DOCUMENT RESUME

ED 225 858 SE 040 341

AUTHOR Marshall, Gail; Herbert, Martin
TITLE Sixth Grade Evaluation, Preliminary Study. Evaluation Report 8-B-1. Extended Pilot Trial of the Comprehensive School Mathematics Program.
INSTITUTION CEMREL, Inc.; St. Louis, Mo.
SPONS AGENCY National Inst. of Education (ED), Washington, DC.
PUB DATE Oct 81
NOTE 209p.; For related documents, see SE 040 181-196 and SE 040 340-348.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC09 Plus Postage.
DESCRIPTORS Educational Research; *Elementary School Mathematics; *Grade 6; Intermediate Grades; *Mathematics Achievement; *Mathematics Curriculum; Mathematics Instruction; *Program Evaluation; *Quantitative Tests
IDENTIFIERS *Comprehensive School Mathematics Program; Mathematics Applied to Novel Situations Test; *Mathematics Education Research

ABSTRACT

The Comprehensive School Mathematics Program (CSMP) is a program of CEMREL, Inc., one of the national educational laboratories, and was funded by the National Institute of Education (NIE). Its major purpose is the development of curriculum materials for kindergarten through grade 6. An Extended Pilot Test was scheduled for spring 1982 for several school districts using CSMP through the sixth grade. Several Mathematics Applied to Novel Situations (MANS) scales were developed and tried out in spring 1981, and several scales used with fifth graders were retested with sixth-grade students at the same time. This material was designed to present preliminary evaluation data from two school districts regarding the achievement of CSMP versus non-CSMP sixth graders, and note statistical data from the tryout of scales. Results indicated that CSMP classes continued large advantages in fractions and decimals, elucidation, and number relationships. At the second investigation site, an advantage CSMP pupils had in probability as fifth graders disappeared, but so did a disadvantage they had with estimation scales. (MP)

Extended Pilot Trials of the Comprehensive School Mathematics Program: Evaluation Report Series

EVALUATION REPORT 8-B-1

SIXTH GRADE EVALUATION, PRELIMINARY STUDY

Extended Pilot Trial of the Comprehensive School Mathematics Program

Evaluation Report 8-B-1

Sixth Grade Evaluation, Preliminary Study

Gail Marshall
Martin Herbert
Math Research and Evaluation Studies
October, 1981

Developed by CEMREL, Inc., a private nonprofit corporation supported in part as an educational laboratory by funds from the National Institute of Education, Department of Education. The opinions expressed in this publication do not necessarily reflect the position or policy of the National Institute of Education, and no official endorsement should be inferred.

Description of Evaluation Report Series

The Comprehensive School Mathematics Program (CSMP) is a program of CEMREL, Inc., one of the national educational laboratories, and is funded by the National Institute of Education. Its major purpose is the development of curriculum materials for grades K-6.

Beginning in September, 1973, CSMP materials began being used in classrooms on a regular basis, beginning in kindergarten and first grade. The evaluation activities have paralleled the development and dissemination of materials so that the primary evaluation emphasis is now at the upper elementary grades. All activities have been conducted by a group within CEMREL which is independent of CSMP.

The evaluation of the program in this extended pilot trial is intended to be reasonably comprehensive and to supply information desired by a wide variety of audiences. For that reason the reports in this series are reasonably non-technical and do not attempt to widely explore some of the related issues. On the next page is given a list of reports through 1980. Below is given a list of reports completed in 1981:

Evaluation Report: 8-B-1 Sixth Grade Evaluation, Preliminary Study

8-B-2 Evaluation of Revised Second Grade, MANS Blue Level

8-B-3 Evaluation of Revised Third Grade, MANS Green Level

8-B-4 Three Evaluations of Gifted Student Use

8-C-1 Preliminary Study of CSMP "Graduates"

Extended Pilot Trials of the
Comprehensive School Mathematics Program

Evaluation Report Series

Evaluation Report (1974)	1-A-1	Overview, Design and Instrumentation
	1-A-2	External Review of CSMP Materials
	1-A-3	Final Summary Report Year 1
	1-B-1	Mid-Year Test Data: CSMP First Grade Content
	1-B-2	End-of-Year Test Data: CSMP First Grade Content
	1-B-3	End-of-Year Test Data: Standard First Grade Content
	1-B-4	End-of-Year Test Data: CSMP Kindergarten Content
	1-B-5	Test Data on Some General Cognitive Skills
	1-B-6	Summary Test Data: Detroit Schools
	1-C-1	Teacher Training Report
	1-C-2	Observations of CSMP First Grade Classes
	1-C-3	Mid-Year Data from Teacher Questionnaires
	1-C-4	End-of-Year Data from Teacher Questionnaires
	1-C-5	Interviews with CSMP Kindergarten Teachers
	1-C-6	Analysis of Teacher Logs
Evaluation Report (1975)	2-A-1	Final Summary Report Year 2
	2-B-1	Second Grade Test Data
	2-B-2	Readministration of First Grade Test Items
	2-B-3	Student Interviews
	2-C-1	Teacher Questionnaire Data
	2-C-2	Teacher Interviews, Second Grade
	2-C-3	Teacher Interviews, First Grade
Evaluation Report (1976)	3-B-1	Second and Third Grade Test Data Year 3
	3-C-1	Teacher Questionnaire Data Year 3
Evaluation Report (1977)	4-A-1	Final Summary Report Year 4
	4-B-1	Standardized Test Data, Third Grade
	4-B-2	Mathematics Applied to Novel Situations (MANS) Test Data
	4-B-3	Individually Administered Problems, Third Grade
	4-C-1	Teacher Questionnaire Data, Third Grade
Evaluation Report (1978)	5-B-1	Fourth Grade MANS Test Data
	5-B-2	Individually Administered Problems, Fourth Grade
	5-C-1	Teacher Questionnaire and Interview Data, Fourth Grade
Evaluation Report (1979)	6-B-1	Comparative Test Data: Fourth Grade
	6-B-2	Preliminary Test Data: Fifth Grade
	6-C-1	Teacher Questionnaire Data: Grades 3-5
Evaluation Report (1980)	7-B-1	Fifth Grade Evaluation: Volume I, Summary
	7-B-2	Fifth Grade Evaluation: Volume II, Test Data
	7-B-3	Fifth Grade Evaluation: Volume III, Non-Test Data
	7-B-4	Re-evaluation of Second Grade, Revised MANS Tests
	7-B-5	Achievement of Former CSMP students at Fourth Grade
	7-B-6	Student Achievement, Rapid Implementation Model

Key to Indexing

Evaluation Reports are labelled m-X-n,
where m is the year of the pilot study, with 1973-74 as Year 1.
X is the type of data being reported where A is for overviews and summaries, B is for student outcomes and C is for other data.
n is the number within a given year and type of data.

Table of Contents

Evaluation Report 8-B-1
Sixth Grade Evaluation, Preliminary Study

Introduction

In the spring of 1982 an Extended Pilot Test will be conducted in several school districts which use CSMP through sixth grade. In preparation for this evaluation study, several MANS scales were developed and tried out in the spring of 1981. In addition, several scales used the previous year in fifth grade were retested with sixth graders in 1981.

This report, then, is intended to serve two purposes:

a) present preliminary evaluation data from two school districts regarding the achievement of CSMP versus Non-CSMP sixth graders,

b) present statistical data from the tryout of these scales.

The MANS (Mathematical Applied to Novel Situations) Tests are short scales, most of which were developed especially to assess what are thought to be some of the underlying thinking skills emphasized in CSMP. The scales are administered by a tester who follows a standardized script including sample problems for each scale. Then the students do the test items in that scale and the process is repeated for the next scale. The scales do not contain any of the special vocabulary or techniques of the CSMP program and most of them are built around mathematical situations that are unfamilar to both CSMP and Non-CSMP students. Hence, they tend to be difficult tests with a problem solving orientation.

