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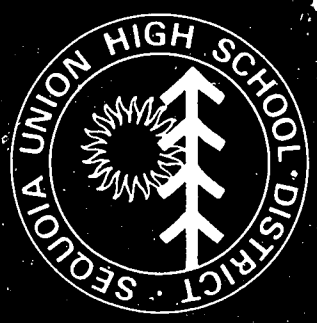
ABSTRACT

A description is provided of comprehensive Achievement Monitoring (CAM), a tool which enables classroom teachers to function as researchers and evaluators. Part I reviews the CAM philosophy and the section following discusses computerized feedback in CAM operations. The final two portions of the report describes the use of CAM in mathematics programs in a pair of high schools. (PB)



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COMPREHENSIVE ACHIEVEMENT MONITORING IN THE SEQUOIA UNION HIGH SCHOOL DISTRICT

SYMPOSIUM

CALIFORNIA MATHEMATICS COUNCIL

NORTHERN SECTION

December 8, 1973

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For some time it has appeared necessary to refocus the direction that educational research in the public schools has traditionally taken. Educational research for many years has emphasized tightly controlled experiments in which only one variable at a time is manipulated in experimental groups, while control groups are maintained as static as possible.

Educators have tried to control many different variables in an attempt to isolate a single variable that might have some causative effect on student performance. Most generally this approach has been a dismal failure. One has only to examine the literature on any particular problem to note that for most problems there appears to be no clear cut solution. Experiments on a single problem usually produce as many neutral and negative results as positive results.

It's not difficult to understand the reason for this. In almost any experimental situation researchers have tried to control as many variables as possible. The irony is that there are too many variables to control in an educational setting. Among these variables are the students, the instructional material, the teachers, time of day, length of class time, number of students, instructional strategies, reinforcement patterns, etc. The dynamics of classrooms too often preclude successful experimental control.

As one solution to improving experimental control, good research design advocates randomization of students into experimental and control groups. This is often difficult to achieve. If you structure the school just for experimental purposes you often disrupt teachers. If you try to change the structure for different experiments, management of the school becomes more difficult. One compromise solution used is randomization by classes. However, classes often are not uniformly heterogeneous in composition.

Recently educational researchers have begun to explore the possibility of using multivariate statistical analysis as a way to circumvent the problem of controlling variables. This technique shows promise but many of the procedures and applications still have to be developed before wide spread implementation of this approach will occur.

The previous discussion has briefly highlighted concerns educational researchers and evaluators should have. Perhaps their primary concern should be, however, to recognize the effect their work has upon the classroom teacher in terms of disrupting classroom routine. Educational research is an instructional intervention in the classroom. The most commonly recognized and

quoted research effect that is guarded against, or to which abnormally good results are sometimes credited, is the Hawthorne effect. The very introduction of a research effort, with its attendant publicity and hoopla, often creates a short term benefit that is measureable and significant. But it can also disrupt the daily routine and operation of the classroom, upsetting both the students and the teacher. Negative results may be a reflection of the negative affect created by disrupting the classroom.

Today's society is demanding that much more emphasis be placed on evaluation. This emphasis gives educational researchers and evaluators more status which aids their attempt to document the learning process and the effectiveness of educational systems. What they often forget, however, as they focus on finding a solution to some educational problem, is that any method or procedure is only as good as the person who is using it. If research and evaluation are indeed to become a panacea for improved education then teachers must become experimentalist and empirical in their decision making. Teachers must be directly involved in research to make it a living, functional part of today's educational process, rather than some educational researcher's ego trip collecting dust on university library shelves or ERIC microfiche.

As conceived by the Sequoia Union High School District, Comprehensive Achievement Monitoring is a tool that enables teachers to function as researchers and evaluators. Its conceptual framework includes a curriculum defined by performance objectives. These objectives serve as discrete items to be studied in curriculum product research, or as the focus for educational process research. The measurement of student performance on objectives produces a partial indication of the success of the educational establishment. Student performance on an objective is measured by test items that teachers write specific to an objective. Thus the CAM system, through its test items, more truly reflects what the teacher wants a student to know or be able to do, than any externally created standardized test.

Sets of interchangeable test forms are created for each test. Sampling techniques are used to get estimates of what students know or are able to do without subjecting them to long involved testing situations that turn them off. No student has to respond to all the questions that have to be asked in order to furnish the teacher, who is the researcher, with all the information he needs. Thus that very important factor of class disruption is kept to a

minimum. Furthermore, since the data being collected is relative to the class's regular curriculum, there is no need to add extra tests to the classroom schedule just to satisfy some externally located educational researcher.

Two other components of the conceptual framework of CAM are periodic testing, usually weekly or biweekly as determined by the teacher, and the storage of the collected information so that a longitudinal history of performance is developed. This approach builds a data bank that continually may be tapped for information concerning individual students and groups of students, yet is unobtrusive and a regular part of the usual classroom routine. The massive task of data collation and data storage is done by computer. Without a computer the idea that teachers can also be researchers would be impossible to achieve.

If teachers are to function empirically they must have at their disposal quick feedback of information. It is very difficult to modify curriculum and instructional activities, or to work with students individually, without instant access to data. Reporting of results to the specification of the teacher is another concept of CAM. Computerized analysis and reporting is generally available on an overnight basis.

Each of the above concepts is being implemented to construct a complete evaluation cycle. We hope evaluation will become a continuous process in which the teacher uses a constant feedback of information to improve student learning. Naturally there is a possible weak link in the cycle. Teachers must have a large amount of knowledge to implement CAM before they can use it effectively to make decisions about curriculum, instructional activities, and students. The tool, CAM, can only be as good as the teacher who uses it. If a teacher cannot successfully master CAM concepts and interpret the results that CAM furnishes, then the evaluation cycle will never be completed by that teacher.

To encourage teachers to use data in their daily instructional decision making, we have asked them to define a particular problem that they are interested in exploring and establish an hypothesis that they would like to test. We don't require that this hypothesis be concerned with the total problem of the effectiveness of CAM. By having teachers select an hypothesis, we hope that they will study the data after each test administration in an attempt to discover whether their hypothesis is true. Perhaps they will even try to positively affect the hypothesis by what they do in the classroom.

At that point they will be using CAM data as an everyday part of their teaching operation and the evaluation cycle will be closed. Evaluation will become functional and formative.

What does this mean to educational researchers? Teachers need assistance. Most of them are well read only in their subject matter field, but they generally are creative. They need to be stimulated concerning possibilities for what they can do within their classroom. Educational researchers can serve as tutors and guides to teachers. But they must always keep in mind that unless the teacher enthusiastically embraces what the educational researcher is saying, then the researcher will be an albatross. The teacher is probably the most important variable in today's schools. What works for one teacher may not for another, and that is the most important thing for each teacher and researcher to discover. By focusing our efforts on the classroom teacher, rather than intellectually exciting theories or ideas, we hope eventually to build a mosaic that will give us answers to problems existing in education.

At present, during the first semester of 1973-74, seventy-four courses are being monitored by CAM. Five additional courses will begin the second semester. Many content areas are being monitored, including courses in arithmetic, general math, pre-algebra, algebra I, and algebra II, in the mathematics curriculum. Biology, chemistry, physics, general science, earth science, medical careers, geography, economics, government, social psychology, anthropology, social studies basic skills, history, safety education, child development, reading, vocabulary, English, music, art, physical education, metal work, drafting, foods, Spanish, French, business law, marketing, accounting, and typing, are among courses in other departments that are CAMmed. One hundred and ten teachers and approximately 10,512 students currently are participating in the program. These students are distributed among 376 class sections. Some of these students are enrolled at Notre Dame High School in Belmont, California, as Notre Dame is participating with the Sequoia District in CAM. As of December 5, 1973, 35,780 CAM student tests have been processed. Processing has also been done for 4,755 standardized tests, 3,607 experimental tests, counselor questionnaires from 49 students, and student assessment of teacher responses from 900 students. This latter processing represents research and evaluation efforts closely associated with the CAM program.

The effects of CAM and related efforts have been most encouraging. A comparison of student performance in CAM classrooms as opposed to non-CAM classrooms is included in Table 1. Within each course, both CAM and non-CAM

students took the same tests. Data is reported only for those items from the tests that were related to objectives that a teacher had taught during the semester. In all instances the CAM students showed a greater gain from pretest to posttest than did the non-CAM students.

Another positive effect of CAM is shown in Table 2. In this instance, the same course was examined for the year prior to CAM, the first year of CAM, and the second year of CAM. The grade equivalency increase from pretest to posttest on the Nelson Reading Test showed that the student's performance was better with the CAM system than without it with a gain of 1.15 years during the year without CAM, a gain of 1.52 years during the first year on CAM, and a gain of 1.77 years during the second year on CAM.

TABLE 1

Comparison Testing - Criterion Referenced Tests - Percent Correct

Course	CAM				Non-CAM				Difference in Gains
	Number of Students	Pretest	Posttest	Gain	Number of Students	Pretest	Posttest	Gain	
Algebra I	224	28.15	58.41	30.26	511	35.98	57.30	21.32	+ 8.94
Algebra II	192	34.32	65.80	31.48	173	41.74	67.29	25.55	+ 5.93
Biology	544	38.56	56.50	17.94	404	39.78	50.28	10.50	+ 7.44
General Math, Pre-algebra	140	58.57	74.85	16.28	394	49.29	63.35	14.06	+ 2.22
Chemistry	340	26.09	50.39	24.30	207	29.11	50.27	21.16	+ 3.14

TABLE 2

Reading - Standardized Test - Grade Equivalency Scores

1970-71 Before CAM				1971-72 CAM's First Year				1972-73 CAM's Second Year			
Number of Students	Pretest	Posttest	Gain	Number of Students	Pretest	Posttest	Gain	Number of Students	Pretest	Posttest	Gain
117	5.70	6.85	1.15	139	5.55	7.07	1.52	108	5.95	7.72	1.77

There are six basic types of computerized feedback: individual student reports, group summary reports, class roster reports, form analyses, curriculum analyses, and exception reports.

