The most consistent result of these data is that the time variables, especially time on unit (Variable 2) and time on test (Variable 7), make the least contribution to the multiple correlation. This is probably because the latency variables are highly correlated with time variables and therefore, with other considerations, the time variables can account for no unique variance.

A second reason might be that the mastery philosophy behind CAI would lead to a low correlation between unit achievement and any other variable. The variability of topic test scores should theoretically be low if the curriculum guides the pupil until he masters the material. The low variability would then lead to low correlations. Typically the standard deviations (SIGMA) of the variables employed in this analysis do not support this hypothesis. However, future data might. There was no variable which consistently made a large contribution to the multiple correlation. In addition, there was no indication of a substantial sex difference in achievement.

What this means is that in order to predict student achievement, we need to include all the variables in an analysis. For example, we cannot consistently predict achievement by knowing only the sex of a pupil. This is analogous to the problem of a college admissions office. No one variable can predict college achievement to any great degree. However, if many variables are included, the accuracy of prediction is much greater.

Our data have really served two purposes. First, they can be used to predict achievement and secondly, they can be used to describe how the average student performs on the SAVI console. By consulting Tables 1 through 4, the reader can see what the average performance was with an indication of variability. We might have anticipated that the mean number correct on the topic achievement tests would have been higher. These means went from 61% on Energy and Life to 76% on Elements and Compounds. Future analyses on larger groups of subjects will allow us to determine the effectiveness of the remedial loops in the project GROW curriculum. These data and others will then be used to interpret the present results. All of these will then add to our knowledge of the interaction between the student and the computer.

Section Two

Note on Selecting Standardized Achievement Tests:

In selecting a standardized instrument for use in a project, one often has to compromise. Standardized tests are constructed for use over a wide range of educational settings with a number of different objectives in mind. An individual test user typically has only a few objectives in mind with a relatively small number of students. One cannot expect the standardized test to deal exactly with the objectives and content of a single classroom curriculum. However, it is possible to select one which comes as close as is feasible and which will provide meaningful data. We believe this end has been achieved for both Biology and Reading.

Standardized Test Results: Gates-MacGinitie Reading Tests:

Survey D and Survey E of the Gates-MacGinitie Reading Tests were employed as final standardized tests to be given to the Project GROW students in Reading. Survey D was used at Roosevelt Junior High School and Survey E was used at Germantown High School and Overbrook High School.

Each Survey consists of three parts: Speed and Accuracy, Vocabulary, and Comprehension. The Speed and Accuracy Test contains 36 short paragraphs each followed by a question or an incomplete statement for which the student selects one of four alternatives which best answers the question. We scored this test only for Accuracy and did not deal with a Speed score which would ordinarily be the number of paragraphs a student completed in four minutes.

The 50 item Vocabulary Test requires the student to select one of five words whose meaning is the closest to the stem word.

For example:

home

a. rock
b. moment
c. talk
d. house
e. some

The items are arranged in order of difficulty. That is, the beginning items are the easiest. while the final items are much more difficult.

The Comprehension Test requires the student to choose words from those given which will, when placed in blank spaces in a paragraph, make the material the most understandable. For the 21 reading passages included in this subtest, there are 52 blank spaces which the students must fill in.

For example:

Homing pigeons may be used to carry messages. Their sense of C1 enables them to find their way C2 over unfamiliar territory.

	a	b	c	d	e
C1	humor	direction	distinction	valves	confusion
	f	g	h	i	j
C2	blocked	masked	driving	lost	home

For the Project GROW students, three scores were derived. The Accuracy score was the number correct on the Speed and Accuracy Test, while the Vocabulary and Comprehension scores were the number correct on those corresponding subtests.

The basic objective of the Project GROW Reading curriculum was to "...improve the ability of students in the 8th, 9th, and 10th grades in Junior and Senior High Schools to better comprehend what they read..." The program and curriculum were designed for students of "normal" intelligence who were reading at approximately fifth grade level. The program was not designed to teach a student to read but rather to take a poor reader and improve his comprehension skills.

The Comprehension subtest of the Gates-MacGinitie Reading Tests comes the closest to the objectives of the program. The other tests were included to supplement the Comprehension data and to obtain information on other areas where the program might have had a differential effect between CAI pupils and traditionally instructed pupils. Since students were assigned at random to the CAI classes (given the above reading level requirements), meaningful comparisons can be made between the two methods of instruction. In addition to emphasis in other areas, the traditional classroom curriculum was also

designed to improve the comprehension skills of pupils. We therefore believe that the most important comparison would be for the Comprehension subtest scores with Accuracy and Vocabulary being of relevant but secondary interest.

Because we were dealing with a study where data on three dependent variables were collected, the results were analyzed using a multivariate Analysis of Variance. In this way, we hoped to control our Type I error rate. That is, we hoped to avoid the situation in which one finds significant differences among treatment groups when in fact there are none simply by virtue of doing a great number of statistical tests. As with other analyses, the results will be presented separately for each school.

Roosevelt Junior High School:

Data from three Reading classes, all taught by the same teacher, were analyzed using a multivariate Analysis of Variance. Two were CAI classes and the third was a traditionally instructed class. All pupils were of similar ability.

Table 1 shows the means and standard deviations of the three classes for the three dependent variables.

Table 1

Mean and Standard Deviations of the Reading Classes of Roosevelt Junior High School on the Three Subtests of the Gates-MacGinitie Reading Tests

	CAI_1	CAI_2	Traditional
Accuracy			
Mean	18.21	18.83	14.13
Standard Deviation	5.27	5.75	7.30
Vocabulary			
Mean	35.29	33.00	20.75
Standard Deviation	8.04	4.39	7.67
Comprehension			
Mean	38.86	36.50	22.88
Standard Deviation	8.48	7.18	13.30

The multivariate F-ratio generated from these data was 3.558 which was significant at the 0.01 level. This statistic is interpreted in the same manner as a univariate F-ratio. That is, the significant F-ratio indicates that the three means of one of the treatment groups differ significantly from the three means of at least one other treatment group. Inspection of Table 1 clearly indicates that the performance of the CAI classes was superior to the traditionally instructed class on all three variables. With respect to Vocabulary and Comprehension, the differences were practically as well as statistically significant. The average CAI student scored about 60% higher than the average traditionally instructed pupil in Vocabulary and Comprehension. There was no difference between the groups on Accuracy.

Germantown High School:

At Germantown High School the multivariate F-ratio was equal to 0.783 which was not significant at the 0.10 level. Table 2 shows the means and ~~shows the means~~ and standard deviations of the five Reading classes used in the analysis. As can be seen, there is no clear tendency for the CAI classes to outperform the traditionally instructed classes. This is true regardless of whether we look at the Accuracy score, the Vocabulary score, or the Comprehension score. This is of course, what is conveyed by the non-significant F-ratio.