In order to reduce testing time, frequent use is made of item sampling, in which half the students in a class do one set of items of a test, while the other half do another. In some cases, entire scales are sampled, i.e., different halves of the class do entirely different scales.

An intensive pilot test review procedure is used in developing MANS Scales: CSMP evaluation Report 4-B-2 contains a detailed description of this process. Previous scales are often reused and new ones added.

Each of the next two chapters summarizes the data from a district in which CSMP classes were compared with Non-CSMP classes. Site A, whose results are described in the next chapter, had mostly students of high ability level; many of the scales used in Site A were being pilot tested for the first time. Site B, whose results are described in the chapter after next, had mostly students of lower ability; most of the scales used in Site B had been administered in fifth grade so that the present administration of scales provided a CSMP-Non-CSMP comparison both at fifth grade, and a year later in sixth grade. Tests were also administered in a third site, Site C. These results are not reported in a separate chapter since they are not concerned with the usual CSMP-Non-CSMP comparison. Rather, one group received instruction on materials similar to CSMP for one day per week for about 14 weeks. However, the data from Site C are included in Appendix A where the scale and item statistics are described, since many of the scales were new and their use in Site C constituted an excellent pilot trial of the scales.

Preliminary Evaluation, Site A

Site A is an upper middle class suburb of a large Midwestern city. The district began using CSMP about eight years ago; in another year or two all K-6 classes will be using CSMP.

There were 6 sixth grade CSMP classes from two schools. Six Non-CSMP classes, from three schools, were selected to serve as comparison classes. The schools and classes were known to be of similar academic ability and this was confirmed by reading scores of the participating students, as will be shown below. The testing required two periods of about 50 minutes for each class, and was conducted by a specially trained tester in May.

Most of the students had participated in a similar comparison in fifth grade in the previous year. At that time a random half of a reading comprehension test, from the Comprehensive Test of Basic Skills, was also administered to each student. These scores were retained and used as a covariate in the present study. The mean reading score across the six CSMP classes was identical to one decimal place to the mean across the six Non-CSMP classes. The mean score was 20.0, which corresponded to a percentile rank, on national fifth grade student norms, of between 70 and 80.

Based on students who were tested this year and who also had reading scores from last year, mean scores for each class were computed for each MANS scale and correspondingly for the reading test. An Analysis of Covariance procedure was then used on the class means, using mean class reading score as a covariate.

For each of the 27 individual scales, the results of these analyses are presented in Appendix A (along with results from the other two sites). These results include among other things, a listing of the items in the scale, percent correct for each item, graphs of class means and the covariate data.

The 27 scales were grouped into eight categories according to the content of the scale. The results are shown in Table 1: a description of the category, the mean scores across classes, and the p-value of the Analysis of Covariance t-test (i.e., the probability of a difference in mean scores as large as occurred happening by chance. If the p-value is less than .05—a one-in-twenty probability of happening by chance—the difference is sometimes said to be statistically significant.)

Table 1

Adjusted Mean Scores[1]

on MANS Categories

Category[2]	CSMP (n=6)	Non-CSMP (n=6)	p-Value[3]
(A) Pre-Algebra (5 scales, 54 items) (Includes five types of scales, each of which requires students to solve simple equations given operators and/or unknown quantities)	28.5	25.2	<.02
(C) Computation (1 scale, 9 items) (Requires exact answers to calculations amenable to non-algorithmic solution)	5.5	4.6	<.10
(L) Logic (6 scales, 42 items) (Requires the solution of several types of logic problems: implication, Venn diagrams, order relations, and others)	22.8	23.0	—
(N) Other Number Systems (8 scales, 63 items) (Requires computation with, or applications of, negative numbers, fractions, and decimals)	43.4	37.7	<.02
(P) Probability (2 scales, 13, 12 items) (Requires the determination of the likelihood of given orderly events)	11.5	10.1	—
(R) Number Relationships (2 scales, 27 items) (Requires finding or applying a given pattern in sets of numbers)	15.5	14.0	<.01
(U) Elucidation (1 scale, 4 items) (Requires producing many correct answers to a given problem)	29.7	21.0	<.01
(W) Word Problems (2 scales, 11 items) (Requires the solution of problems involving simple computation as well as logical thinking)	5.7	5.5	—
TOTAL MANS SCORE	162.1	140.4	<.01

[1] Adjusted for differences in ability among classes, based on 1980 reading scores

[2] See Appendix A for a description and summary statistics of each of the individual scales.

[3] A dash (—) indicates the p-value was not less than .20.

There were four categories on which CSMP classes had significantly higher scores. One of these, Pre-Algebra, was a newly developed MANS category; the other three are categories on which CSMP students have always performed very well i.e., Other Number Systems, Number Relationships, and Elucidation.

The mean total scores were 162 for CSMP classes versus 140 for Non-CSMP classes, a difference which is significant at the .01 level. In Figure 1, below, the Total MANS score for each class is plotted against the mean reading score for that class.

Again these means are based only on students for whom a 1980 reading score was available. A regression line has been drawn to indicate the best linear prediction of MANS score for given reading scores; its upward slope indicates that classes with higher reading scores would be expected to have higher MANS scores.