Figures 1 through 3 are examples of individual student reports. Each student receives a copy of his own student report after each test administration. The data shown in Figure 1 are for Kim Ann Bunyan's fifth test administration. Kim is a student in Mr. Reed's General Math Course (CA105) at Carlmont High School. The left portion of the report tells the student her performance for the test that was just administered. This left portion includes an objective number for each item on the test, whether each item was right (+) or wrong (-), which response the student selected if she answered incorrectly, and if instruction had occurred for each objective (YES). The right portion of the report consists of the student's performance history. This right portion tells the student her cumulative total score (CUM TOTAL) and tells her the test form and score for the present test administration and all previous test administrations. Each teacher decides whether he (or she) wants the individual student reports in terms of percentages or fractions. The teacher also has the choice of which two scores are to be printed. The data in Figure 1 indicate that Mr. Reed has chosen to have fraction correct reported for the total test (FRN COR ALL) and for all items on the test for which instruction has been completed (FRN COR YES). Mr. Reed's classes are group paced so each individual student report for Test Administration 5 is a report on how the student did for the test on Unit 5, (Form 51 or 52). These forms have a majority of items from Unit 5 with a few retention items from Unit 4.

The individual student reports shown in Figures 2 and 3 are for students in Mr. McCann's individually paced Pre-Algebra course (RA103) at Ravenswood High School. The reports shown in Figures 2 and 3 are different from the one shown in Figure 1. First, Mr. McCann has chosen to have the history portion of the report (the right hand portion) in terms of percent correct rather than fraction correct. Second the two scores chosen are for all pretest items in the test (PCT COR PRE) and for all posttest items on the test (PCT COR POST). Finally, since the course is individually paced, the history portion reflects different numbers of test administrations for different students and the test date is shown rather than the test administration number. Thus, although both of the students represented took their last test on November 28th, George Edwards (Figure 2) has taken five tests and Myrna Smith (Figure 3) has taken twelve tests.

BUNYAN KIM ANN 737403 SECTN 11 REED 11/28/7

3105

TEST ADM 5 - 11/28/73

FRACTION CORRECT ON ALL ITEMS IS 27/29 FORM 52

FRACTION CORRECT ON YES ITEMS IS 27/29

QN	OBJ	RP	INS	QN	OBJ	RP	INS	TEST ADM	FORM	FRN COR ALL	FRN COR YES
1	404	+	YES	16	506	+	YES	1	2	18/50	0/ 0
2	405	+	YES	17	506	+	YES	2	22	23/25	23/25
3	407	+	YES	18	506	+	YES	3	32	24/25	24/25
4	409	+	YES	19	507	4-	YES	4	42	27/28	27/28
5	501	+	YES	20	507	4-	YES	5	52	27/29	27/29
6	501	+	YES	21	508	+	YES				
7	502	+	YES	22	508	+	YES				
8	502	+	YES	23	508	+	YES				
9	502	+	YES	24	509	+	YES				
10	503	+	YES	25	509	+	YES				
11	503	+	YES	26	510	+	YES				
12	503	+	YES	27	510	+	YES				
13	504	+	YES	28	510	+	YES				
14	505	+	YES	29	510	+	YES				
15	505	+	YES	30	0						

CUM TOTAL 119/157 101/107

Figure 1. Example of an individual student report in fractions for group paced instruction. General Math course at Carlmont High School.

EDWARDS GEORGE W 518597 SECTN 26 MCCANN 11/29/73

5103

TEST ADM 5 - 11/28/73

PERCENTAGE CORRECT ON PRE ITEMS IS 12 FORM 33

PERCENTAGE CORRECT ON POST ITEMS IS 87

QN	OBJ	RP	INS	QN	OBJ	RP	INS	TEST DATE	FORM	PCT COR PRE	PCT COR POST
2	1104	2-		11	3307	1-		9/14	11	33	22
1	1105	1-		12	3308	+		10/24	12	83	100
3	2201	+		13	4401	+		11/ 6	31	0	25
4	2204	+		14	4402	2-		11/20	32	12	37
5	3301	+		15	4403	2-		11/28	33	12	87
6	3302	+		16	4404	4-					
7	3303	+		17	4405	4-					
8	3304	+		18	4406	3-					
9	3305	+		19	4407	3-					
10	3306	+		20	4408	1-					

CUM AVG 25 54

Figure 2. Example of an individual student report in percentages for individually paced instruction. Pre-Algebra course at Ravenswood High School.

SMITH MYRNA 623785 SECTN 26 MCCANN 11/29/73

5103

TEST ADM 12 - 11/28/73

PERCENTAGE CORRECT ON PRE ITEMS IS 83 FORM 53

PERCENTAGE CORRECT ON POST ITEMS IS 76

QN	OBJ	RP	INS	QN	OBJ	RP	INS	TEST DATE	FORM	PCT COR PRE	PCT COR POST
1	1102	+		14	5508	+		9/22	1	77	0
2	1105	+		15	5509	2-		9/22	13	83	77
3	2206	+		16	5510	+		9/22	33	75	87
4	3306	+		17	5511	+		9/22	11	83	88
5	4407	+		18	5512	+		9/24	33	75	87
6	4408	+		19	5513	4-		9/24	13	83	77
7	5501	+		20	6601	+		9/24	11	83	88
8	5502	+		21	6602	1-		9/24	13	33	33
9	5503	+		22	6603	+		11/16	32	100	87
10	5504	+		23	6604	+		11/19	51	33	53
11	5505	+		24	6605	+		11/27	52	66	76
12	5506	+		25	6606	+		11/28	53	83	76
13	5507	1-		26	0						
									CUM AVG	74	75

Figure 3. Example of an individual student report in percentages for individually paced instruction. Pre-Algebra course at Ravenswood High School.

A copy of a Class Roster Report is shown in Figure 4. This report provides the teacher with a summary of each student's performance. The report shows for each test administration the fraction correct for all items on the test (ALL), the fraction correct for items which have been instructed (YES), and the form the student took (FORM). The report also gives the cumulative total (CUM TOTAL) for each student for all tests that have been given.

The Group Summary Report is used to present percentage correct for any specified set of objectives, e.g., unit, chapter, pre objectives, all objectives, and the percentage correct for each objective. After each test administration each teacher receives a group summary for all students in the course, one for all of his (or her) students, and one for each of his classes. The Group Summary Report shown in Figure 5 is the first page of a report for all of Mr. Reed's students. For each content group the report gives the average percent correct (AVG) and the number of student responses used to calculate the average (NUM).

Figure 6 contains reduced copies of the form analysis for Form 51 and Form 52. After each test administration, the teacher receives a form analysis for each form used during a test administration. The data for a given form always includes data from all the students who took that form for that test administration. The print-out shows how many students took the form, the date of the test administration, and then prints data for each item on the test in the order the items appear on the test. These data include the objective number, the correct answer, the average percent correct (AVG SCORE), the percentage of students who did not respond (NR), and the percentage of students who chose each response alternative. The total percentage correct for the form is printed at the bottom of the report. The two forms shown in Figure 6 were the only two forms given for Test Administration 5 in Mr. Reed's General Math course. Although the objectives are the same on both forms, the items are not. The percentage correct shown at the bottom of each report, 62 for Form 51 and 60 for Form 52, indicate that the teacher did a good job in constructing comparable forms.

COMPREHENSIVE ACHIEVEMENT MONITORING - CLASS ROSTER REPORT 3105

CARLMONT GENERAL MATH, SEM. 1 SECTN 11 TNB 71 REED 11/28/73

NUMBER	NAME		CUM TOTAL	TEST ADMINISTRATION 1	2	3	4	5	6
613919	BRODT BILL C	ALL	71/107	0/ 0	18/25	13/25	24/28	16/29	
		YES	71/107	0/ 0	18/25	13/25	24/28	16/29	
		FORM		0	21	31	41	51	
293506	BRUNNER DAVE J	ALL	90/157	9/50	20/25	19/25	18/28	24/29	
		YES	81/107	0/ 0	20/25	19/25	18/28	24/29	
		FORM		1	21	31	41	51	
737403	BUNYAN KIM ANN	ALL	119/157	10/50	23/25	24/25	27/28	27/29	
		YES	101/107	0/ 0	23/25	24/25	27/28	27/29	
		FORM		2	22	32	42	52	
722157	CHESSER JAMES B	ALL	112/157	20/50	23/25	21/25	27/28	21/29	
		YES	92/107	0/ 0	23/25	21/25	27/28	21/29	
		FORM		2	22	32	42	52	
776260	COLER DAN	ALL	86/107	0/ 0	23/25	20/25	20/28	23/29	
		YES	79/ 98	0/ 0	23/25	13/16	20/28	23/29	
		FORM		0	21	31	41	51	
90250.	CONNELLY KATHLEEN	ALL	112/157	19/50	22/25	24/25	22/28	25/29	
		YES	93/107	0/ 0	22/25	24/25	22/28	25/29	
		FORM		2	22	32	42	52	
775544	DEMPSTER PRESCOTT	ALL	119/157	24/50	23/25	19/25	27/28	26/29	
		YES	95/107	0/ 0	23/25	19/25	27/28	26/29	
		FORM		2	22	32	42	52	
737379	DONOHUE THEODORE P	ALL	88/157	26/50	18/25	14/25	22/28	8/29	
		YES	62/107	0/ 0	18/25	14/25	22/28	8/29	
		FORM		1	21	31	41	51	
722504	DOUGLAS ALAN L	ALL	87/157	18/50	18/25	17/25	22/28	12/29	
		YES	69/107	0/ 0	18/25	17/25	22/28	12/29	
		FORM		2	22	32	42	52	
722538	DOWNES TAYLOR	ALL	23/ 29	0/ 0	0/ 0	0/ 0	0/ 0	23/29	
		YES	23/ 29	0/ 0	0/ 0	0/ 0	0/ 0	23/29	
		FORM		0	0	0	0	51	
722686	FISHER BARBARA J	ALL	108/157	15/50	21/25	23/25	26/28	23/29	
		YES	93/107	0/ 0	21/25	23/25	26/28	23/29	
		FORM		2	22	32	42	52	

Figure 4. An example of a class roster report for General Math.