Table 2

Means and Standard Deviations of the
Germantown High School Reading Classes on the
Three Subtests of the Gates-MacGinitie Reading Tests

	CAI_1	CAI_2	$TRAD._1$	$TRAD._2$	$TRAD._3$
Accuracy					
Mean	11.09	12.14	9.33	10.50	11.88
Standard Deviation	4.25	4.62	5.57	3.33	5.59
Vocabulary					
Mean	16.27	16.07	18.78	13.33	17.38
Standard Deviation	4.67	5.34	5.59	4.55	5.26
Comprehension					
Mean	27.46	25.71	25.44	22.83	25.38
Standard Deviation	10.01	6.50	6.50	9.54	11.15

Overbrook High School:

The results of 4 CAI Reading classes were compared with one traditionally instructed class. Two different teachers were involved, one for the CAI classes and one for the traditional class. All the students were of average ability and randomly assigned to the treatments within the sampling limits mentioned above.

The obtained multivariate F-ratio of 5.805 was significant at the 0.01 level. Inspection of the means of the five classes shows substantially superior performance (statistically and practically) for the CAI students. The reader of course notes that these differences may be due to the differences in teacher ability rather than method of instruction. While this is true, it is very unlikely that teachers of similar experience, as was the case here, would differ in effectiveness to the degree implied by these data. It would appear that these results would most correctly be interpreted as relating to difference in instructional method with the CAI method leading to superior achievement.

Table 3 shows the results for the five classes in question.

Table 3

Means and Standard Deviations of the
Overbrook High School Reading Classes on the
Three Subtests of the Gates-MacGinitie Reading Tests

	CAI_1	CAI_2	CAI_3	CAI_4	Trad.
Accuracy					
Mean	10.83	13.50	11.27	14.25	5.25
Standard Deviation	2.79	3.34	3.80	6.62	2.66
Vocabulary					
Mean	16.17	21.25	19.09	18.17	5.38
Standard Deviation	5.23	3.81	4.37	4.04	3.74
Comprehension					
Mean	30.83	35.75	24.46	29.92	11.00
Standard Deviation	6.80	3.85	11.36	11.15	5.18

Summary

Except at Germantown High School, statistically significant differences were obtained between the Comprehension scores of the CAI students and the traditionally instructed students. We could not attribute this difference to either the ability level of the students or the differences in teacher effectiveness. When one teacher teaches only CAI classes and another teacher teaches only traditionally instructed classes, we have what is called in experimental design, a confounding. We do not know whether any differences in performance obtained among these classes are due to teacher differences or to method of instruction: they are confounded. However, when teachers are of similar experience and training, we make the assumption that they are equally effective. Given the results from other schools and from other studies, it is much more likely that the superior performance of the CAI students was due to the method of instruction rather than the different teachers. The confounding was present at Overbrook High School but not at Roosevelt, where one teacher taught both the CAI and traditional classes, and the former group performed significantly better.

There is no clear explanation for the results at Germantown High School. Toward the end of the year, this school experienced a great deal of "down-time" due to a malfunction in an air conditioner. It is possible that the differential effect of the two instructional methods was "wiped out," as it were, by this "down-time." Future studies and experience with CAI will help us to answer this question.

Standardized Test Results:

Nelson Biology Test Form F:

The Revised Edition of the Nelson Biology Test was administered to the Project GROW students and to the Biology students in the traditionally instructed classes. The Nelson Biology Test includes items which measure the extent to which students have attained important educational objectives. These objectives could be classified according to Bloom's Taxonomy as dealing with Knowledge, Comprehension, and Application.

In the Revised Edition of the Nelson Biology Test, the authors have attempted to include new materials which reflect the changes in biology instruction such as the three approaches of the Biological Science Curriculum Study. They have, however, retained approximately one-third of the items from the 1950 edition.

Fifty-two percent of the items on the Nelson Biology Test deal with what the authors call Life Processes. This includes: (1) Human Health and Functions, (2) Plant and Animal Life, (3) Life Cycles, Reproduction, Heredity, and Biological History. Twenty eight percent of the items contain content related to Living Things including Characteristics, Cellular and Molecular Structure, Classification and Grouping. The remaining items deal with Ecological Relationships and Methodology and Research. The total test contains 65 4-choice multiple choice items with a fifth distractor for guessing. If a student does not know the answer to a question, he is instructed to mark the fifth option which is labelled "DK" for "Don't Know." The authors have found that the use of this option tends to cut down on wild guessing and may therefore make the scores more reliable or consistent.

The data generated from the administration of the Nelson Biology Test were analyzed using Analysis of Variance techniques and are reported for each school separately.

Roosevelt Junior High School:

Nelson Biology data were obtained for six classes at Roosevelt Junior High School. Three of the classes, taught by one teacher, were in CAI; while the other three classes, taught by a second teacher, received traditional instruction in Biology.

Table 3 shows the means and standard deviations and the results of the analysis of variance for the six groups tested.

Table 4

Analysis of Variance Data for the Nelson Biology Test from Roosevelt Junior High School

	CAI_1	CAI_2	CAI_3	Tr_1	Tr_2	Tr_3
Mean	18.12	20.56	13.80	15.65	20.12	14.92
Standard Deviation	4.74	7.91	2.34	8.12	9.23	5.32

ANOVA Source Table

Source	df	SS	MS	F
Between Groups	5	759.55	151.91	3.19
Within Groups	110	5236.47	47.60	

The 0.01 rejection rule for 5 and 110 degrees of freedom is almost exactly 3.19. We went ahead, and in a sense "made believe" the null hypothesis was rejected. That is, post-hoc analyses were done using the Scheffé technique. Two comparisons were made. The first involved a comparison of the performance of the students in the two academic tracks present at Roosevelt. The second involved the comparison of the CAI and Traditionally instructed pupils. Neither of these comparisons were significant. Our general conclusion was to suspend judgement regarding Roosevelt Junior High School and to wait until more data can be collected.

Germantown High School

Data from three CAI classes and three traditionally instructed classes were analyzed using analysis of variance techniques.

Table 5 shows the analysis of variance data for these calculations.

Table 5

Analysis of Variance Data for the Nelson Biology Test
from Germantown High School

	CAI_1	CAI_2	CAI_3	$Trad_1$	$Trad_2$	$Trad_3$
Mean	11.50	10.67	9.00	8.89	8.67	9.13
Standard Deviation	2.64	6.41	5.15	6.19	6.19	6.31

Anova Source Table

Source	df	SS	MS	F
Between Groups	5	56.90	11.38	0.38
Within Groups	41	1230.93	30.02	

Inspection of the means and the obtained F-ratio indicates that there was no difference in the performance of the pupils in the two instructional methods.