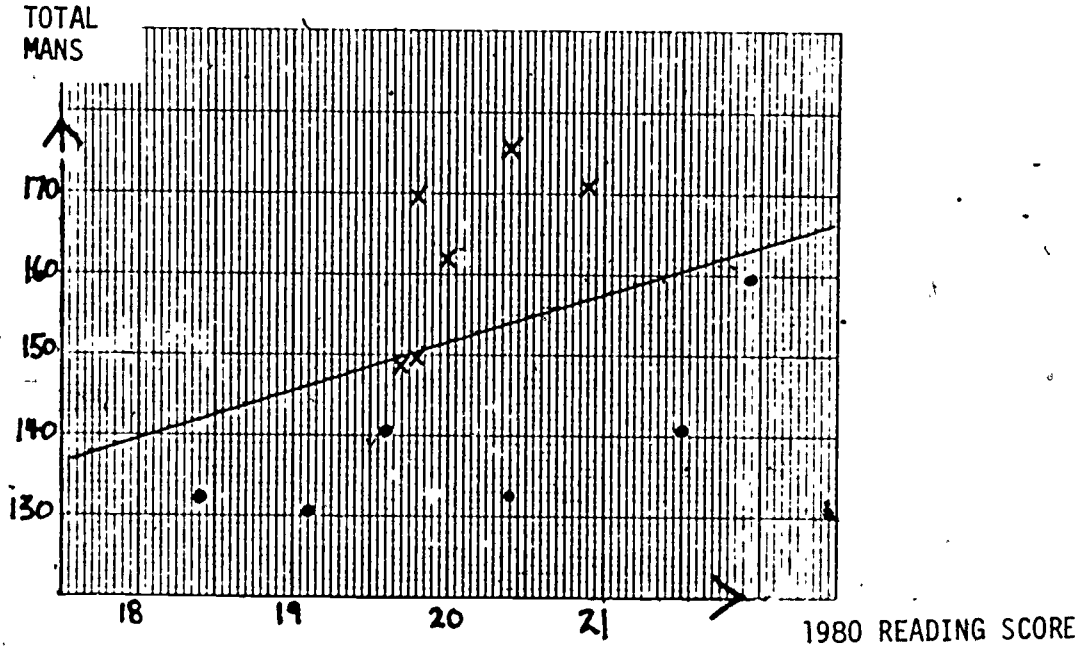


Fig. 1, Graph of Class Means Total MANS
x = CSMP class, • = Non-CSMP class

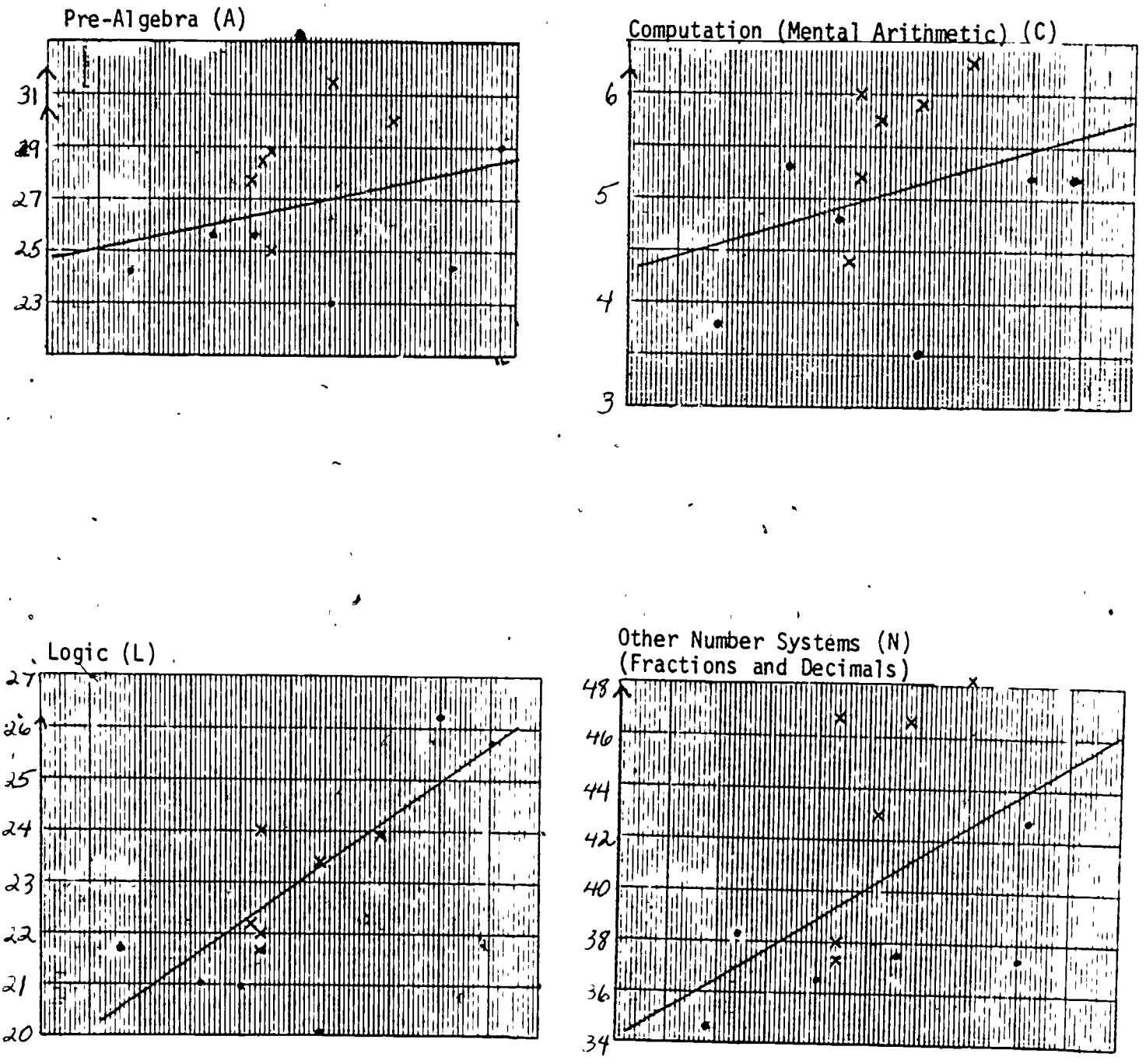
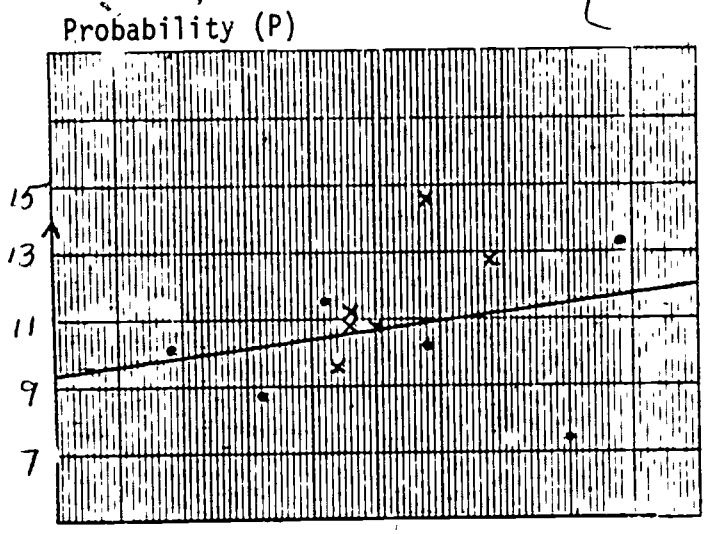
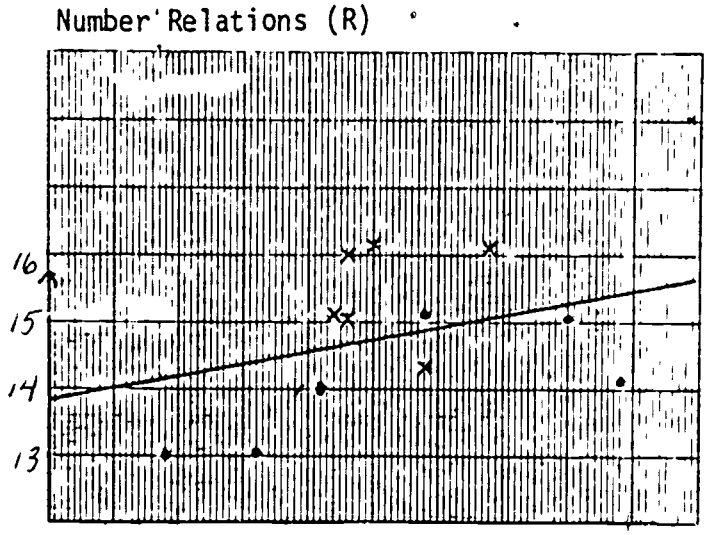
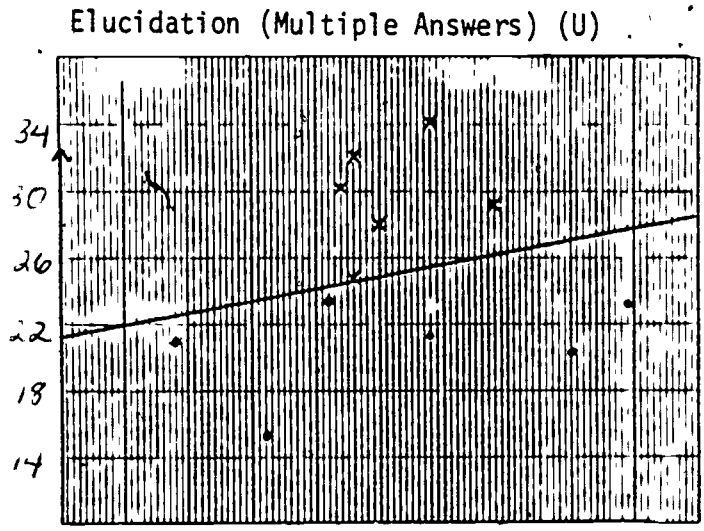


Figure 2, Graphs of Class Means by Category

X = CSMP class, ● = Non-CSMP class







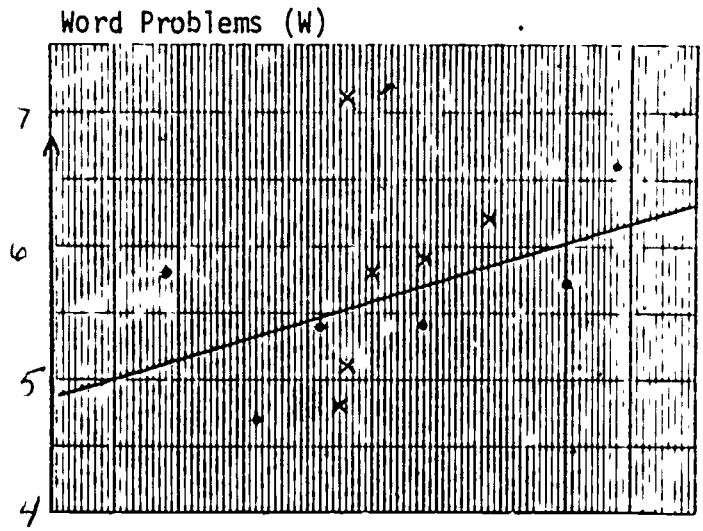


Figure 2, continued

A secondary analysis used the mean MANS scores for each class based on all students, regardless of whether or not a 1980 reading score existed for each student. An Analysis of Variance, i.e., a comparison of the CSMP versus Non-CSMP class means, was then performed for each MANS scales without regard to class ability level. The analysis yielded results even more favorable to CSMP but are not reported here.