COMPREHENSIVE ACHIEVEMENT MONITORING - GROUP SUMMARY REPORT 3105
CARLMONT GENERAL MATH, SEM. 1 11/28/73
STUDENT GROUP 7100 REED'S STUDENTS

CGN	CONTENT GROUP		TEST ADMINISTRATION 1	2	3	4	5	6	7	8	9	10
	NUMBER OF STUDENTS		49	51	56	61	48					
0	ALL OBJECTIVES	AVG	34	74	75	80	76					
		NUM	2450	1275	1375	1708	1392					
10	CHAPTER 1	AVG	57	81	$$$	$$$	$$$					
		NUM	69	306	0	0	0					
20	CHAPTER 2	AVG	38	72	78	$$$	$$$					
		NUM	323	969	330	0	0					
30	CHAPTER 3	AVG	41	$$$	74	79	$$$					
		NUM	314	0	1045	427	0					
40	CHAPTER 4	AVG	36	$$$	$$$	81	76					
		NUM	383	0	0	1281	192					
50	CHAPTER 5A	AVG	29	$$$	$$$	$$$	76					
		NUM	891	0	0	0	1200					
51	CHAPTER 5B	AVG	$$$	$$$	$$$	$$$	$$$					
		NUM	0	0	0	0	0					
61	CHAPTER 6A	AVG	30	$$$	$$$	$$$	$$$					
		NUM	470	0	0	0	0					
62	CHAPTER 6B	AVG	$$$	$$$	$$$	$$$	$$$					
		NUM	0	0	0	0	0					
70	CHAPTER 7	AVG	$$$	$$$	$$$	$$$	$$$					
		NUM	0	0	0	0	0					
9991	POST OBJECTIVES	AVG	$$$	74	76	80	76					
		NUM	0	1275	1330	1708	1392					
9992	PRE OBJECTIVES	AVG	34	$$$	60	$$$	$$$					
		NUM	2450	0	45	0	0					
404	.OBJECTIVE 404	AVG	46	$$$	$$$	82	89					
		NUM	49	0	0	183	48					
405	.OBJECTIVE 405	AVG	51	$$$	$$$	78	83					
		NUM	29	0	0	61	48					
407	.OBJECTIVE 407	AVG	18	$$$	$$$	67	70					
		NUM	49	0	0	122	48					
409	.OBJECTIVE 409	AVG	14	$$$	$$$	67	60					
		NUM	49	0	0	122	48					

Figure 5. An example of a Group Summary Report for all of Mr. Reed's General Math students.

COMPREHENSIVE ACHIEVEMENT MONITORING - FORM ANALYSIS REPORT
CARLMONT GENERAL MATH, SEM. 1 3105 11/28/73

FORM 51 99 STUDENTS RESPONDED TO THE FORM DURING TEST ADMINISTRATION 5

QUESTION NUMBER	OBJECTIVE	ANSWER	AVG SCORE	RESPONSES(%) NR	1	2	3	4	5
1	404	4	69	2	10	14	4	69	0
2	405	1	66	4	66	14	13	2	0
3	407	3	47	3	9	31	47	9	0
4	409	3	53	2	34	2	53	8	0
5	501	4	74	2	12	4	7	74	0
6	501	1	89	2	89	1	3	4	0
7	502	3	63	2	6	6	63	22	0
8	502	4	75	2	3	7	12	75	0
9	502	2	56	2	3	56	27	11	0
10	503	3	71	3	19	5	71	1	0
11	503	2	70	2	19	70	4	4	0
12	503	1	66	3	66	11	15	4	0
13	504	3	32	6	25	17	32	19	0
14	505	1	72	3	72	7	9	8	0
15	505	3	66	4	7	15	66	7	0
16	506	3	74	2	9	7	74	7	0
17	506	4	61	4	8	12	14	61	0
18	506	2	54	4	13	54	26	8	0
19	507	3	73	2	8	4	73	12	0
20	507	4	56	2	33	2	6	56	0
21	508	3	63	5	16	11	63	4	0
22	508	2	60	7	6	60	19	13	0
23	508	4	42	9	21	12	15	42	0
24	509	4	74	5	5	8	7	74	0
25	509	3	69	6	9	8	69	7	0
26	510	1	53	5	53	13	18	10	0
27	510	3	63	5	8	13	63	10	0
28	510	1	43	8	43	17	15	16	0
29	510	3	38	11	6	19	38	25	0

FORM 51: TOTAL PERCENTAGE CORRECT = 62

COMPREHENSIVE ACHIEVEMENT MONITORING - FORM ANALYSIS REPORT
CARLMONT GENERAL MATH, SEM. 1 3105 11/28/73

FORM 52 112 STUDENTS RESPONDED TO THE FORM DURING TEST ADMINISTRATION 5

QUESTION NUMBER	OBJECTIVE	ANSWER	AVG SCORE	RESPONSES(%) NR	1	2	3	4	5
1	404	1	62	1	62	8	25	1	0
2	405	2	66	2	16	66	13	2	0
3	407	2	50	1	25	50	16	11	0
4	409	1	25	2	25	28	14	29	0
5	501	2	85	2	0	85	10	0	0
6	501	3	70	1	21	1	70	4	0
7	502	1	50	0	50	3	6	34	0
8	502	3	70	1	5	2	70	19	0
9	502	4	59	2	16	8	9	59	0
10	503	2	63	2	22	63	10	0	0
11	503	1	67	3	67	17	1	8	0
12	503	4	57	3	17	16	4	57	0
13	504	2	63	3	4	63	20	8	0
14	505	2	72	2	6	72	15	3	0
15	505	4	47	6	25	8	11	47	0
16	506	4	74	1	3	13	7	74	0
17	506	2	59	5	5	59	14	15	0
18	506	1	53	4	53	8	21	12	0
19	507	1	70	0	70	6	16	6	0
20	507	2	45	0	5	45	44	3	0
21	508	1	73	2	73	10	8	4	0
22	508	4	67	4	9	9	8	67	0
23	508	1	51	5	51	17	12	12	0
24	509	1	66	3	66	10	13	5	0
25	509	2	61	2	8	61	8	18	0
26	510	4	54	3	13	9	18	54	0
27	510	2	70	5	2	70	15	6	0
28	510	4	44	7	10	21	16	44	0
29	510	2	36	8	33	36	7	14	0

FORM 52: TOTAL PERCENTAGE CORRECT = 60

Figure 6. Form Analysis Reports for Form 51 and Form 52 given on Test Administration 5 in General Math

Examples of exception reports are shown in Figures 7 through 9. This type of reporting allows the teacher to focus attention on individual students in terms of their overall performance on a test and/or in terms of their strengths or weaknesses on specific objectives. The report shown in Figure 7 lists Mr. Reed's students who are in the lowest 33 percent of his class for the test given for Test Administration 5. It also lists those objectives which these students have not mastered. The mastery level is determined by the teacher. In figure 7 the mastery level is 50 percent and those objectives on which student perform below 50 percent are listed. With this information the teacher can, if time allows, either work individually with each of the students, or, let each student know which objectives should be reviewed. For this type of a report, the teacher chooses both the percent of the class that is to be listed and the mastery level for student performance on objectives. He has the option of choosing either the highest or the lowest "x" percent of his class. He then decides whether he wants mastery information on these students. If he decides to have mastery information on objectives, he then decides whether this information will be performance above a certain percentage level or performance below a certain performance level.

Figure 8 shows an exception report that groups objectives based on student performance during the current test administration. Mr. Reed has chosen to have objectives listed that are in the highest 50 percent of student performance and objectives that are in the lowest 50 percent of student performance. The teacher chooses what percent of the objectives he wants. For example, a teacher may request the highest 25 percent and the lowest 50 percent. The objectives are listed in order by objective number within each set. This allows the teacher to see if the high (or low) objectives are grouped in a meaningful way. Thus, as seen in Figure 8, Mr. Reed can quickly determine that two of the 400 series objectives are in the high group and two are in the low group. Teachers find many uses for this report. As examples, a teacher may decide to pick certain objectives in the low group to review with the class, or, if some of the objectives were pretest information and occurred in the high group, the teacher may decide not to spend as much time teaching these objectives as originally planned.

An example of the third type of exception report is shown in Figure 9. In this example the names of students who performed below mastery level (50 percent) on an objective, are listed for each objective that was tested during Test Administration 5. As with the other exception reports the teacher chooses

the percent mastery level used for the listing. The teacher also decides whether he wants a report that lists names of students that are above a given mastery level or names of students below a given mastery level. One of the uses of this report is that a teacher can group students for review of certain objective, or, in some cases, allow students above a certain mastery level to delete those objectives from their study plan.

There are two versions of the Curriculum Analysis Report: a long version and a short version. These analyses can be requested by the teacher at any point in time, usually at the end of a quarter or semester. A portion of the long version for Test Administrations 1-5 for all students in the General Math course for 1973-74 is shown in Figure 10; the same portion for all test administrations for the same course during the first semester of 1972-73 is shown in Figure 11. On this report the percentage correct and the percentage of students responding to each response alternative is shown for each item and each objective as a function of when the item was administered. Thus, the teacher is able to determine how the students performed prior to instruction (PRE), immediately following instruction (POST = 0 to 20 days), and on a long-erm retention basis (RETN = longer than 20 days since instruction). The teacher has the option of determining how many days must have elapsed since instruction for performance data to be considered as a reflection of long-term retention.