Overbrook High School:

At Overbrook High School, we have the situation where each of two teachers teaches one class in CAI and one traditionally instructed class at each of two academic tracks. In the language of experimental design, we say that the factors of Method of Instruction, Academic Track, and Teacher are completely crossed. This is a very desirable situation because it allows us to look beyond the basic question as to whether the students in CAI achieve higher than those in the traditional classes. We can look at other issues. For example, if there is a difference between CAI and traditional classes, does this difference exist regardless of which academic track the students are in? Using the language of analysis of variance, we would be looking for an interaction between Method of Instruction and Academic level.

Table 6 shows the cell means and marginal means plus the analysis of variance of the Nelson Biology scores at Overbrook High School. The analysis of variance indicated that the only significant effect obtained was for Academic Track. The students in the Academic level performed significantly better than those in the Regular Track. This is not surprising. There was no difference between

the performance of students taught by Teacher A versus those taught by Teacher B. In addition, there was no difference between CAI performance and those students in the traditionally instructed classes.

Table 6

Cell Means, Marginal Means, Analysis of Variance for Nelson Biology Test Scores at Overbrook High School

CELL IDENTIFICATION	CELL MEAN
CAI, Academic Track, Teacher A	17.00
CAI, Academic Track, Teacher B	19.88
CAI, Regular Track, Teacher A	8.50
CAI, Regular Track, Teacher B	12.50
Traditional, Academic Track, Teacher A	11.25
Traditional, Academic Track, Teacher B	20.50
Traditional, Regular Track, Teacher A	11.25
Traditional, Regular Track, Teacher B	9.13

FACTOR	LEVEL	MEAN
Instructional Method	CAI	14.47
	Traditional	13.03
Academic Track	Academic	17.16
	Regular	10.34
Teacher	A	12.00
	B	15.50

ANOVA Source Table

Source	df	Mean Squares	F
Between Instructional Methods	1	33.06	<1
Between Academic Track	1	742.56	17.23
Between Teachers	1	796.00	4.54
I.M. XA.T.	1	20.25	<1
I.M. XT.	1	0.06	<1
A.T. XT.	1	105.06	2.44
I.M. XA.T.XT.	1	156.25	.3.63
Within Cells	56	2412.75	

$F_{.99,1,56} \doteq 7.09$

Summary:

The general result from these data was that the CAI students did not achieve significantly higher scores than the traditionally instructed pupils. At Roosevelt Junior High School, there was some indication of a difference, but it was not large enough to be meaningful statistically. At both high schools, there was clearly no difference between the groups.

There are three possible explanations which come to mind. Because these data are based upon the results of standardized tests, we need to remember that although the test selected may have been the most suitable, it may not have enough content validitv to show the differences which actually exist.

A second possibility involves the system itself. As stated many times in this report, problems with the hardware and software resulted in large amounts of "down-time" expecially at Germantown High School. One might argue that in reality no student really attended a CAI class and, therefore, any comparison made is not between CAI and traditional instruction and therefore not relevant.

A third explanation would be that there is really no difference between CAI and traditional methods. While it is possible that this is true, the data from this study are somewhat tentative and we believe that this conclusion is premature and basically incorrect.

Section Three

Attitude Survey:

A questionnaire was constructed to obtain information on how the students and teachers perceived the computer system and some of the areas where they believed it was particularly strong or weak. Data were obtained from 4 Reading teachers, 5 Biology teachers, 76 Reading students, and 124 Biology students. The data are reported for students and teachers separately. No breakdown was made according to school unless the responses to a particular question differed markedly over different schools. Readers interested in the complete questionnaires employed can consult the appendices to this report where copies are presented. Any percentages that are reported are given to the nearest whole percent.

Reading Students:

Data were gathered from 76 Reading students. Twenty-three students were from Germantown High School, 22 were from Roosevelt Junior High School, and 31 were from Overbrook High School.

> Question 1: "During each period, you worked part of the time with the SAVI Unit and part of the time with the teachers. Do you think that there should be more time spent on the machines?"

Responses to this question showed considerable variation over schools. At Germantown, 39% of the students in Reading answered "yes" to this question while at Roosevelt, 59% responded affirmatively. At Overbrook 26% said they would like more time on the machines while 52% said they would not. Generally speaking the students who indicated that they would not want more time at the machines said the reason was that their teachers could answer questions and give information that the computer did not or could not give. The students in favor of more time on the SAVI consoles indicated that they felt they could learn more from the machine. The students favoring more time on the machines were quite

specific in their desires, as were those who were negatively disposed. The issue is clearly not settled. The preference for more or less time on the machines may reflect different personality characteristics of the pupils. There is a possibility that we are dealing with two distinct populations: one "pro" machine and the other "anti" machine. This would be an interesting area for future research.

Virtually 100% of the students in Reading indicated that the machines were easy to use and they enjoyed working with them. However, in this latter area, 52% of the Overbrook students either disliked or had no opinion on that part of the lesson that was at the SAVI unit. At the other schools, only an occasional student indicated that he disliked working with the SAVI unit.

When asked why one liked working with the consoles most students chose reasons such as "I could go at my own speed" or "it took nice small steps which I could understand."

When asked for reasons as to why one did not like working with the SAVI, these students who answered this question generally indicated that "it was boring." The percentage of students falling into this category ranged from 52% at Germantown and Roosevelt to 72% at Overbrook High School. When contrasted with the corresponding percentages for the Biology students, we may be seeing a reaction to some factor in the Reading curriculum which is inherently tedious rather than anything involved in the hardware. (As shown below, very few Biology students reported that working with the SAVI was boring.)

A sizable percentage of the students (e.g. 48% at Roosevelt) indicated that they were unhappy with the SAVI units because they didn't work properly. These students were pointing to "bugs" in the software packages. For example, there are instances in which the computer says that a child gave a wrong answer to a question when he did not. This is particularly frustrating to the pupils. The students also commented on the fact that the machines did not work reliably. Since this program is still experimental, problems such as this are to be

expected and will be dealt with.

The Reading pupil, generally speaking, had no suggestions for improving the SAVI units although there was minor dissatisfaction with the light-pen and some students thought the use of sound or arranging the keys in alphabetical order would be a help.

Summary:

Typically the students in Reading enjoyed working with the SAVI unit. They were undecided as to whether more or less time should be spent with the machine. The self-pacing aspect of CAI was favorably received by the students although there was some indication that working with the machine could be boring.