Preliminary Evaluation, Site B

Site B is a large Southern city. CSMP was in its third year of use; consequently the CSMP students had used CSMP in grades 4-6, but not previously.

The comparison in Site B was a follow-up to an evaluation study conducted the previous year when the students were fifth graders. At that time, five CSMP classes were compared with three Non-CSMP classes.

In the present study there were really three groups of classes:

a) three classes whose students had studied CSMP in grades 4-6,

b) two classes, whose students had studied CSMP in grades 4 and 5, but a more traditional curriculum in grade 6, and

c) two classes, whose students had studied a traditional curriculum throughout.

A total of 34 scales were administered, 26 of which were repeated from last year's testing and 8 of which were new. The tests were administered by a trained tester and required three periods of about 45 minutes. As in Site A, scores from a random half of the CTBS Reading Comprehension Test from the previous year were available for some students. Table 2 shows the available covariate data.

Table 2

Mean Scores and Number of Students Tested,

CTBS, Reading Comprehension from May, 1980, Site B

	Number Tested MANS, 1981	Number Tested Reading, 1980	Mean Reading (Raw Score)	Mean Reading Across Classes
CSMP Classes: 1	23	17	13.8	
2	28	23	13.4	
3	26	19	15.2	14.1
Former CSMP Classes: 1	24	14	15.6	
2	28	17	14.1	14.9
Non-CSMP Classes: 1	25	23	16.3	
2	28	12	14.6	15.5

Thus based on these data (about 2/3 of the students), the CSMP classes were a little lower in ability, as measured by reading scores, than the other two groups of students. The overall mean reading score in Site B, about 15, corresponds to a percentile rank on national student norms of between 30 and 40.

Comparison of class means, however, was based on all students in the class (i.e. regardless of whether or not they had 1980 Reading scores). Mean scores on the various MANS scales were computed for each class and then the 3 CSMP classes were compared with the other 4 classes (which were lumped together as Non-CSMP) using an Analysis of Variance procedure on the class means.

Table 3 shows the mean scores in the various MANS categories.

Table 3

Mean Scores on MANS Categories, Site B

Scale Category[1]	Number of Scales	Total Number of Items	Mean Scores		p-value[2] (if <.10)
			CSMP (n=3)	Non-CSMP (n=4)	
Computation (Mental arithmetic requiring exact answers to calculations amenable to non-algorithmic solution)	4	31	17.2	13.8	<.14
Estimation (For a given computation problem rapidly select the best of three possible answers, none of which is exactly right)	4	24	15.1	12.6	<.14
Other Number Systems (Computation and applications of fractions and decimals)	9	70	40.0	31.4	<.08
Logic (Requires the solution of several types of logic problems: implication, Venn diagrams, order relations, and others)	4	33	14.7	14.2	—
Organizing Data (Organize and interpet data with graphs, charts, tables, etc.)	1	10	5.5	4.7	<.03
Probability (Compare and estimate the probability of the occurrence of various events in probabilistic situations)	2	30	12.8	12.1	—
Number Relations (Finding and applying patterns to given sets of numbers	4	41	23.0	18.8	<.04
Elucidation (Produces as many possible correct answers to a given set of conditions)	2	34	19.0	13.7	<.04
Word Problems (Requires the solution of two to three stage word problems involving low- level computation)	3	17	8.0	6.2	<.01
TOTAL MANS	31	290	154.7	127.2	<.07

[1] See Appendix A for a description of each individual scale (including sample items and the means for each scale.

[2] p-value from Analysis of Variance t-test with 5 degrees of freedom. A dash (—) indicates the p-value was not less than .20.

With only 7 classes, and 5 degrees of freedom in the analysis, very large differences are required to achieve statistical significance. Nevertheless the CSMP classes did score significantly higher on 4 categories and almost significantly higher on the total. In fact, on all categories except Logic and Probability there was a considerable CSMP advantage of at least 15%.

The CSMP advantage is even more compelling when one considers the fact that the available reading scores suggest the CSMP classes were probably slightly lower in ability to begin with.

The graphs of the class means are shown in Figure 3. These means were derived differently; they were based on only those students in each class for whom a reading score was available, an average of about 2/3 of the students in each class.

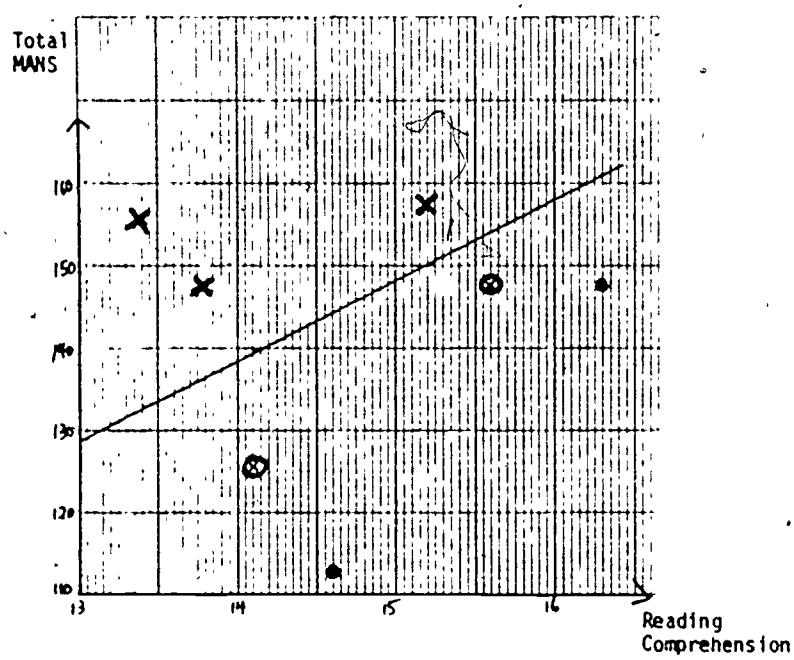


Figure 3, Graph of sixth grade class means, Total MANS, Site B

x = CSMP Class, ⊗ = Former CSMP Class, ● = Non-CSMP Class

It can be seen that there is a clear relationship between the amount of CSMP instruction and Total MANS score: Relative to the regression line, which is the best predictor of MANS for given class ability level (as measured by reading scores), the 3 CSMP classes had the highest scores (furthest above the line) followed by the 2 "Former-CSMP" classes followed by the 2 Non-CSMP classes (furthest below the line).

The data were similar to last year's results, although comparisons are difficult to make because 2 of the classes which were treated as Non-CSMP this year were part of the CSMP group last year. But generally, CSMP classes continued to have a large advantage on Word Problems, Fractions and Decimals (Other Number Systems), Elucidation and Number Relationships. The advantage they had in Probability in fifth grade disappeared this year. The disadvantage CSMP classes had in the Estimation scales last year also disappeared.

Introduction to Appendix A

This Appendix describes statistics from the administration of various MANS scales at three sites. Some of the scales were new, some were repeated from 5th grades and some were revisions of previous scales. Altogether, about 60 scales were administered, 45 of which were unique to one site and the other 15 common to two or more sites.