A copy of a portion of the short version of the Curriculum Analysis Report is shown in Figure 12. This report shows the percentage correct for each objective as a function of when the item was administered. Also shown is the gain from pre to post and the gain from pre to retention for each objective. In all the curriculum analysis reports the column labeled TOT RESP is the total number of student responses used to calculate the average score (AVG SCOR). Both versions of the report can be obtained for a specified semester or a specified set of test administrations. In addition to specifying the time span the report should cover, the teacher can specify the group of students to be included in the analysis. He can ask for an analysis for all students in the course, all students of a given teacher, and/or all students in a given class.

COMPREHENSIVE ACHIEVEMENT MONITORING -- TEACHER DIAGNOSTIC ROSTER LIST
CARLMONT GENERAL MATH, SEM. 1 3105 11/29/73

***** REED SECTN 11 ***** TEST ADMINISTRATION 5

PERFORMANCE BY THE FOLLOWING STUDENTS ON ALL OBJECTIVES FOR THE CURRENT TEST ADMINISTRATION IS IN THE LOWEST 33 PERCENT OF THE CLASS

THE STUDENT'S ACHIEVEMENT LEVEL IS BELOW 50% ON LISTED OBJECTIVES

BRODT BILL C 55% ACHIEVEMENT LEVEL

503 504 508 509

CHESSER JAMES B 72% ACHIEVEMENT LEVEL

407 409 504

COLER DAN 79% ACHIEVEMENT LEVEL

DONOHUE THEODORE P 27% ACHIEVEMENT LEVEL

407 409 502 503 504 505 506 508 510

DOUGLAS ALAN L 41% ACHIEVEMENT LEVEL

405 407 409 503 507 509 510

DOWNES TAYLOR 79% ACHIEVEMENT LEVEL

409 504

FISHER BARBARA J 79% ACHIEVEMENT LEVEL

407 409 502 509

FRANKLIN BERNARD T 58% ACHIEVEMENT LEVEL

409 502 507 510

Figure 7. This example of exception reporting lists the names and performance (achievement) level for students in the lowest 33 percent of the class for the current test administration. (List shown is incomplete) For each student all objectives for which performance was below 50 percent are shown.

IN A RANKING OF ALL OBJECTIVES THE FOLLOWING OBJECTIVES WERE IN THE HIGHEST 50 PERCENT OF STUDENT PERFORMANCE

OBJECTIVE	PERFORMANCE LEVEL
OBJECTIVE 404	96%
OBJECTIVE 405	88%
OBJECTIVE 501	98%
OBJECTIVE 503	83%
OBJECTIVE 506	91%
OBJECTIVE 508	80%
OBJECTIVE 509	78%

IN A RANKING OF ALL OBJECTIVES THE FOLLOWING OBJECTIVES WERE IN THE LOWEST 50 PERCENT OF STUDENT PERFORMANCE

OBJECTIVE	PERFORMANCE LEVEL
OBJECTIVE 407	73%
OBJECTIVE 409	65%
OBJECTIVE 502	69%
OBJECTIVE 504	53%
OBJECTIVE 505	78%
OBJECTIVE 507	75%
OBJECTIVE 510	73%

Figure 8. This is example is a listing of the highest 50 percent and the lowest 50 percent of the objectives based on student performance for the current test administration.

STUDENTS WHOSE ACHIEVEMENT LEVEL IS BELOW 50% ON LISTED OBJECTIVES

OBJECTIVE 404

VEGA RICK B

OBJECTIVE 405

DOUGLAS ALAN L	KETCHENS DENAUAR F	NICKEL BRAD

OBJECTIVE 407

BRUNNER DAVE J	CHESSER JAMES B	DONOHUE THEODORE P
DOUGLAS ALAN L	FISHER BARBARA J	VEGA RICK B
WOLFENBORGER DARA		

OBJECTIVE 409

CHESSER JAMES B	DEMPSTER PRESCOTT	DONOHUE THEODORE P
DOUGLAS ALAN L	DOWNES TAYLOR	FISHER BARBARA J
FRANKLIN BERNARD T	KARPENKO NICHOLAS	NICKEL BRAD

OBJECTIVE 501

OBJECTIVE 502

BRUNNER DAVE J	CONNELLY KATHLEEN	DONOHUE THEODORE P
FISHER BARBARA J	FRANKLIN BERNARD T	GIUSTI JULIANNE
VEGA RICK B		

OBJECTIVE 503

BRUDT BILL C	DONOHUE THEODORE P	DOUGLAS ALAN L

OBJECTIVE 504

BRUDT BILL C	BRUNNER DAVE J	CHESSER JAMES B
DONOHUE THEODORE P	DOWNES TAYLOR	JONES ELIZABETH A
KETCHENS DENAUAR F	NEWTON ALFREDO	NICKEL BRAD
PRENTISS JIM E	SULLIVAN GAYLE E	VEGA RICK B

OBJECTIVE 505

DONOHUE THEODORE P	GIUSTI JULIANNE	

Figure 9. This example of exception reporting lists the names of students who performed below 50 percent on each objective tested during the current test administration. (All objectives not shown in example.)

COMPREHENSIVE ACHIEVEMENT MONITORING --- CURRICULUM ANALYSIS PROGRAM

CARLMONT GENERAL MATH, SEM. 1 3105
TEST ADMINS 1 - 5 ALL STUDENTS IN THE COURSE
UNIT 2

PRE = -999 TO -1 DAYS POST = 0 TO 20 DAYS RETN = 21 TO 9999

	ITEM NUMBER	CUR ANS		TOT RESP	AVG SCOR	NR	RESPONSES (%) 1	2	3	4	5
	20101.	1	PRE	136	22	3	22	41	30	1	0
			POST	140	52	0	52	19	25	2	0
			RETN	124	58	0	58	20	20	0	0
	20103.	3	PRE	124	24	7	57	11	24	0	0
			POST	132	37	0	36	25	37	0	0
			RETN	0	0	0	0	0	0	0	0
	20104.	3	PRE	0	0	0	0	0	0	0	0
			POST	129	62	0	9	24	62	3	0
			RETN	0	0	0	0	0	0	0	0
	20182.	3	PRE	0	0	0	0	0	0	0	0
			POST	138	55	0	7	7	55	28	0
			RETN	128	55	0	12	4	55	26	0
OBJ	201		PRE	260	23						
			POST	539	52						
			RETN	252	57						
	20201.	4	PRE	136	33	16	7	17	19	33	5
			POST	129	57	6	12	8	14	57	0
			RETN	0	0	0	0	0	0	0	0
	20202.	2	PRE	0	0	0	0	0	0	0	0
			POST	132	61	6	11	61	14	6	0
			RETN	0	0	0	0	0	0	0	0
OBJ	202		PRE	136	33						
			POST	261	59						
			RETN	0	0						
	20301.	2	PRE	0	0	0	0	0	0	0	0
			POST	132	42	2	21	42	18	15	0
			RETN	0	0	0	0	0	0	0	0
	20302.	4	PRE	124	27	15	11	25	18	27	1
			POST	132	43	0	12	25	17	43	0
			RETN	0	0	0	0	0	0	0	0

Figure 10. A portion of the Curriculum Analysis Report (long version) for all students in the Carlmont General Math course - Test Administrations 1-5, 1973-74.

COMPREHENSIVE ACHIEVEMENT MONITORING --- CURRICULUM ANALYSIS PROGRAM

CARLMONT GENERAL MATH CA105
SEMESTER 1--ALL STUDENTS IN THE COURSE
UNIT 2

PRE = -999 TO -1 DAYS POST = 0 TO 20 DAYS RETN = 21 TO 9999 DAYS

	ITEM NUMBER	COR ANS		TOT RESP	PCT COR	RESPONSES (%) NR	1	2	3	4	5
	20101.	1	PRE	0	0	0	0	0	0	0	0
			POST	146	70	1	70	12	15	0	0
			RETN	0	0	0	0	0	0	0	0
	20102.	4	PRE	53	16	7	54	15	3	16	1
			POST	153	47	1	34	14	1	47	0
			RETN	75	41	1	28	28	1	41	0
	20103.	3	PRE	0	0	0	0	0	0	0	0
			POST	70	70	1	12	15	70	0	0
			RETN	0	0	0	0	0	0	0	0
	20104.	3	PRE	77	61	9	7	22	61	0	0
			POST	0	0	0	0	0	0	0	0
			RETN	0	0	0	0	0	0	0	0
OBJ	201		PRE	130	43						
			POST	369	60						
			RETN	75	41						
	20201.	4	PRE	0	0	0	0	0	0	0	0
			POST	146	68	7	9	6	8	68	0
			RETN	0	0	0	0	0	0	0	0
	20202.	2	PRE	130	40	20	16	40	13	8	0
			POST	74	81	2	10	81	5	0	0
			RETN	78	76	0	10	76	7	5	0
OBJ	202		PRE	130	40						
			POST	220	72						
			RETN	78	76						
	20301.	2	PRE	0	0	0	0	0	0	0	0
			POST	146	50	3	23	50	8	14	0
			RETN	0	0	0	0	0	0	0	0
	20302.	4	PRE	0	0	0	0	0	0	0	0
			POST	223	40	2	16	24	16	40	0
			RETN	0	0	0	0	0	0	0	0

Figure 11. A portion of the Curriculum Analysis Report (long version) for all students in the Carlmont General Math course - Semester 1, 1972-73.