Reading Teachers:

Since responses were available on only four Reading teachers, the reader should be cautioned that the opinions reported herein may represent only one or two teachers.

The Reading teachers indicated that they felt CAI could be a success but that its success has yet to be demonstrated. In addition, they indicated that student interest and motivation could be higher than in traditionally instructed classes.

The teachers generally believed that there were changes needed with the SAVI consoles centering on the lightpen or screen. The lightpen did not work consistently and there was some indication that glare on the SAVI screen was a problem.

The teachers all reported that the curriculum, although it made excellent use of graphics (two teachers said this), did not sufficiently stress the application of principles (one teacher), and was not adequately "debugged." This last comment was the most reliable in that all the teachers reported this as did many of the Reading students. It is suggested that a closer look be made of the curriculum and the "bugs" which may still be present.

All the teachers indicated that the concept of CAI could be used with children of all ability levels although one teacher reported that the brighter students would become bored with the repetition inherent in the Project GROW curriculum and would need some enrichment materials. The reader will recall that many of the Reading students indicated that boredom was also a factor for them.

Groups of the size presently employed can be handled but too many more pupils regardless of whether more SAVI consoles are supplied would put a prohibitive burden on the teachers' management of the system. Right now the duties of the

teacher in a CAI classroom are reasonable and manageable.

The weekly topic summaries indicating pupil progress seemed adequate in terms of format but they did not arrive weekly nor were they accurate. We are aware of this problem and are making efforts in this area. Much of the difficulty with the topic summary reports can be traced to the movement of the computers from Willow Grove to 5th and Luzerne. In essence, the entire software package had to be changed.

Biology Students:

As with the Reading students' data, the responses from the Biology students will be treated separately by school only when substantial variability over schools was observed. Otherwise, all schools will be grouped together.

> Question 1: "During each period you worked part of the time with the SAVI Unit and part of the time with the teachers. Do you think that there should be more time spent on the machines?"

As with the Reading classes, there was a divergence of opinion with respect to this question. At Germantown and Roosevelt, 77% and 74% respectively answered "yes" to this question while at Overbrook the affirmative response was only 41%.

Those students who answered affirmatively generally said that the machines were easier to work with than a teacher. Some indicated that "you could go at your own speed" and if somebody was absent, it didn't matter as the class was not held up. Nevertheless many pupils indicated that they needed more time on the machines because they (the machines) were not functioning properly and the material was not covered. Therefore they needed more time.

Those students who were not in favor of more time at the consoles indicated that there were questions and explanations a teacher could give that the SAVI could not. We may again be observing a pro and anti-machine split as with the Reading students although it is not immediately clear why they should cluster

in one school. That is, the students at Overbrook High School generally gave more negative responses to questions dealing with the machines than did the pupils at the other schools.

All the students reported that the machine was easy to use and that they enjoyed the part of the lesson at the SAVI.

When asked why they enjoyed working with the SAVI the majority of the Biology pupils said it was because they could go at their own speed and that the machine "took nice small steps which I could understand."

> Question 5: "Sometimes students do not like working with the SAVI units. If you did not was it for any of the reasons given below? Select the one that applies <u>most</u> to you."
>
> I did not like working with the SAVI because
>
> a. The machine was too slow.
> b. Each step was so small that I never felt I was learning anything.
> c. I could not read a lot of the words.
> d. It was boring.
> e. Other.

There were some school differences with respect to this question. None of the students, except in isolated cases, chose a, b, or c. However 33% of the Germantown pupils indicated that working with the machine was boring, whereas in Roosevelt and Overbrook these percentages were 11% and 12% respectively. There is no clear explanation for these data.

A number of students indicated that they had "Other" reasons for not liking to work with the SAVI. The percentages of students falling into this category were 21%, 40%, and 21% for Germantown, Roosevelt, and Overbrook respectively. Many of these students complained about the "bugs" in the material and the fact that many times the machines did not work. These same comments were made in the Reading classes.

<u>Summary</u>

Again we obtained data from the Biology students which reinforced the teacher data. The students basically liked the machines and considered them

easy to use especially because they could go at their own speed. However, the "down-time" and the errors in the curriculum were a source of frustration to the students and need to be be corrected.

Interestingly enough, the possible breakdown of students into those in favor of more and more time with the consoles versus those who wanted more time with the teacher was obtained with the Biology as well as Reading students. In the future, we will need to identify these students to see if there is any relationship between their attitudes toward machines and their achievement. We believe that the negative responses, that is responses saying "less time on the machine" may be particularly significant. In some sense, the questionnaire was constructed to favor a positive response. In addition, the socially desirable response was a positive one. However, it is not clear why the "negative" Biology students should cluster in Overbrook High School. This school certainly did not have a monopoly on "down-time."

Biology Teachers:

Responses were obtained from the 5 Biology teachers involved in Project Grow. As with other small groups, one needs to remember that percentages can be deceiving in that with a group of size 5, the only percentages possible are 0, 20, 40, 60, 80, and 100%.

Generally, the Biology teachers responded as did the Reading teachers. They considered that CAI could be a success but that its success has yet to be demonstrated. They did agree with the Reading teachers that interest and motivation might be an important advantage of CAI over traditional instruction. Two out of five Biology teachers were willing to say that CAI could be a great success. None of the Reading teachers made this statement. However, in view of the small group sizes, more weight must be given to those questions where all teachers agreed rather than where only one or two did.

There was agreement that changes needed to be made in the SAVI units but there was no unanimity with respect to what these changes should be. In fact, changes were suggested for all areas of SAVI: the keyboard, lightpen, and the SAVI screen. One teacher provided the following comments:

"The lightpen should have been designed with a twenty degree angle at the tip. The present necessity of holding the pen at a full ninety degree angle to the screen is difficult at best. Further, the pen should have been reinforced at its juncture with the cord to prevent the frequent breaks. The screen should also have been angled and hooded. The light requirement of the offline activities make the present ninety degree screen angle prone to annoying reflection. The table and chairs used in conjunction with the terminal should be subject to a careful study, as at present they are dissatisfactory." This was the only comment with respect to tables and chairs and unfortunately, there was no elaboration.

The Biology teachers as a group indicated that the CAI concept could be used with children of all ability levels but that the curriculum, although logically written, and generally of very high quality, was not sufficiently "debugged." It may be of some interest to note that the Reading teachers also commented on the "bugs" in the curriculum but generally had less favorable remarks about the curriculum.

Favorable reaction was obtained to the pupil/teacher ratio. It was generally agreed that the ratio of 1 teacher to 16-20 pupils was manageable.