The three sites are described briefly below.

	Site A	Site C	Site B
Location	Suburban St. Louis	Urban Midwest	Urban South
CSMP/Non-CSMP Classes	6/6	6/6	3/4
Ability Level	High	Below Average	Below Average
Curriculum Studied by "CSMP"	Regular 6th	TOPS[1]	Part 5th, Part 6th
Type of MANS Scale	Mostly new	Some new/ some revised	Mostly repeats
Percentage of students participating in similar testing the previous year	70%	None	80%

The data will be presented scale-by-scale with scales grouped by categories. Each category is preceded by an advanced organizing page. Each scale presentation consists of a left and a right hand page, whose format is described below.

[1] TOPS is a one-day-per week supplement, intended to teach problem solving and using various CSMP techniques. Last year was the first year of a two-year project, funded by Title II Basic Skills of the Department of Education. Students had only about 4 months of TOPS; hence Site C is considered mainly a pilot site for test development rather than an indication of CSMP-Non-CSMP differences.

Left Hand Pages

The left hand pages will present all the items in a scale, together with the percent correct for CSMP and Non-CSMP students and the r-biserial correlation between item and the total scale score, corrected for item inclusion in the scale. (For convenience, the TOPS classes in Site C will be referred to as "CSMP".) At the bottom of the page will be given the number of students on whom the above data is based, the KR20 reliability coefficient for each group, the mean reading score, and the correlation between this reading score and the scale score across students at the site.

The reading scores are the same in Sites A and B, namely the Reading Comprehension test from the CTBS administered in the spring of 1980 as part of the fifth grade MANS testing. At Site C, a previous reading score was available for almost all students, but it was from a different test, the Reading Comprehension Test of the CAT. For convenience, mean scores (or later, mean class scores) from this test have been converted, on an equi-percentile basis, to raw scores on the CTBS, thus yielding roughly comparable scores from site to site. At all sites, some of the students were not present for the respective reading tests, but the item analysis data on this page (as well as the frequency distributions on the next page) are based on all students regardless of previous testing.

Where more than one entry appears, it is usually the separate entries for the various sites that are given, in alphabetical order.

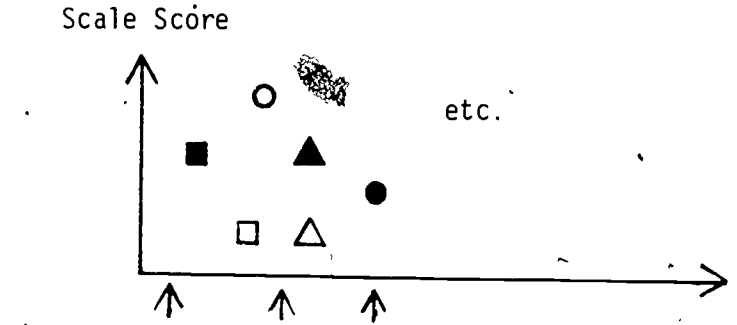
Right Hand Pages

Five kinds of information may be presented:

1. Sample page. Where it has not been possible to show, on the left hand page, the full student page of a scale, a reduced sample page will be shown to illustrate the examples used with the students, the page layout, the format of the items, etc.

2. Frequency distribution. A frequency distribution of scores on the scale is given for each group of students, i.e., the percentage of students attaining a given score or score range on the scale. These data are based on all students whether or not they had a reading score.

3. A graph of class means will be given in the following format:



where: solid figures represent CSMP classes, empty figures Non-CSMP and ■,□ = Site A; ●,○ = Site B; and ▲,△ = Site C

The data points were graphed using mean raw scores for each class and were based only on students also present for the reading test. The vertical axis will change from scale to scale, and will therefore be labelled numerically. However, the horizontal axis will be the same from graph to graph and will be essentially unlabelled except for the three arrows which indicate approximately the corresponding reading scores for the 25th, 50th and 75th percentiles based on national norms for

individual students, thereby giving a rough indication of the general ability level of the class. Most graphs will show data from only one site and hence will have only one kind of geometric symbol (i.e., square, circle, or triangle).

In one corner of the graph is given the adjusted means, CSMP versus Non-CSMP, and the p-value of the t-test from the Analysis of Covariance data, with reading score as covariate and classes as units of analysis. If the scale was used in more than one site, the data are given separately for each. On most graphs, a regression line has been drawn to show the best linear predictor of MANS score for given reading scores.

4. Means by ability levels. At each site, students were grouped according to the quartile their reading score would have placed them in, using national norms. For each quartile grouping of students, a mean score on the scale was calculated and is given. Also given for each grouping is the t-statistic of the Analysis of Covariance test comparing CSMP and Non-CSMP students. The same procedure was used for all students combined who had reading scores; i.e., a mean calculated for CSMP and Non-CSMP students and a t-statistic produced. As a rule of thumb, a t-statistic larger than 2.0 is significant at the .05 level if one uses the liberal model of students, rather than classes, as the units of analysis. Means by ability levels are not given for Site A because there were too few students in the lower quartiles. Occasionally, they are also not given at other sites if there were too few students in a grouping (< 15). This means the overall mean and t-statistic shown may seem anomalous since they represent more quartiles than are shown in the table.

5. Comments. Comments may explain directions, point out important results or questionable items, suggest revisions, etc.

A: Pre-Algebra Category

This is a new category. Five scales were administered at Site A only:

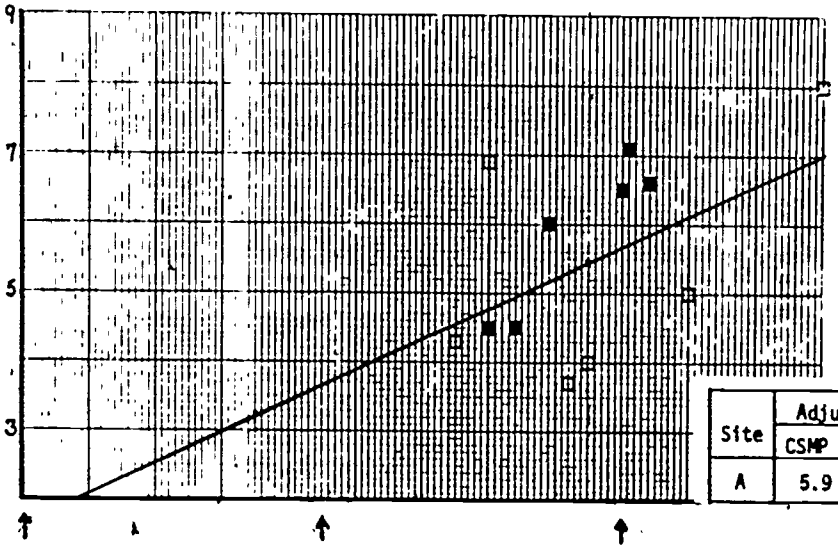
(A1) Algebraic Symbols, Site A

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
In these problems, letters stand for numbers.				
A/Samples: 2a means 2 times a. If a = 6, 2a = 2x6 = 12.				
3bc means 3 times b times c. If b = 2 and c = 5, 3bc = 3x2x5 = 30.				
Problems:				
If c = 4 and d = 3, then 5cd = _____	72	63	.85	.85
If c = 2, f = 2 and g = 3, then 4efg = _____	63	57	.76	.74
If $y = \frac{1}{2}$, then 14y = _____	64	48	.81	.52
B/Samples: 5^2 means 5 times 5. So 5^2 = 5x5 = 25.				
d^4 means d times d times d times d.				
c^3 means c times c times c. If c = 2, c^3 = 2x2x2 = 8.				
Problems:				
6^2 = _____	83	67	.92	.70
4^2 = _____	81	67	.92	.81
If d = 8, then d^2 = _____	73	56	.70	.73
If c = 2 and b = 3, then a^3b^2 = _____	27	13	.70	.65
If c = 1, then c^5 = _____	53	30	.84	.69
If d = 5, then $2d^2$ = _____	27	24	.71	.33
If a = 3 and b = 2, then $4ab^2$ = _____	22	17	.66	.46
If c = 5 and a = 6, then $c^2 - 3a$ = _____	25	11	.68	.60
If a = 85, then $a^7 \div a^6$ = _____	13	10	.39	.32
Number of Students	64	63		
KR20 Reliability	.86	.81		
Mean Reading Score	20.0	19.8		
Correlation: Scale and Reading	.29			