COMPREHENSIVE ACHIEVEMENT MONITORING --- CURRICULUM ANALYSIS PROGRAM

CARLMONT GENERAL MATH, SEM. 1 3105
TEST ADMINS 1 - 5 ALL STUDENTS IN THE COURSE
UNIT 2

PRE = -999 TO -1 DAYS POST = 0 TO 20 DAYS RETN = 21 TO 9999 D

			TOT RESP	AVG SCOR
OBJ	201	PRE	260	23
		POST	539	52
		RETN	252	57
		GAIN POST =	29%	
		GAIN RETN =	34%	
OBJ	202	PRE	136	33
		POST	261	59
		RETN	0	0
		GAIN POST =	25%	
		NO GAIN RETN COMPUTED		
OBJ	203	PRE	260	25
		POST	522	40
		RETN	0	0
		GAIN POST =	14%	
		NO GAIN RETN COMPUTED		
OBJ	204	PRE	124	38
		POST	539	66
		RETN	252	74
		GAIN POST =	28%	
		GAIN RETN =	35%	
OBJ	205	PRE	136	28
		POST	539	60
		RETN	252	67
		GAIN POST =	31%	
		GAIN RETN =	39%	
OBJ	206	PRE	124	62
		POST	539	74
		RETN	252	72
		GAIN POST =	12%	
		GAIN RETN =	10%	

Figure 12. A portion of the Curriculum Analysis Report (short version) for all students in the Carlmont General Math course - Test Administrations 1-5, 1973-74.

III. CAM in General Mathematics at Carlmont High School

Student Profile

Entering students to Carlmont High School come from Belmont, San Carlos, and East Palo Alto. The population is predominantly white with only 12 percent minority students. Most of the General Math classes are a representative cross section of the student population of the school (spirited 9th graders with some 10th graders). The grade equivalency scores of Mr. Reed's students ranged from 4.2 to 9.4. These scores are based on the Total Score (Computation, Concepts, and Application) from the standardized test Comprehensive Tests of Basic Skills, Level 3. Coincidently, the mean, median, and mode scores were all 7.3. Thirteen sections of General Math are scheduled daily with at least one class scheduled for each of the 45 minute periods during the day. Seven teachers are participating in the CAM program. *

Basic Philosophy and Content

The offering "General Math" at Carlmont is geared for the student who chooses to continue math on the high school level as well as the terminal math student. Semester One deals specifically with reinforcing fundamental skills, development of number systems, set notation, properties, and an introduction to simple equation solving. Semester Two affords the student the opportunity to apply the first semester skills in the areas of ratio and proportion, percent, inequalities, graphing, formulas, measurement, and problem solving. The textbook is Foundations of Mathematics by Arthur Wiebe.

Classroom Management

Before each chapter is taught, a copy of the objectives is distributed to each student. At the same time, the student is given an assignment sheet with the specification of which objectives are related to each assignment. Instruction then occurs on the set of pre-determined objectives. Prior to testing, students are required to take notes as the retention and post objectives are reviewed. The students are then tested. After the test, the teacher goes over the results on both a group and an individual basis. The CAM results contribute approximately 50% to the student's grade.

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* Other CAM efforts in mathematics at Carlmont are an Algebra I course with 12 sections and 8 teachers and an Algebra II course with 4 sections and 2 teachers. Materials are available for a Geometry course but are not used at this time.

Revision for 1973-74 Based on Data from 1972-73

The revision of a course using the CAM system involves changes in the following areas:

1. Course design
2. Objectives
3. Test items
4. Evaluation design

For the 1973-74 revision of the Carlmont General Math course, a teacher who had participated in the program during 1972-73 was chosen to assist the lead teacher (the author of the original objectives and test items). This approach proved beneficial in many aspects to the success of the thorough investigation of the 1972-73 course. The weapons at hand for revision were the Curriculum Analysis Reports, the Test Form Analysis Reports, and the expertise of two experienced teachers interested in the improvement of what they had to offer their students.

Course Design

Because of changes in schedule (less class time per day) it was felt that in order to get into some three dimensional work (Chapter 11) by the end of the school year something had to go. With the exception of set notation, the data on Chapter 1 (number basis, predictions, venn diagrams, and history of notation) indicated that the pay off for what followed in the course wasn't apparent, given the time spent in these areas. Therefore, in no way intending a dispersion toward these areas of a mathematics curriculum, these content areas were deleted. As it turned out this year, the course got into areas very quickly where the students showed success. That, in itself, began the year in a positive manner.

Objectives

The course revision related to objectives, consisted of additions, deletions, and rewriting for clarity of a concept. The following examples are representative of the many changes made based on the data received.

Improvement for clarity of concept.

Example 1

Old objective - Given a worded description of a set the student will identify it as either finite, infinite, or empty. (pretest = 52%, posttest = 64%, 1972-73)

Revised objective - Given a worded description of a set the student will identify it as either finite or infinite. (pretest = 58%, posttest = 91%, 1973-74)

Rationale - The data show that the students were scoring low on this objective. When the teachers involved discussed this it was found that there was a difference of opinion between the text and the instructors concerning the concept of an empty set as it relates to a finite set. Therefore, the identification of an empty set was removed from the objective.

Example 2

Old objective - The student will select the correct quotient for a problem involving decimal fractions (answer expressed to the nearest hundredth).

Revised objective - The student will select the correct quotient for a problem involving decimal fractions (answer expressed to 2 digits pass the decimal point).

Rationale - Someone questioned whether the old objective related to rounding off or division. Hence, the objective was rewritten to relate clearly to division per se. The effect of this change has not been tested yet.

Deletion of objectives.

Deleted objective - Given a proportion of the type $\frac{3}{5} = \frac{6}{10}$, the student will identify the extremes and means terms.

Rationale - Memorization of this concept had little bearing on the students' success in computing proportions. The data showed that the students retained the knowledge of how to compute a proportion even though they no longer knew the naming of which term belonged to which position.

Addition of an objective.

Added objective - Given a division problem involving decimals, the student will select the correct decimal placement needed to solve the problem.

Rationale - Stressing a technique that leads to success in the division of decimals seemed to be important.

Test Items

Non-parallelism.

Item A - Select the lowest common denominator for the fractions $\frac{5}{3}, \frac{4}{5}, \frac{7}{8}$

Old Item B - Select the lowest common denominator for the fractions $\frac{19}{35}, \frac{8}{21}, \frac{1}{6}$

New Item B - Select the lowest common denominator for the fractions $\frac{7}{3}, \frac{9}{7}, \frac{2}{5}$

Rationale - Old Item B was too difficult when compared to Item A. The item was rewritten to be more parallel to Item A.

Does response order make a difference? For the following example, only the order of the responses was changed. The percent correct for each item is shown beside the response alternative with the response position number underlined. The percent of students selecting each of the other response alternatives is also shown.

Old Item C - Select the set that best describes the set of whole numbers.

(42) 1. {0,1,2,3,4,5,6,7,8,9} (2) 3. {1,2,3,4,5,6,7,8,9}

(15) 2. {1,2,3,4,..... } (40) 4. {0,1,2,3,4,.....}

New Item C - Select the set that best describes the set of whole numbers.

(3) 1. {1,2,3,4,.....} (73) 3. {0,1,2,3,4,.....}

(3) 2. {1,2,3,4,5,6,7,8,9} (19) 4. {0,1,2,3,4,5,6,7,8,9}

According to the data from the 1973-74 Curriculum Analysis Report, the percent correct increased when the order of the responses was changed from 40% for Old Item C in 1972-73 to 73% for New Item C.

What about the response alternative "none of these"?

Old Item D - Select the correct sum for 85.674 + 405.6 + .586 + 19.

1. 510.850	3. 510.860
2. 511.860	4. none of these

New Item D - Response alternative 4 was changed to read 492.050.

Rationale - The teachers involved felt that if a student added incorrectly and arrived at a sum that was not one of the response alternatives, the student would "cop out" for Response 4 instead of adding again. These items have not been tested yet this year so there is no data available to prove or disprove the rationale behind the change.

Game playing (entrapment).

Old Item E - Select the correct area for a square whose side measures 17 in.

1. 298 sq. in.	3. 289 sq. in.
2. 289 in.	4. 298 in.

New Item E - Select the correct area for a square whose side measures 17.2 in.

1. 298.84 sq. in.	3. 295.84 sq. in.
2. 34.4 sq. in.	4. 68.8 sq. in.

Rationale - On Old Item E, Response 1 was a great choice because of the reversed digits. Response 2 was also a winner to the students because the number was correct even though the units were wrong. The item was therefore changed since the intention was to test the concept of area not the concept of square units. "Square units" as the unit for measuring area is included as an objective earlier in the chapter. Time and the Test Form Analysis Report will tell the story.

"When objectives consistently tested low (relative to other objectives) and, in our expertise, we saw nothing wrong with the objectives or the test items, we made note during the revision that we must improve instruction in this area"

Evaluation Design

A decision was made to concentrate more during 1973-74 on the aspect of retention. The evaluation design was altered to reteach and retest on objectives in a previous chapter that, according to the data received after each test administration, needed to be zeroed in on again. Pretesting is a factor only at the beginning of each semester's work, and not during every test administration. The added emphasis on retention for selected objectives is resulting in an improvement in performance as compared to last year's performance data. The comparison of the two years on an objective by objective basis is shown in Table 1.

Is CAM Worth It?

Having been involved in the CAM Project for three years in the capacity of participating teacher, lead teacher, instructor, and CAM Coordinator, the question arises "Is the CAM system worth it?" To get an answer, the following sub-questions must be answered, hence leading to a conclusion that CAM is or is not worth it.

1. Does the CAM system require a school district to have evaluation expertise, computer hardward, and management skills?
2. Is the CAM system applicable to both group paced and individually paced courses?
3. Does CAM require the teacher to organize his curriculum?
4. Does CAM require the teacher to write objectives in performance terms related to the curriculum?
5. Does CAM require the teacher to write testable items to match the objectives?
6. Does CAM require the teacher to look systematically at the results of his means of evaluation?
7. Does CAM give the student the opportunity to know what is expected of him?
8. Does CAM give the student the opportunity to zero in on the areas that he is deficient in?
9. Does CAM require the teacher to revise his curriculum based on computer feedback?
10. Will the teacher feel comfortable in having student progress related in data form?
11. Do the students accept CAM?
12. And, in the final analysis, "does using CAM improve student performance?"