A majority of the teachers reported that the duties involved in managing the system, working the machines, teletypes, and so on were reasonable and the system was manageable.

As with the Reading teachers, 100% of the Biology teachers would like to receive a weekly summary report of each pupil's progress. This summary should be teacher oriented, providing averages of a student's performance. In this area, the student summary report may be more useful than the weekly summary report.

Summary:

Generally speaking, the Biology and Reading teachers reported that the CAI concept has great potential, but that due to problems with the hardware (e.g. SAVI console) and software (curriculum programs), this potential has yet to be realized. Basically, the physical set-up of the classrooms is adequate, the class-size and system management duties are reasonable. As one teacher put it: "The program has a potential unequalled by any other system or instructional aides. Unfortunately, the program barely taps this reservoir."

Section Four

Introduction:

Following each instructional unit in the CAI curriculum, the students in the CAI classes took a unit test at the SAVI console. The students received immediate feedback on their performance to each question and to the test as a whole. The items that were used in the first two Multi-Unit Tests were a stratified random sample of these items. The stratification was done on unit length. It is clear that when the CAI students responded to the items on the Multi-topic tests, they were doing so for a second time and therefore may have had an advantage over the traditionally instructed students who had never seen the items before. Therefore any observed difference between the two instructional groups may be due completely or in part to the fact that they (the CAI pupils) had seen the items before and not to the method of instruction per se. Below an attempt will be made to estimate the effect of this initial testing. However this is only an estimate and an extremely crude one. One must be very cautious in interpreting the results of these analyses until further data can be collected.

The multi-topic test cover approximately six units in Biology. They were constructed by taking a random selection of about 40 questions from a given group of six units in the Biology SAVI curriculum. The selection was made to keep the relative emphasis of the units proportional to length of each unit in the curriculum. That is, if unit A was twice as long as unit B, then in the multi-topic test, twice as many of the questions dealt with unit A as with unit B.

As indicated, the questions used were the same ones as had been previously presented to the on-line classes. This was undoubtedly an advantage for the CAI students. The magnitude of this advantage is unknown. Several strategies

were considered and for many reasons, this multi-topic test strategy was chosen even though it does favor the on-line classes. Initially, it was decided to remove these questions from the SAVI instruction. This was not acceptable since the tests are used for instructional purposes. While responding to the questions, the student is informed immediately as to whether his answer was right or wrong and what the correct answer was. In the opinion of the curriculum writers, removing these tests would constitute a serious shortcoming in the logic of the instructional sequence. Secondly, it was decided to construct new tests which would be essentially parallel forms of the current on-line tests. This presented an investment in time and personnel which was prohibitive at the present time. It was also thought that this strategy would give an advantage to the on-line classes also and since the use of the multi-topic tests involved considerable savings in time and effort, it was decided to use them. Finally, all the questions were four-choice multiple choice questions and were administered in booklet form with separate Digitek answer sheets.

Data analysis of the first Two Multi-Unit Tests (MUT-1 and MUT-2):

In each of the three schools where data were available on the first two Multi-Unit Tests, an analysis of variance was performed with Method of Instruction as one of the factors. Initially an item analysis was done for both tests for the CAI students and the traditionally-instructed students in separate groups. The data from the item analyses can be used to revise the instrument for later use. By examining the item structure, the difficulty, discrimination, and distractor effectiveness, revisions of faulty items can be accomplished in order to obtain better evaluation instruments. Before considering the results of the analyses of variance, the basic psychometric characteristics of MUT-1 and MUT-2 for CAI and the non-CAI students will be reported.

Table 1

Psychometric Characteristics of MUT-1 for
CAI Students

Number of Items on Test	40
Number of Students	148
Test Mean	28.82
Test Variance	37.08
Test Standard Deviaition	6.09
The Mean Difficulty of the Items on This Test	.720
The Average Biserial Correlation	.489
Standard Error of the Biserial Correlation	.082
Estimated Interitem Correlation	.240
Kuder-Richardson 20 Estimate of Reliability	.833
Standard Error of Measurement	2.49

Psychometric Characteristics of MUT-1 for
Non-CAI Students

Number of Items on Test	40
Number of Students	247
Test Mean	22.51
Test Variance	41.49
Test Standard Deviation	6.44
The Mean Difficulty of the Items on This Test	.563
The Average Biserial Correlation	.452
Standard Error of the Biserial Correlation	.064
Estimated Interitem Correlation	.204
Kuder-Richardson 20 Estimate of Reliability	.819
Standard Error of Measurement	2.74

Table 2

Psychometric Characteristics of MUT-2 for
CAI Students

Number of Items On Test	39
Number of Students	123
Test Mean	23.01
Test Variance	53.37
Test Standard Deviation	7.31
The Mean Difficulty of the Items on This Test	0.590
The Average Biserial Correlation	0.550
Standard Error of the Biserial Correlation	0.091
Estimated Interitem Correlation	0.302
Kuder-Richardson 20 Estimate of Reliability	0.873
Standard Error of Measurement	2.60

Psychometric Characteristics of MUT-2 for
Non-CAI Students

Number of Items On Test	39
Number of Students	194
Test Mean	17.60
Test Variance	37,59
Test Standard Deviation	6.13
The Mean Difficulty of the Items on This Test	0.451
The Average Biserial Correlation	0.437
Standard Error of the Biserial Correlation	0.072
Estimated Interitem Correlation	0.191
Kuder-Richardson 20 Estimate of Reliability	0.797
Standard Error of Measurement	2.76

On the first Multi-Unit Test, there were virtually no differences in the data from the two groups for test characteristics such as the average biserial correlation and interitem correlation. There were some differences for the second test centering in the area of reliability estimation.

A preliminary examination of the remainder of the item analysis data indicated that there were slight ambiguities in some of the item stems. These will be remedied before further use is made of this instrument. Other appropriate methods will be used to improve any item distractors as the data warrant.

Results of Analyses of Variance of MUT-1 Scores:

Because there were differences among the schools in terms of the manner

in which the CAI system was implemented, the most meaningful picture of these data can be seen if the results from the schools are dealt with separately.

Roosevelt Junior High School:

At Roosevelt, seven classes are involved in the CAI project. Three of these classes receive CAI instruction in Biology while the remaining four are instructed in Biology in a traditional classroom. There are different teachers in each instructional method, that is "Teachers" as a factor is nested within the factor of "Instructional Method." In addition, one of the CAI classes is of lower ability than all the other classes, both CAI and traditional. A one-way analysis of variance was carried out to investigate the presence of mean differences in achievement among the classes. A significant F ratio ($F = 8.5330$ df: 6, 105 $\alpha < .01$) indicated the presence of at least one mean difference. A post-hoc analysis using Scheffé contrasts was done to isolate the differences present. The results of the Scheffé analysis indicated that while there was no difference in the mean achievement of the two academic tracks represented at Roosevelt Junior High School, the students in the CAI classes scored significantly higher than those in the non-CAI classes. The means and standard deviations of the seven groups involved and the results of the analysis of variance are shown in Table 3 and Table 4.