(A1) Algebraic Symbols

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	5.9	5.3	—

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	09	13
1	03	05
2-6	36	32
7-11	47	50
12	05	00

Comments:

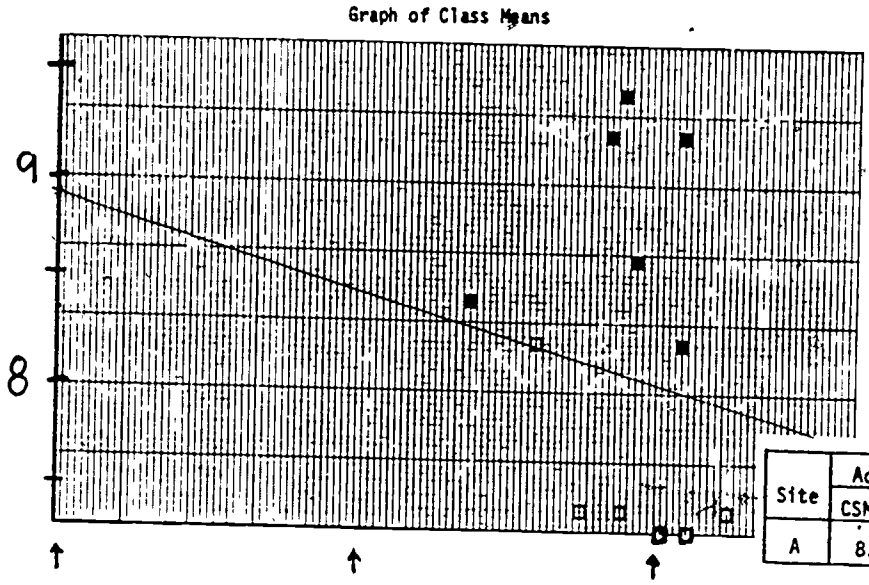
-After the sixth item, the percent correct dropped abruptly, probably because students were being asked for the first time to simultaneously use both of the conventions defined in the two sample sets. For example, $2d^2$ (where d = 5) elicited many 2 x 5 = 10 answers.

(A2) Solving Equations, Site A

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
In these problems, letters stand for numbers.				
Samples: a + 7 = 12, so a = 5				
3 x b = 33 so b = 11				
(4 x c) + 1 = 41, so c = 10				
You do the rest:				
d + 13 = 14, so d = _____	97	92	1.46	1.12
e - 4 = 5, so e = _____	92	85	1.11	1.08
6 x f = 12, so f = _____	97	89	1.46	1.12
g ÷ 4 = 8, so g = _____	76	61	.82	.79
(7 x h) + 1 = 15, so h = _____	95	77	1.42	.92
(3 x i) - 6 = 15, so i = _____	81	67	.72	.89
(j x j) + 1 = 26, so j = _____	87	72	1.04	1.00
k + 2 + k + 1 = 11, so k = _____	82	65	1.00	.84
(3 x m) x 2 = 18, so m = _____	79	65	.78	.78
(n + 1) ÷ 3 = 6, so n = _____	69	48	.83	.80
p + p + q = 7, so what could p be and q be? p = _____ and q = _____				
Number of solutions correct				
0	03	08		
1	00	00		
2	05	06		
3 or 4	08	09		
5 or 6	65	48		
more than 6	08	05		
Number of Students	62	66		
KR20 Reliability	.87	.90		
Mean Reading Score	21.0	20.2		
Correlation: Scale and Reading	.29			

(A2) Solving Equations

(Student page is shown on the facing page.)



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	8.7	7.4	.01

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	03	08
1	00	02
2-6	12	20
7-10	85	70

(excluding last problem)

Comments:

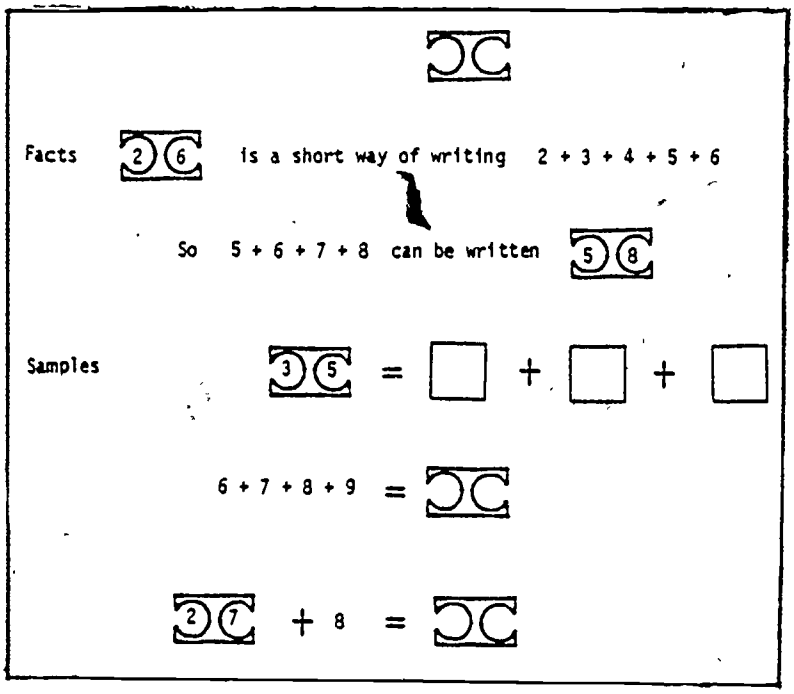
-Although the CSMP advantage is clear and consistent across items, both groups did very well on this set of problems; even for Non-CSMP the average percent correct was over 78.

-The scale was very homogeneous; note the high biserial coefficients which conceptually should not exceed 1.0.

(A3) Summation Operator, Site A

Test Items. (See facing page.)	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Common to both Form A and B:				
$\square_{4}\square_{8} = \square_{4}\square_{7} + \square$	62	51	.52	.56
$\square_{4}\square_{9} - \square_{5}\square_{9} = \square$	30	29	.67	.47
$\square_{1}\square_{3} + \square_{4}\square_{6} = \square\square$	70	64	.48	.39
Form A:				
$\square_{3}\square_{6} + \square_{8}\square_{10} = \square\square - \square$	38	22	.81	.68
$\square_{2}\square_{5} - \square_{2}\square_{5} = \square$	78	68	.51	.26
$\square_{2}\square_{14} - \square_{6}\square_{10} = \square_{2}\square_{5} + \square\square$	13	06	.89	.78
$\square_{3}\square_{5} + \square_{9}\square_{12} = \square_{3}\square_{12} - \square\square$	14	11	.93	.84
Form B:				
$\square_{2}\square_{9} - \square_{7}\square_{9} = \square\square$	18	15	.66	.68
$\square_{1}\square_{7} + \square_{6}\square_{9} = \square\square + \square$	02	05	.79	.54
$5 + \square_{7}\square_{9} = \square\square - \square$	18	18	.60	.59
$\square_{2}\square_{9} + \square_{9}\square_{15} - \square_{2}\square_{15} = \square$	13	14	.17	.19
Number of Students	126	129		
KR20 Reliability	.67	.61		
Mean Reading Score	20.0	20.0		
Correlation: Scale and Reading	.07			