It is this writer's opinion that there are teachers presently using CAM who will answer affirmatively to all these questions. They will answer this way because they are willing to put forth the on-going effort needed to succeed in an exciting approach to evaluation. Yes, for this teacher, "it is worth it."

TABLE 1

Comparison Data By Objective (Reed's Students)

CA105 General Mathematics

Objective	1972-73			1973-74			
	Pretest	Post-test	Gain (post-pre)	Pretest	Post-test	Retention	Gain (post-pre)
101	27	80	53		72		
102	33	61	28				
103	83	85	2				
104	47	66	19	60	91		31
105	23	57	34				
106	27	91	64	30	85		55
107	19	61	42				
108	5	43	38				
109	14	65	51				
Unit 1	30	68	38	47	82		43
201	44	60	16	14	69	80	55
202	35	72	37	32	72		40
203	18	44	26	29	57		28
204	31	80	49	25	72	88	47
205	21	66	45	28	59	76	31
206	58	75	17	65	85	82	20
207	84	82	-2	70	77	86	7
208	14	89	75	17	82		65
209	73	84	11	75	84		9
210	56	65	9	42	66		24
Unit 2	43	72	29	38	72	82	34
301	45	77	32	40	82		42
302	58	78	20	39	82	84	43
303	62	85	23	62	81	79	19
304	30	81	51	15	69		54
305	40	77	37	35	69	72	34
306	16	80	64	28	64	83	36
307	45	82	37	47	85	93	38
308	35	65	30	46	73	72	27
309	47	57	10	51	63	71	12
Unit 3	42	76	34	43	74	79	31

TABLE 1 (cont'd)

Comparison Data By Objective

Objective	1972-73			1973-74			
	Pretest	Post-test	Gain (post-pre)	Pretest	Post-test	Retention	Gain (post-p
401	46	84	38	50	97		47
402	68	82	14	40	86		46
403	41	66	25	47	75		28
404	60	77	17	45	83	89	38
405	30	66	36	50	79	83	29
406	57	88	31	65	89		24
407	20	67	47	20	67	71	47
408	26	79	53	18	85		67
409	23	63	43	12	67	61	55
410	31	90	59	40	88		48
Unit 4	41	77	36	36	81	76	45
501	23	83	60	45	92		47
502	40	66	26	39	69		30
503	38	75	37	14	78		64
504	37	45	8	28	55		27
505	30	73	43	35	69		34
506	27	80	53	27	82		55
507	32	64	32	29	80		51
508	26	64	38	29	76		47
509	14	63	49	33	79		46
510	14	45	31	37	69		32
Unit 5	28	66	38	32	75		43

IV. CAM in Mathematics at Ravenswood High School

The general use of Comprehensive Achievement Monitoring techniques are described elsewhere in this paper. The purpose of this section is to describe those applications of CAM which are unique to the Math Department at Ravenswood High School.

The School

Ravenswood High School is one of six high schools in the Sequoia Union High School District. Two years ago it opened as a newly reorganized school. The reorganization was part of a desegregation effort in our District. It had formerly been an all Black school. The teaching staff, who were volunteers to teach in the "new school", designed the program to attract Caucasian students as voluntary transfers by offering an alternative program to the traditional structure offered in the other schools. Now, in semester one of 1973, Ravenswood is an ethnically mixed school with a student body which is approximately 53% Black and 47% Caucasian.

The student achievement profile is bimodal, with one large cluster of students in a low achievement group, another large group in a high achievement group, and very few average achievers.

Ravenswood is on a modular schedule with an A/B day pattern. The year is divided into 10 cycles of approximately three weeks each.

Curriculum

Mathematics Curriculum offerings are as follows:

	Use CAM	Individually Paced	Group Paced
Arithmetic	X	X	
General Math	X	X	
Pre-Algebra	X	X	
Algebra I	X	X	
Geometry			X
Coordinate Geometry			X
Algebra II	X		X
Advanced Math			X

All courses that use CAM have a course design specifying performance objectives. Following is a content description of four courses that are taught in the Math Learning Center and a sample of objectives for each of these courses.

Each course has been organized into ten units, corresponding to the ten cycles of the school year. Graduation credits are awarded to the students as units are completed. The basic aim is for mastery of course objectives.

Arithmetic

Text: Modern Mathematics for Achievement; Herrick, Houghton, Mifflin

Unit	Title	Number of Objectives
1	Whole Numbers	13
2	Addition	9
3	Number Relationships	14
4	Subtraction	11
5	Multiplication	18
6	Division	11
7	Rational Numbers	14
8	Applications	16
9	More rational numbers	19
10	Decimal rational numbers	14

RA102 Arithmetic — SAMPLE OBJECTIVES — Harold McCann, Ravenswood High School

1031 The student will name all the counting numbers between a specified pair of numbers.

1032 Given a sentence which uses one of the following phrases: more than, less than, times, equal to, sum of, the student will supply the correct answer.

1041 Given any one of the common names for numbers such as those on the list below, the student will write another numeral that is equivalent.

pair	dozen	half-dozen
couple	single	quartet
4 + 1	triple	thousand
8 - 3	twins	ten thousand
million	five	V

1051 Given a number sentence involving either addition or subtraction with one of the 3 elements replaced by a frame, the student will give the number which will make the sentence true.

e. g. $3 + \square = 7$ $\square - 5 = 9$

1061 Given a number sentence illustrating the commutative property of addition, the student will supply any missing part.

1071 The student will give the identity element for the set of whole numbers and will fill in the blanks in number sentences such as the following:

$7 + \square = 7$ $7 + 0 = \square$ $\square + 0 = 7$

General Mathematics

Text: Modern General Mathematics; Eicholz, Addison Wesley Co.

Unit	Title	Number of Objectives
1	Place Value	9
2	Operations	9
3	Whole Numbers	12
4	Computations	8
5	Geometry	10
6	Number Theory	10
7	Fractions and Rational Numbers	8
8	Addition and Subtraction Rational Numbers	14
9	Ratio and Decimals	8
10	Percent and Integers	13

RA110 General Mathematics — SAMPLE OBJECTIVES — Math Department Ravenswood High School

Unit 1 - Place Value and Number Bases

1101 Given a base ten abacus, choose the number shown by the beads.

1102 Given a base ten number, show the number on a base ten abacus.

1103 Given a number, tell what place value each digit has.

1104 Given a number, write it in expanded notation.

1105 Given two numbers, the student will place the correct symbol ($<$ or $>$) between them.

1106 Given a six-digit number, round off to the nearest tens, hundreds, thousand, ten thousands.

1107 Given ten to a power, write the number without using the exponent.

1108 Given a number between one and ten with several zeroes after it, write the number using the number times the correct power of ten.

1109 Given a polygon, find the perimeter.

Unit Two - Equations and Operations

2201 Given a function machine, supply the missing value.

2201 Given the values, find the function rule.

2203 Given an equation of the form a + b = c, where b and c are whole numbers, find a.

2204 Given an equation of the form a x b = c, where b and c are whole numbers, find a.

Pre-Algebra

Text: Foundations of Mathematics; Wiebe, Holt, Rinehart and Winston

Unit	Title	Number of Objectives
1	Patterns and Sets	6
2	Addition with Whole Numbers	6
3	Multiplication	8
4	Integers	8
5	Rational Numbers	13
6	Formulas and Proportions	6
7	Percent	7
8	Graphing	7
9	Measurement	8
10	Area	9

RA103 SAMPLE Mathematics Department
Pre-Algebra OBJECTIVES Ravenswood High School

Patterns and Sets - Unit One

1101 Given a sequence of numbers, the student will choose the next three numbers which will continue the number pattern.

1102 Given a sequence of ordered pairs, the student will select the correct number which completes the sequence.

1103 Given a word description of a set, the student will recognize the elements which correspond to the word description.

1104 Given a roster description of a set, the student will determine whether a set is finite, infinite or empty.

1105 Given a Venn Diagram, the student will select the truth set which corresponds to a particular symbolic description of the diagram.

1106 Given a five digit number written in expanded notation using exponents, the student will select the corresponding unexpanded five digit number.

Addition With Whole Numbers - Unit Two

2201 The student will recognize a set of numbers which is closed under the operation of addition.

2202 Given two whole numbers, the student will correctly choose the form which demonstrates the Commutative Property of Addition.

2203 Given the operation of three whole numbers, the student will correctly choose the form which demonstrates the Associate Property of Addition.

2204 The student will identify the identity element for the addition of whole numbers.

Algebra I

Text: Algebra 1; Smart, Ginn and Co.

Unit	Title	Number of Objectives
1	Set, Numbers, Relations	11
2	Operations and Number Systems	13
3	Open sentences in one variable	10
4	Linear systems in two variables	14
5	Systems of two linear variables	8
6	Operations on Polynomials	12
7	Factors and Polynomial sentences	16
8	Rational expressions	11
9	Real numbers and radical expressions	12
10	Quadratic functions, Equations, and Inequalities	4

RA111 Algebra I — SAMPLE OBJECTIVES — Smart, Rogulsky, Reuhmann, Ravenswood High School

		Textbook Page/Prob. No.
0101	Given a word description of a set give the corresponding roster description of the set.	5/1-8
0102	Given two sets related with the symbols $\subseteq$, $\subset$, $=$, and $\sim$, indicate if the sentence is true or false.	8 TBU
0103	Describe completely the set of rational numbers (or counting numbers), N.	11
0104	Describe completely the set of whole numbers, W.	11
0105	Given a partial number line, graph a set of whole numbers in W.	16
0106	Given a partial graph, graph a set of ordered pairs in W x W.	19/1-12
0107	Given a set described in set builder notation in W or WxW, give its roster description.	25
0108	Given three relations state whether or not each is a function.	28 Oral/ 13-15
0109	Given an open sentence that has W or WxW as its universal set, name the truth set.	28/1-8
0110	Given two sentences and the names reflexive =, symmetric =, transitive =, substitution =, addition =, and multiplication =, select the correct axiom name.	31,32/1-12
0111	Given two sets give their intersection and their union.	41/5-12

Development of an Individualized Program

Our individualized learning program began at another of the District's high schools during 1970-71. We had been using an individualized Math program upon which we imposed a CAM evaluation system, with some decision options for students wishing to accelerate and work at a faster pace. The text used was Modern Mathematics for Achievement, M. C. Herrick, Houghton Mifflin Co., which is an eight booklet course. We organized the course into four units consisting of two booklets in each unit. Seven parallel tests were written for each unit. Tests were administered at intervals of approximately six to eight days.