Table 3

Means and Standard Deviations for the Seven Treatment Groups at Roosevelt Junior High School

	CAI_1	CAI_2	CAI_3	$Trad_1$	$Trad_2$	$Trad_3$	$Trad_4$
Mean	34.5625	31.9333	28.7857	26.94444	27.7143	27.5789	22.8125
Standard Deviation	2.8976	4.7879	4.0417	3.5723	6.1071	4.5743	8.3044

Table 4

Analysis of Variance of MUT - 1 Results at
Roosevelt Junior High School

	Sum of Squares	DF	Mean Squares	F
Between Groups	1351.6699	6	225.2783	8.5330
Within Groups	2772.0942	105	26.4009	
Total	4123.7617	111		

$F_{.99,6,105} \doteq 3.00$

Germantown High School:

At Germantown High School the data were analyzed in a 2x2 factorial design. The factors of "Instructional Method" (CAI and Traditional) and "Academic Track" were completely crossed. There were also two teachers involved in the CAI study in this school. Each teacher taught one class in each of the four cells except the traditionally instructed slow class. Therefore, a third factor of "Teacher" could not be included in the design. The results of the analysis of the Germantown High School data indicated that there was a significant difference in mean achievement between the academic tracks with the slower students' mean performance significantly lower. There was also a significantly higher mean score in the CAI classes than in the traditional classes. The respective F - ratios of 19.73 and 26.86 with df 1,72 were both significant at the .01 level. The interaction F - ratio was less than 1.0. The marginal means and the cell means and the results of the analysis of variance are shown in Table 5 and Table 6.

Table 5

Cell Means and Marginal Means of the MUT-1 Scores at Germantown High School

Cell Identification	Cell Means
Regular track; CAI instruction	29.789
Regular track; traditional instruction	22.526
Slow track; CAI instruction	23.526
Slow track; traditional instruction	16.789

Factor	Level	Means
Academic Track	Regular	26.158
	Slow	20.158
Instructional Method	CAI	26.658
	Traditional	19.658

Table 6

Analysis of Variance of MUT-1 Results for Germantown High School

Source	DF	Mean Squares	F
Between Academic Tracks	1	684.000	19.73
Between Instructional Methods	1	931.000	26.86
A.T. x I.M.	1	1.311	$\ll 1$
Within Cells	72	34.664	

$F_{.99,1,72} \doteq 6.95$

Overbrook High School:

At Overbrook High School it was possible to analyze the data in a 2x2x2 completely randomized design. The three factors which were crossed were "Academic Track," "Instructional Method," and "Teacher." The only main effect which was significant was that due to "Instructional Method." The students instructed in the CAI classes had a significantly higher mean performance than the students in the traditional classes. ($F = 19.231$, df: $1,80, p < .01$). None of the other main effects or interactions were significant at the required alpha level. The cell means, the marginal means, and the results of the analysis of variance are shown in Table 7 and Table 8.

Table 7

Cell Means and Marginal Means of the MUT-1 Scores at Overbrook High School

Cell Identification		Cell Mean
Academic Track, CAI, Teacher A		28.545
Academic Track, CAI, Teacher B		29.727
Academic Track, Traditional, Teacher A		22.091
Academic Track, Traditional, Teacher B		27.455
Regular Track, CAI, Teacher A		28.182
Regular Track, CAI, Teacher B		25.727
Regular Track, Traditional, Teacher A		19.182
Regular Track, Traditional, Teacher B		22.545
Factor	**Level**	**Mean**
Academic Track	Academic	26.955
	Regular	23.909
Instructional Method	CAI	28.045
	Traditional	22.818
Teacher	A	24.500
	B	26.364

Table 8

Analysis of Variance of MUT-1 Results for Overbrook High School

Source	Df	Mean Square	F
Between Academic Tracks	1	204.045	6.528
Between Instructional Methods	1	601.136	19.231
Between Teachers	1	76.409	2.444
A.T. x I.M.	1	16.409	<1
A.T. x T.	1	43.682	1.397
I.M. x T.	1	137.500	4.399
A.T. x I.M. x T.	1	3.679	<1
Within Cells	80	31.259	
Total	87		

$F_{.99,1,80} \doteq 6.90$

Summary of Analysis of Variance:

The data from the three schools clearly indicate that the students in the classes have significantly higher performance than those in the traditionally instructed classes. As one can see from observing the means of the various groups,

this effect has practical as well as statistical significance. The fact that in only one school was there a significant difference in test performance of the academic tracks may be a within-school variable with respect to just this one institution. The students in the other schools may be more alike academically but divided into various tracks as part of the school's procedural policy, while in Germantown High School where the difference in academic tracks was found, there may be real differences in the ability of the students in the various tracks rather than a relative difference as may be the case in the other schools. In any event, as further data is collected it will be possible to look in greater detail at the effect of different academic tracks upon performance in the Project GROW schools. The absence of any interactions greatly aids in the clear interpretation of the main effects.

The effect of previous item exposure on the performance of the CAI pupils on MUT-1:

As indicated above, the CAI students had had previous exposure to the items that were used in the multi-unit tests. It was anticiapated that a sample of the CAI pupils could be taken to estimate the effect of this previous exposure. However, due to technical problems involving the CAI system and programs, these data could not be obtained. Out of the eight units whose content was included in the first multi-unit test, data was available for only a very small group of students on two different groupings of three units. Each of these small samples represents less that 10% of the pupils in the CAI classes. One group of eight pupils had data available on the 5th, 7th, and 8th Biology units. (The first eight units were included in MUT-1). The average percent correct for the first testing was 62%. When the same pupils were tested on the same units with MUT-1, the average percent correct was 69%. A second group of nine students had data for the 5th, 6th, and 8th Biology units. At the first testing, the average percent correct on these units was 74%. For the second testing, it

was 71%. What conclusions one could draw from these data is questionable. One is tempted to say that if there was a substantial effect of the first testing, then these data would not be equivocal as they are. However, this is not known and therefore the reader is cautioned to be extremely careful in making generalizations from these data.

Results of the Analyses of Variance of MUT-2 Scores:

Roosevelt Junior High

The general analysis method used was a one-way fixed effects ANOVA with 3 CAI and 4 Traditional classes. All of the traditional classes were in the Academic track as were two of the CAI classes. The remaining CAI class was in the General track. Table 9 shows the results of the ANOVA and the Scheffe post-hoc comparisons.