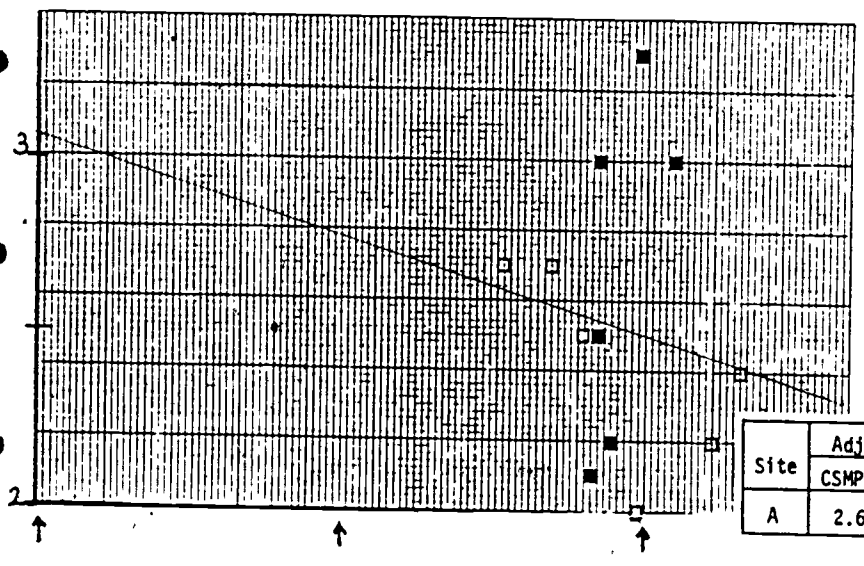
(A3) Summation Operator



Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
	Form A	B	A	B
0	06	13	08	20
1	19	29	25	18
2/4	52	52	52	53
5-7	23	06	14	09

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	2.6	2.4	.30

Comments:

-This scale was very difficult. Although many students could do the samples and some of the early items, the percent correct dropped precipitously when the right hand side of the equation contained something more complicated than ▭ or ⊃C (i.e., if the "brute force" method did not apply). About a third of the students got no more than one item correct.

-The sample items and the first few items may have increased too abruptly in complexity.

-There was virtually no relationship between this scale and vocabulary.

(A4) Multiplying Summations, Site A

Test Items (See facing page.)	Percent Correct C	Percent Correct N	Biserial C	Biserial N
$\sum_{4}^{7} C = \sum C + \sum C$	90	78	.47	.24
$\sum_{2}^{7} C + \sum_{2}^{9} C = \sum^{\square} C + \square$	34	17	.42	.39
$\sum_{3}^{6} C + \sum_{4}^{7} C = \sum^{\square} C + \square + \square$	06	07	.82	.69
$\sum_{10}^{5} 50 - \sum_{11}^{5} 50 = {}^{5}X \square$	13	19	.60	.38
$\sum_{5}^{3} 10 - \sum_{6}^{2} 10 = {}^{3}X \square + \sum C$	08	05	.79	.51
$\sum_{1}^{2} 5 + 1+3+5+7+9 = \sum C$	06	02	.53	.14
Number of Students	126	129		
KR20 Reliability	.60	.45		
Mean Reading Score	20.0	20.0		
Correlation: Scale and Reading	.17			

(A4) Multiplying Summations

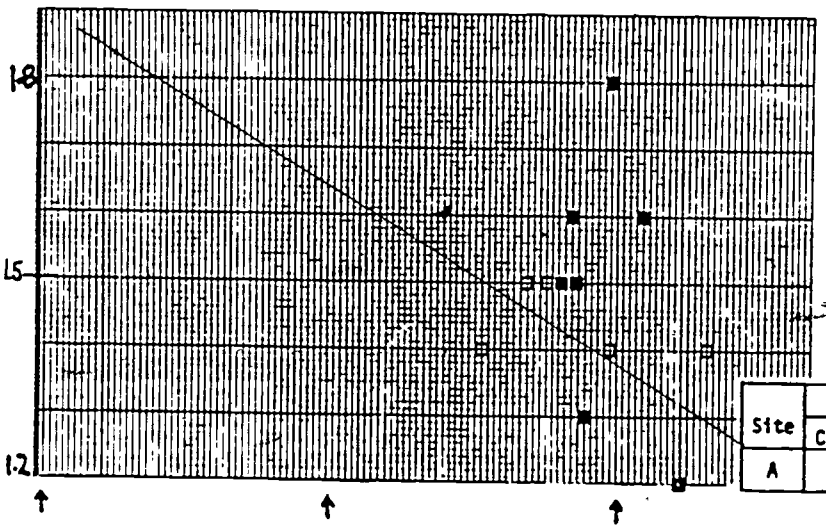
Fact $\sum_{2}^{5} 3 = \sum_{2}^{5} + \sum_{2}^{5} + \sum_{2}^{5}$

Sample $\sum_{3}^{8} + \sum_{3}^{8} = \sum_{3}^{\square}$

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	06	06
1	02	12
2-3	80	74
4-5	09	06
6	02	02

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	1.5	1.3	.20

Comments:

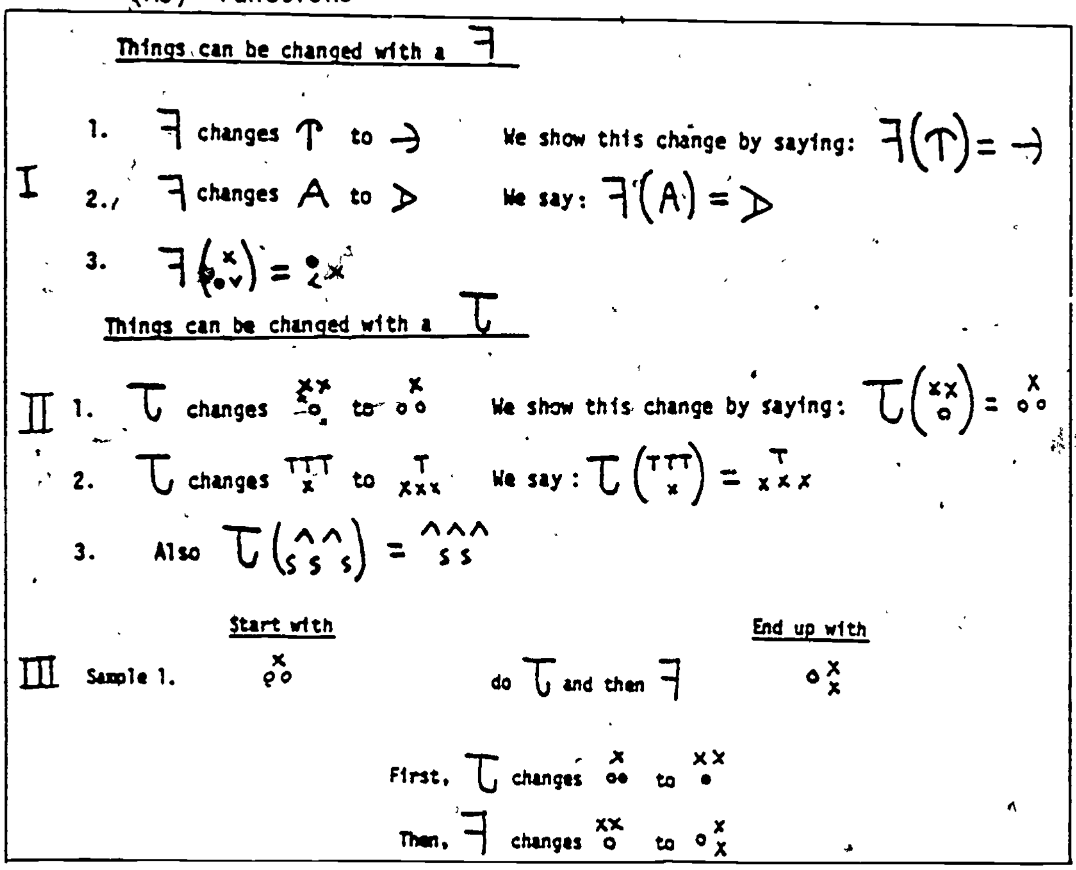
-This scale, like A3, was very difficult. Although the items formed logical progressions, the jump in difficulty level from the first to second item was evidently too great. The right hand side of the second item might better have been i.e., part of the information given.