During the 1971-72 school year the program was transferred to Ravenswood and Pre-Algebra was individualized. Classes were still organized in groups of 20 to 25 students with one teacher. Periodic test administrations were continued but the interval was lengthened to 10 to 12 days.

In 1972-73 we added General Math to the individualized program and reorganized the class structure. We combined classes into groups of 30 to 40 students with two teachers and two student aides. Beginning with the second semester in February, 1973, we made a very significant change when we went to daily testing whenever a student completed an assigned unit.

The Math Learning Center

During the 1973-74 school year we have organized a Math Learning Center. Students taking Arithmetic, General Math, and Pre-Algebra are all taught there. Their program is self paced. They have no options in this matter since there are no group-paced classes in any of these three subjects. After an initial period of three weeks in a group-paced regular class Algebra I students may change to an individualized study program working in the Math Learning Center.

Students are required to attend a minimum of 200 minutes per week on a drop-in basis. They may attend in any pattern they wish. Although the students are not programmed for a specific time slot when they attend the Center, they must leave time for it in their schedule, and therefore tend to group themselves into more or less standard patterns. The bulk of the students come every day for three mods, or a total of 45 minutes. About 30 to 35 are on an every-other-day basis for six mods, and we have about eight or nine who come for two mods twice a day. Attendance is taken and reports on student attendance that have been generated by the CAM system are mailed home to parents every six weeks.

The Center is staffed by one certificated teacher and two classified paraprofessionals during the entire time the center is open, from 8:30 to 1:30

daily. There are also eight student clerks who assist in the paper correcting, sorting, filing, and other tasks. Seven additional teacher hours of instructional time are spread out over a three-hour time span.

Student performance is monitored by tests taken on mark sense cards that are machine scored. Turn-around time is 12 hours. Cards turned in at 3 o'clock in the afternoon are returned the following morning with a complete student report as shown in Figure 1. These individual student reports are prepared in duplicate. One becomes the teacher's record of what the student is doing and the other is returned to the student.

When the individual student report is studied by the teacher the following decision rules are applied to determine what the student's prescription will be.

1. Any student receiving a score of 90% or better on any unit will receive an A for that unit and may accelerate to the next unit without any further work in that unit.
2. Any student receiving a score of between 80 and 89% must complete work in any deficiencies if it is the first time he has been tested on the unit, and then must retake the test. The second time he scores in the 80's he may take the grade of B and go to the next unit or may retake the test again if he wishes for a higher grade.
3. If the student scores between 70 and 79%, he will get a C. The first time he scores in this class he must complete all assigned work and then retake the test. If he scores again in the 70's, he must complete the work again but may take the grade if he wishes or retake the test as often as he wishes.
4. Any grade below 70% is considered unsatisfactory and such students must retake the test and be recycled through the learning activities until this level of mastery is reached.

Then if necessary a remedial prescription is given to the student with his report. This prescription is an assignment for the student to complete learning activities covering those, and only those, objectives for which he missed the item. A sample of the prescription sheet is shown in Figure 2.

All work is done in the Math Learning Center. Each student has a folder in which to keep his work in progress, his student reports, and his assignment sheets. Books are kept in the Center and students are not allowed to take them out of the Center.

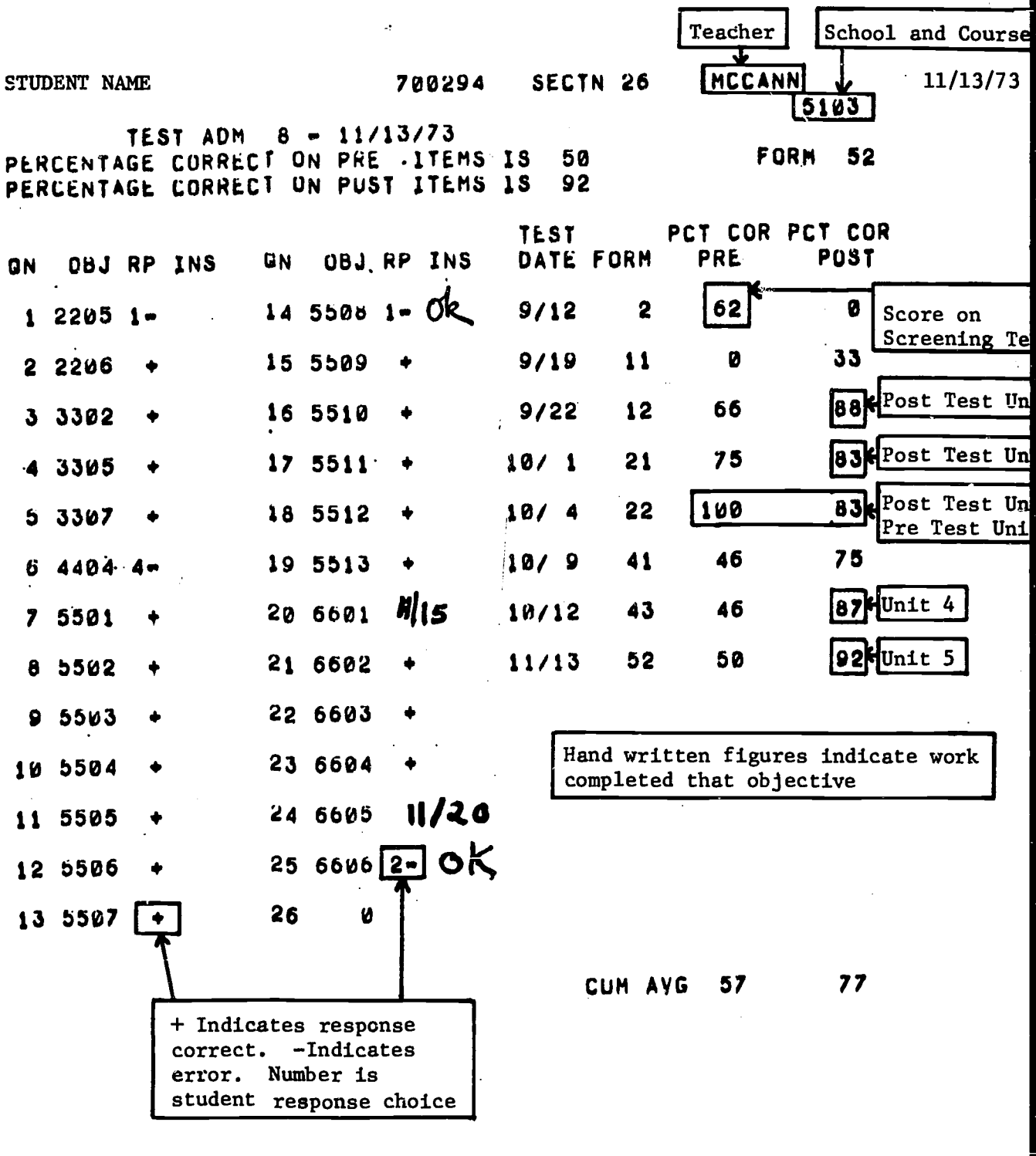

Figure 1. Individual student report.

NAME:

PRE-ALGEBRA RA 103

UNIT 5 CHAPTER 5

On a pretest of this unit you missed the objectives circled below. Complete all the problem assignments for each of these objectives and turn them in with this sheet. You will have to turn these in before you can take the next CAM exam. If this sheet is lost you will have to complete all the objective work for this unit ..... SO DON'T LOSE IT.

OBJECTIVE	PAGE	PROBLEMS
5501	156-157	20, 22, 26, 28, 31bdfh
5502	161-162	1-13 (ODD)
5503	162	14abcdefg
5504	164-165	1, 2abcdef, 3abce, 4, 5abcdef, 6abcd
5505	170-171	1-31 (EVEN)
5506	179	9-16
5507	174-175	1bdf, 2, 4, 6, 8, 10, 16, 18, 22, 24-36 (EVEN)
5508	177-178 179	1-25 (EVEN) 1-15 (ODD)
5509	183	4, 5bdf, 6bd, 9
5510	185	1a, 2bd, 3
5511	188	1-16 (EVEN)
5512	190-191	1-14 (EVEN)
5513	191	16-26 (EVEN)
TAKE THE SELF TEST		

re 2. A prescription for remedial work on unit 5 for Pre-Algebra.

When a student completes any assigned work he turns it in for correction. Teachers and aids are available for tutorial help during this period. If the work has been done satisfactorily this is noted on the teachers's record. If the student has not done the work satisfactorily, a new prescription is made. Once he has completed all the assigned work in a given unit, the student then takes the next CAM test.

Evaluation Design

When a student enrolls in the Center for the first time, he is given a screening test. The objectives used as a basis for this test are shown on Table 1. The test has 27 items and can be completed in approximately 30 to 35 minutes by the average student. There is one item for each of the objectives listed. Students are placed in a course on the basis of this screening test. Criteria for placement is as follows:

26 % or less - Arithmetic
27% to 41% - General Math
42% to 63% - Pre-Algebra
Above 64% - Algebra

After the student has been assigned to the appropriate course his performance is evaluated by an evaluation design established for that course. The evaluation design for Arithmetic, General Math, Pre-Algebra and Algebra I is basically the same with a few minor variations from course to course. Table 2 shows the basic design.