Table 9

Results of MUT-2 Testing At
Roosevelt Junior High School

Source	DF	SS	MS	F
Between Groups	6	1564.66	260.78	8.87
Error	101	2970.00	29.41	

$F_{.99,6,101} \doteq 3.03$

Post-Hoc Scheffé Analysis

Comparison

CAI vs Traditional $p < .01$
Academic vs General $p > .01$

Cell Means and Standard Deviation

	CAI_1	CAI_2	CAI_3	$Trad_1$	$Trad_2$	$Trad_3$	$Trad_4$
Mean	28.71	30.73	24.70	20.96	23.62	23.92	19.79
Standard Deviation	5.18	3.43	6.17	4.03	7.07	6.20	6.24

As can be seen from Table 9, the overall F-ratio was highly significant. Two post-hoc comparisons were made. The initial one was for the CAI vs. the Traditional classes. This comparison was significantly different from zero at the .01 level. The difference needed for significance was 4.866; the difference actually obtained was 5.976. In view of the error mean square for this analysis, this difference has practical as well as statistical significance.

A second comparison between the Academic and General classes was made. The mean of the General students was 24.7000; for the Academic classes it was 24.6265. This difference was non-significant as can be seen by inspection.

Germantown High School

At Germantown High School, the MUT-2 results agreed with those from MUT-1. The main effects for Academic Track and for Method of Instruction were highly significant. The direction of significance favored the regular students and the CAI students respectively. There was no interaction.

Table 10

Results of MUT-2 Testing At
Germantown High School

Source	DF	MS	F
Academic Level	1	429.02	17.22
Method of Instruction	1	540.25	21.68
A.L. x M.I.	1	1.23	<1
Error	36	896.90	

$F_{.99,1,30} \doteq 7.37$

Cell Means and Marginal Means

Cell Identification	Mean
Regular, CAI	25.50
Regular, Traditional	17.80
Slow, CAI	18.60
Slow, Traditional	11.60

Academic Level	Regular	21.65
	Slow	15.10
Instructional Method	CAI	22.05
	Traditional	14.70

Overbrook High School:

For the second multi-unit test, data were available for only five classes. One was a traditionally instructed class and the other four were CAI classes. The F-ratio obtained from the analysis of variance was 5.68 which was significant at the .01 level. A post-hoc analysis using the Scheffé technique showed that there was a significant difference in the average performance of the CAI and traditionally instructed pupils. The CAI pupils performed significantly better. Table 11 shows the results of the analysis of variance and the cell means and standard deviations.

Table 11

Results of MUT-2 Testing At
Overbrook High School

Source	DF	MS	F
Between groups	4	200.37	5.68
Error	42	35.29	

$F_{.99,4,42} \doteq 3.82$

Cell Means and Standard Deviations

	CAI_1	CAI_2	CAI_3	CAI_4	$Trad_1$
Mean	21.50	18.30	24.27	18.40	13.65
Standard Deviation	6.76	5.19	6.54	8.65	4.85

Summary:

The data from the second Multi-Unit test pointed again to the significantly superior performance of the pupils in the CAI classes. As a point of interest, it might be beneficial to remind the reader that when we obtain a significant F-ratio from an analysis of variance, we conclude that the means in the populations from which our data were obtained are not all equal. We then often use some sort of post-hoc analysis to help isolate the differences. That is, the overall F-ratio tells us that there is a difference, it does not tell us where. The second point is that the statistics do not tell us the cause of the difference.

The analyses of the MUT-2 test scores clearly indicate a significant difference in means. The reason for this difference may be due to the method of instruction. It may also be due to the fact that the CAI students had an advantage over the traditionally instructed pupils because they saw the items before. Also some combination of these two effects may be the reason for the observed differences. The fact is that we do not know which of these is the case; or if any of them are.

We urge the reader to be extremely cautious with these data. They may point to the effectiveness of CAI, or they may not. We do not have sufficient data to correctly interpret these scores. Next year, when the system and program are less experimental, we will have more information on which to base a conclusion.

Section Five

Summary

An overall summary of the research of this past year cannot legitimately be made independent of events which took place during the implementation of this work. As noted in the preface of this report, the project GROW hardware and personnel were relocated during the early part of February, 1969. This event had great repercussions. Computers can be exceedingly versatile. They can also be exceedingly delicate. In reality, the system did not operate optimally after the relocation. In addition, coincident with the movement of the system to the 5th and Luzerne Streets was a change in the Central Processor. The result was that much of the software packages had to be modified. This presented a further setback. There were a number of problems particular to each school which added to the difficulty. Both Germantown High School and Overbrook High School experienced periodic malfunctioning of the air-conditioning system. This was particularly severe at the former school. The program at Wanamaker Junior High School had difficulty getting started and was always many months behind the other schools. In addition, all schools were affected by "down-time."

The conclusion one must arrive at is that, in reality, Project GROW has just begun! To say that students at the GROW schools received computer assisted instruction during the past year would not be completely accurate. Rather, they received a combination of CAI and traditional instruction. This makes it very difficult to draw conclusions from the research we have reported. The results of the multi-unit tests look very favorable. However, data collected subsequent to their administration would suggest that the inherent advantage to the CAI students was greater than suspected. We recommend that next year these tests not be used as part of any research.

The results of the standardized tests were equivocal. In Reading, we generally obtained the kinds of effects anticipated. That is, the students in

the CAI classes performed significantly better than comparable students in traditional classes.

The results of the Biology Test were less favorable. Differences in achievement were not obtained in any of the schools where the tests were administered. As we indicated in Section Two, there are several explanations for this. For one, The Nelson Biology Test may not be of sufficient content validity. Although it appeared to be the most relevant of all standardized Biology tests for the pupils in question, it still may not be good enough. The problems with the system make it difficult to draw meaningful conclusions.

The data gathered through the questionnaires may be the most relevant. These data consistently indicated that the pupils and teachers could appreciate the tremendous benefits of computer assisted instruction, but the "bugs" and "down-time" were very frustrating.

We have done many analyses this past year and we find that any conclusions drawn must be extremely tentative. We offer these results as a summary of efforts in an <u>experimental</u> program involving computer assisted instruction. In the coming year we hope to arrive at more of an understanding of the interaction between the curriculum, the student, and the computer. We hope to find out whether a student's attitude toward computers and his personality in general have any relationship to his achievement. We hope to do studies using data generated by the Central Processor. One group of these studies will involve an analysis of the effectiveness of the curriculum's remediation. We believe that the merits of CAI can only be as great as the curriculum used. We recommend that efforts be placed toward developing more basic understanding of the learning process as it is exhibited by students at the SAVI consoles. We believe that this type of work needs to be done before we can answer the overall question of whether CAI is more effective than traditional instruction.

We therefore urge that this report be accepted as a starting point toward

future investigation. As our system becomes operational, we believe that the effectiveness of computer assisted instruction will be exhibited and that the preliminary efforts we have made in this area will be rewarded.

APPENDIX 1

Contents:

Biology Curriculum

Topics

Introdution to Skills Needed
Introduction to Biology
History of Biology
Superstitions and Science
Characteristics of Life
Cells
Energy and Life
Elements and Compounds
Chemical Symbols
Equations and Reactions
Chemistry and Life
Classification
Bacteria
Viruses
Algae
Fungi
Mosses
Vascular Plants I
Vascular Plants II
Seeds and Flowers
Fertilization and Growth
Protozoa
Porifera and Colenterates
3 Worm Phyla
Mollusca and Echinodermata
Arthropoda I
Arthropoda II (Insects)
Fish
Amphibia
Reptilia
Aves
Mammalia
Introduction to Genetics
Mitosis and DNA
Reproduction
Inheritance of Traits
Twins
Mutations
Environment and Heredity
Genetics in Action
Facts and Fiction
Digestion
Circulation
Respiration
Excretion
Sensitivity
Body Regulators
Reproduction
Anthropology (Biology of Man)
Evolution
Ecology

Reading Topics

Introduction (rev.)
Directed Reading Activity (Martin Luther King)
Sentence Recognition (revised)
Summary Statement of Sentence Idea
Labeling
Relationship between Sentences
Ordering Sentences
Finding the General Topic
Finding the Specific Topic
Finding the Supporting Details
Finding the Topic Sentence
Relationships in Paragraphs
Following Directions (Small Details)
Following Directions (Order in Directions)
Fact and Opinion
Drawing Conclusions
Inferences
Cause & Effect
Context
Crossword Puzzles
Games

THE SCHOOL DISTRICT OF PHILADELPHIA
Division of Instructional Research

School_____

I attended the Computer class in reading biology.
(circle one)

Directions: Your answers to these questions will help your teachers and the other people working with the computer classes. Some of the questions can be answered by circling one choice from a list. In others, you will have to write in your answers. Thank you for your cooperation.

1. During each period, you worked part of the time with the SAVI unit and part of the time with the teachers. Do you think that there should be more time spent on the machines?

   a. Yes
   b. No
   c. No opinion

a) If you said yes, why?

b) If you said no, why?

2. Was the machine easy to use? Yes_____ No_____

a) If you said yes, can you think of ways for making it even easier?

b) If you said no, why did you say no?

3. Do you like the part of the lesson that was on the SAVI unit?

   a. Yes
   b. No
   c. No opinion

4. Students give many reasons for liking to work with the SAVI unit. From those listed below select the one that applies most to you.

I liked to work with the SAVI unit because:

a. I could go at my own speed.
b. the machine never got tired of giving the question.
c. it took nice small steps which I could understand.
d. I liked the cartoons and pictures that were used.
e. I could read all the words.
f. Other: _____

_____

5. Sometimes students do not like working with the SAVI units. If you did not was it for any of the reasons given below? Select the one that applies most to you.

I did not like working with the SAVI unit because

a. the machine was too slow.
b. each step was so small that I never felt I was learning anything.
c. I could not read a lot of the words.
d. it was boring.
e. Other: _____

_____

6. Please add anything else which you feel would provide information to your teachers and the other people working with the computer classes.

THE SCHOOL DISTRICT OF PHILADELPHIA
Division of Instructional Research

School _____

Subject taught _____

Directions: The following inventory is designed to help evaluate the CAI program in Philadelphia. The purpose of these questions is to obtain information which will help in making future decisions. You will note that some of the questions are of a multiple choice variety. For these you can circle your answers. Other questions are more open-ended where room has been left for your written responses. If there is not enough room for your answers to these questions, you can continue on the back of these pages. Finally, if there were any points which you want to add, you may do this on the blank side of these pages or on separate sheets. Please fill in the information on top of this page. Thank you for your cooperation.

1) My overall feeling concerning CAI is that it can be: (circle one or more than one)

   a. a great success.
   b. a success but this success has yet to be demonstrated.
   c. better than traditional instruction as far as student interest and motivation is concerned.
   d. about as effective as traditional instruction.
   e. less effective than traditional instruction.
   f. other: _____

   _____

2) Do you believe that any changes are needed with respect to the SAVI units?

   yes_____ No_____ No opinion_____

3) If you answered yes to number 2, do you believe that these changes should be made in the (check one or more than one)

   a. keyboard _____
   b. lightpen _____
   c. SAVI screen _____
   d. other _____

4) If you do think some changes would be beneficial in the SAVI units, what changes would you like to see? (Correlate your answer to this question with that in number 3.)

5) With respect to the CAI curriculum in my area, I feel that (circle one or more than one)

a. it stressed retention of unimportant details.
b. it did not stress application of principles sufficiently.
c. did not make sufficient use of graphics as a visual medium could have.
d. it used vocabulary which was too difficult for the students. (This would be other than technical vocabulary in Biology)
e. it was not sufficiently "de-bugged."
f. it was logically written and helped the student to grasp its ideas.
g. it made excellent use of graphics.
h. generally speaking it was of very high quality.
i. other:_____

_____

6) What is the relationship between a student's ability and CAI?

a. The CAI concept can be used with children of all ability levels.
b. CAI works best with lower ability children.
c. CAI works best with higher ability children.
d. I do not really believe that it makes too much difference what type of instruction is used. The bright students learn and the less bright do not.
e. other:_____

_____

7) The number of students in the CAI classes was

a. too large_____
b. small in the sense that more students could have been handled_____
c. just about right_____

8) Do you agree that the number of students in a CAI class is limited only by the number of SAVI units?

a. Yes_____
b. No because_____

_____

9) Were the duties of the teacher in the CAI classes reasonable? This means other than teaching duties. Were there too many tasks involving turning equipment on or off, working the teletype, and so on? Is the system manageable?

Yes_____ No_____ They were manageable_____

10) Would you like a weekly summary report of each pupil's progress? This is in addition to the ASR reports.

Yes_____
No_____

11) Is the weekly topic summary as it is now printed adequate for your needs? If not, what other information would you like? Or what would you like deleted?

_____

_____

_____

_____

_____

12) Please add anything else which you as an educator believe would be helpful in describing the Philadelphia CAI program.

Department of Develcpmental Research