TABLE 2

Evaluation Design

Test Form	Units 1	2	3	4	5	6	7	8	9	10
1,2	Standard CAM for all objectives on all units produces group pre instructio									
11,12,13	Post	Pre								
21,22,23		Post	Pre							
31,32,33			Post	Pre						
41,42,43				Post	Pre					
51,52,53					Post	Pre				
61,62,63						Post	Pre			
71,72,73							Post	Pre		
81,82,83								Post	Pre	
91,92,93									Post	Pre
101,102,103										Post
1,2	Standard CAM for all objectives on all units produces group post instruction and retention information									

TABLE 1

RA102, 103, 110 Pre-Algebra	SCREENING OBJECTIVES	Mathematics Department Ravenswood High School

0001	The student should be able to add pairs of three-digit numbers which does not involve regrouping.
0002	The student should be able to add four-digit numbers which involves regrouping.
0003	The student should be able to add monetary numbers which involves regrouping when the problem is presented in vertical form.
0004	The student should be able to add single monetary numbers when the problem is presented in horizontal form.
0005	The student should be able to add unit fractions with like denominators.
0006	The student should be able to add simple unit fractions with unlike denominators.
0007	The student shall be able to add mixed numbers not involving regrouping.
0008	The student shall be able to add mixed numbers involving regrouping.
0009	The student shall be able to add decimal numbers where the problem is presented in horizontal form.
0011	The student shall be able to solve subtraction problems not involving regrouping.
0012	The student shall be able to solve subtraction problems involving regrouping.
0013	The student shall be able to solve monetary subtraction problems that are in the vertical form.
0014	The student shall be able to solve monetary subtraction problems where the problem is presented in horizontal form.
0015	The student is able to subtract simple fractions with like denominators.
0016	The student is able to subtract simple subtraction problems with unlike denominators.
0017	The student will be able to subtract mixed numbers involving regrouping.
0018	The student is able to subtract decimal numbers.
0021	The student is able to multiply using a single digit multiplier.
0022	The student is able to multiply using a two-digit multiplier.
0023	The student is able to multiply simple fractions.
0024	The student is able to multiply mixed numbers.
0025	The student is able to multiply decimal numbers.
0031	The student is able to divide using a single-digit divisor.
0032	The student is able to divide using a two-digit divisor.
0033	The student is able to divide simple fractions.
0034	The student is able to divide mixed numbers.
0035	The student is able to divide decimal numbers.

The evaluation design for Algebra I is somewhat different. In this course it was determined that retention information is more important. Therefore, tests are designed so that there are usually 16 items per test with 10 items from the current unit and six retention items from previously taught units.

From 20 to 40 tests are taken every day. Our system has been designed to minimize the amount of time spent by the teacher in handling paperwork and doing routine clerical tasks. We hope that it frees him to give time to the student. During some peak periods for the data processing department, we have tried handling these tests on a hand-scored basis and were unable to keep up with the students.

Conclusion

You will note from the history of the development of the individualized program that we did not begin daily demand testing until February of last year. The CAM system builds in its own evaluation for instruction. The effect of the learning center concept as measured by units completed per student is shown in Table 3. It appears that General Math and Pre-Algebra students are accomplishing more in the learning center than in the self contained classroom environment used the previous year. The Center does not appear, however, to enhance the amount of work accomplished by Arithmetic students.

The amount of work accomplished by students is important, but are students learning as well or better than they did previously? The answer to that question is contained in Tables 4, 5, and 6. Pre-Algebra students are doing significantly better. Not only are they working harder as evidenced by the number of tests they have been taking, but the average percentage gain from pre instruction to post instruction has increased 15 percent to 22 percent (see Table 4). General Math students are also taking more tests, thus indicating they are working harder. They are performing slightly better in the learning center than they did in the self contained environment which indicates the transition to this environment has not been harmful. We should remember, however, that there are probably some students who would perform better in the self contained classroom and we should develop methods to identify who these students are. Arithmetic students do not perform in the learning center as well as they did in the self contained classroom. Not only do they not complete as many units, but they don't take as many tests, and they don't perform as well on those tests. Most probably they are not coming to class. Obviously they need a more structured learning environment. We are looking into new types of structure and learning activities to use with these students.

TABLE 3

RAVENSWOOD MATH DEPARTMENT

INDIVIDUALIZED LEARNING CENTER (1973-74)
VS.
SELF CONTAINED CLASSROOM (1972-73

Summary
AVERAGE NUMBER UNITS COMPLETED PER STUDENT (First Quarter)

ARITHMETIC		
	Self Contained Classroom 1972-73	Individualized Learning Center 1973-74
Number of Students	49	20
Total Number Units Completed	36	11
Average Number Units Completed Per Student	.74	.55

GENERAL MATH		
	Self Contained Classroom 1972-73	Individualized Learning Center 1973-74
Number of Students	98	79
Total Number Units Completed	35	81
Average Number Units Completed Per Student	.36	1.25

PRE ALGEBRA		
	Self Contained Classroom 1972-73	Individualized Learning Center 1973-74
Number of Students	79	113
Total Number Units Completed	51	176
Average Number Units Completed Per Student	.65	1.56

ALGEBRA I	
	Individualized Learning Center 1973-74
Number of Students	21
Total Number Units Completed	51
Average Number Units Completed Per Student	2.43

TABLE 4

RAVENSWOOD MATH DEPARTMENT

INDIVIDUALIZED LEARNING CENTER (1973-74)
VS.
SELF CONTAINED CLASSROOM 1972-73

Summary
PRE ALGEBRA (First Quarter)

SELF CONTAINED CLASSROOM 1972-73

	PRE			POST			GAIN/ LOSS
	Tests Taken	% Points	Avg. %	Tests Taken	% Points	Avg. %	
Unit 1	-	-	-	107	6299	59	-
Unit 2	107	4612	43	25	1618	65	+22
Unit 3	25	1281	51	9	588	65	+14
Unit 4	9	497	55	-	-	-	-
TOTAL	141	6390	45	141	8505	60	+15

INDIVIDUALIZED LEARNING CENTER 1973-74

	PRE			POST			GAIN/ LOSS
	Tests Taken	% Points	Avg. %	Tests Taken	% Points	Avg. %	
Unit 1	107	5453	51	97	6903	71	+20
Unit 2	200	9251	46	63	4580	73	+27
Unit 3	84	4305	51	60	4160	69	+18
Unit 4	85	3851	45	23	1670	73	+28
Unit 5	34	1974	58	10	696	70	+12
Unit 6	13	606	47	1	100	100	+53
Unit 7	5	283	57	1	50	50	-7
Unit 8	3	97	32	1	50	50	+18
Unit 9	1	50	50	-	-	-	-
TOTAL	533	25870	49	256	18209	71	+22

TABLE 5

RAVENSWOOD MATH DEPARTMENT

INDIVIDUALIZED LEARNING CENTER (1973-74
VS
SELF CONTAINED CLASSROOM (1972-73)

Summary
GENERAL MATH (First Quarter)

SELF CONTAINED CLASSROOM 1972-73							
	PRE			POST			GAIN/ LOSS
	Tests Taken	% Points	Avg. %	Tests Taken	% Points	Avg. %	
Unit 1	-	-	-	95	5041	53	-
Unit 2	95	3413	36	3	187	62	+26
Unit 3	3	158	53	2	166	83	+30
Unit 4	2	162	81	-	-	-	-
TOTAL	100	3733	37	100	5394	54	+17

INDIVIDUALIZED LEARNING CENTER 1973-74							
	PRE			POST			GAIN/ LOSS
	Tests Taken	% Points	Avg. %	Tests Taken	% Points	Avg. %	
Unit 1	60	2087	35	70	4011	57	+22
Unit 2	132	3960	30	41	2289	56	+26
Unit 3	47	2033	43	26	1492	57	+14
Unit 4	30	1482	49	3	162	54	+ 5
Unit 5	5	110	22	9	453	50	+28
Unit 6	12	520	43	5	306	61	+18
Unit 7	11	672	61	5	258	52	-9
Unit 8	10	503	50	-	-	-	-
Unit 9	4	265	66	-	-	-	-
Unit 10	3	191	64	-	-	-	-
TOTAL	314	11823	38	159	8971	56	+18

TABLE 6

RAVENSWOOD MATH DEPARTMENT

INDIVIDUALIZED LEARNING CENTER (1973-74)
VS.
SELF CONTAINED CLASSROOM (1972-73)

Summary

ARITHMETIC (First Quarter)

SELF CONTAINED CLASSROOM 1972-73							
	PRE			POST			GAIN/ LOSS
	Tests Taken	% Points	Avg. %	Tests Taken	% Points	Avg. %	
Unit 1	-	-	-	59	3694	63	-
Unit 2	58	2561	44	5	200	40	-4
Unit 3	5	283	57	4	245	61	+4
Unit 4	4	243	51	1	100	100	+49
Unit 5	2	149	74	2	83	42	-32
Unit 6	2	63	32	1	90	90	+58
TOTAL	71	3299	46	72	4412	61	+15

INDIVIDUALIZED LEARNING CENTER 1973-74							
	PRE			POST			GAIN/ LOSS
	Tests Taken	% Points	Avg. %	Tests Taken	% Points	Avg. %	
Unit 1	10	587	59	8	506	63	+4
Unit 2	17	700	41	9	379	42	+1
Unit 3	10	470	47	6	277	46	-1
Unit 4	6	271	45	-	-	-	-
Unit 5	1	58	58	-	-	-	-
Unit 6	3	135	45	-	-	-	-
TOTAL	47	2221	47	23	1162	51	+4