-The frequency distribution shows the inclusion of students' performance on the sample item as well.

(A5) Functions, Site A

Test Items (See facing page.)			Percent Correct C	Percent Correct N	Biserial C	Biserial N
I		∃(1).	90	86	.79	.81
		∃(M).	90	85	.76	.79
		∃(⊙).	83	79	.82	.77
		∃( ). H	81	83	.75	.72
II		τ(⊙⊙).	62	51	.80	.75
		τ(⊙⊙).	69	59	.80	.82
		τ(⊙⊙⊙).	52	34	.71	.77
		τ( ). ⊙⊙⊙	59	46	.79	.70
III	Start with	End up with				
	⊙	do τ and then ∃		52	45	.73	.69
	⊙ ⊙	do τ and then ∃		56	39	.77	.75
		do τ and then ∃	×	34	15	.59	.65
	⊙ ⊙	do τ twice		67	58	.63	.74
	⊙ ⊙	do τ nine times		52	33	.71	.87
	⊙ ⊙	do ∃ twice.		43	31	.43	.37
	⊙ ⊙	do ∃ nine times		64	40	.61	.66
	Number of Students			124	132		
	KR20 Reliability			.87	.88		
	Mean Reading Score			20.0	20.0		
	Correlation: Scale and Reading			.33			

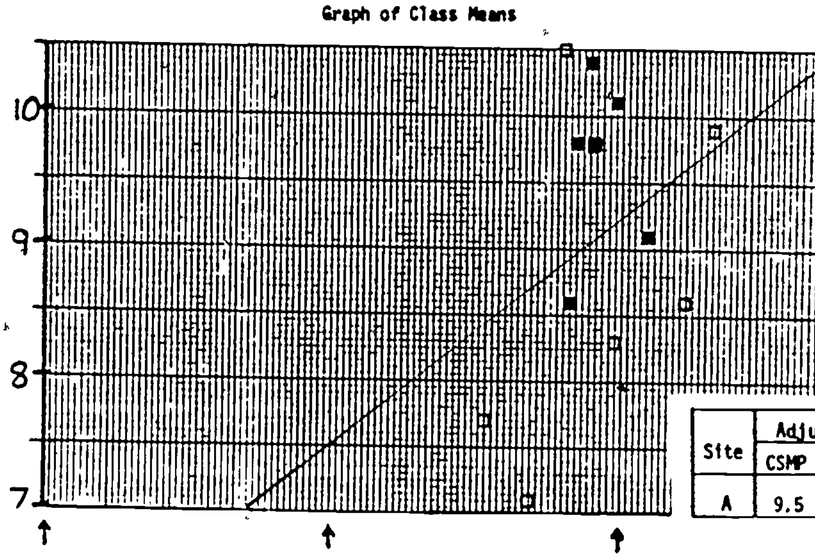
(A5) Functions



Frequency Distribution

Score	% of students CSMP	% of students Non-CSMP
0	03	08
1	01	00
2-7	29	43
8-13	51	38
14	09	06
15	07	05

Graph of Class Means



Site	Adjusted Means CSMP	Adjusted Means Non-CSMP	p-value
A	9.5	8.6	.20

Comments:

-Students seem to be able to understand the heavily symbolic directions.

-The ꟻ (essentially a rotation) was done better than the Ꞁ.

-CSMP students had a larger advantage on set III, where composite functions were employed, than in the first two sets.

C: Computation Category

At each site, a set of mental arithmetic items in the usual format was administered. Although the number, and difficulty, of items varied from site to site, and in Site B the items happened to be aggregated into four scales rather than one, there were many items common to different sites. Site B was simply a repetition of scales used last year; the other sites were revisions of this set of items. In all cases, students were not allowed to do "scratch work".

(C1) Mental Arithmetic, Site C

Multiplication/Division

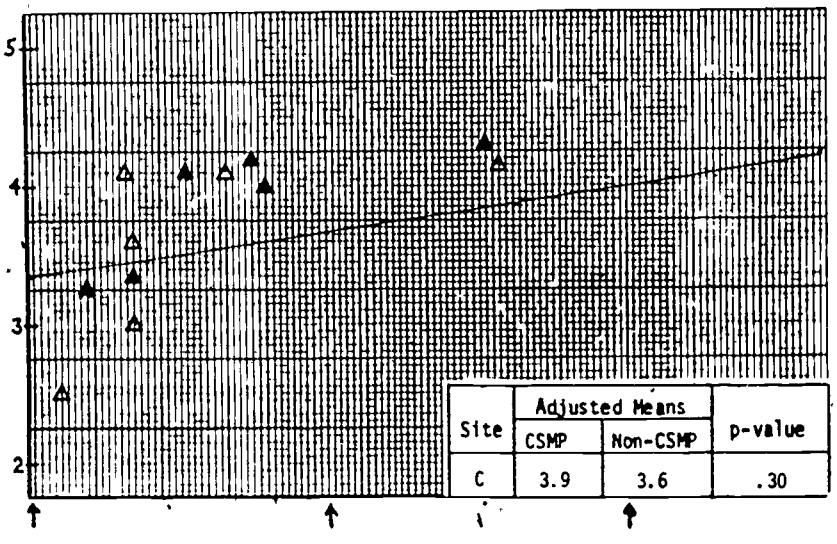
Test Items		Percent Correct C	Percent Correct N	Biserial C	Biserial N
Form A, Multiplication	3 x 125 = ☐	70	76	.49	.24
	☐ x 30 = 900	46	46	.37	.45
	12 x 500 = ☐	47	48	.39	.71
	11 x 273 = 3,003	26	27	.46	.33
	22 x 273 = ☐				
	30 x 20 x 5 = ☐	21	24	.38	.23
	6 x 30 = ☐	84	75	.37	.38
	☐ x 250 = 500	48	34	.53	.67
	7 x ☐ = 280	45	36	.37	.65
	25 x 32 = 800				
	26 x 32 = ☐	24	19	.37	.28
	12 x 500 = ☐	33	35	.57	.23
Form B, Division	700 Divided by 10 = ☐	56	41	.62	.73
	210 Divided by 3 = ☐	41	28	.65	.95
	1,200 Divided by ☐ = 4	33	20	.63	.86
	3,600 Divided by 15 = 240				
	3,615 Divided by 15 = ☐	09	11	.65	.72
	524 Divided by 524 = ☐	49	34	.70	.76
	500 Divided by 2 = ☐	44	47	.81	.58
	800 Divided by ☐ = 200	31	25	.53	.73
	360 Divided by 90 = ☐	19	25	.68	.69
	1,200 Divided by 30 = 40				
	1,200 Divided by 15 = ☐	06	10	.25	.58
	498 Divided by ☐ = 498	60	49	.57	.54
Number of Students	Form A	81	80		
	Form B	86	77		
KR20 Reliability		.74	.81		
		.72	.73		
Mean Reading Score		15.8	15.1		
Correlation: Scale and Reading		.19			

(C1) Mental Arithmetic Multiplication/Division

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
	FORM A B	A B
0	09 03	05 13
1	11 13	28 08
2-4	40 47	38 48
5-8	37 34	20 27
9	01 01	08 04
10	02 02	01 00

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	3.9	3.6	.30

Means by Ability Level

	1	2	3	4	All
CSMP	4.3	4.0	4.1	3.4	4.0
Non-CSMP	4.4	4.0	3.3	2.7	3.5
t-Stat.	.2	.1	1.4	1.2	1.3

Comments:

-It should be recalled in Site C, "CSMP" students had studied only parts of CSMP and for only about 15 lessons.

-Students were not allowed to do rough work; they were to figure the answer out in their heads.

-In general the performance of both groups was surprisingly poor. For example, only about half the students were able to do 700 divided by 10.

-Especially difficult for these students were the "two part" items such as
11 x 273 = 3,003
22 x 273 = ☐

(C2) Mental Arithmetic, Site A

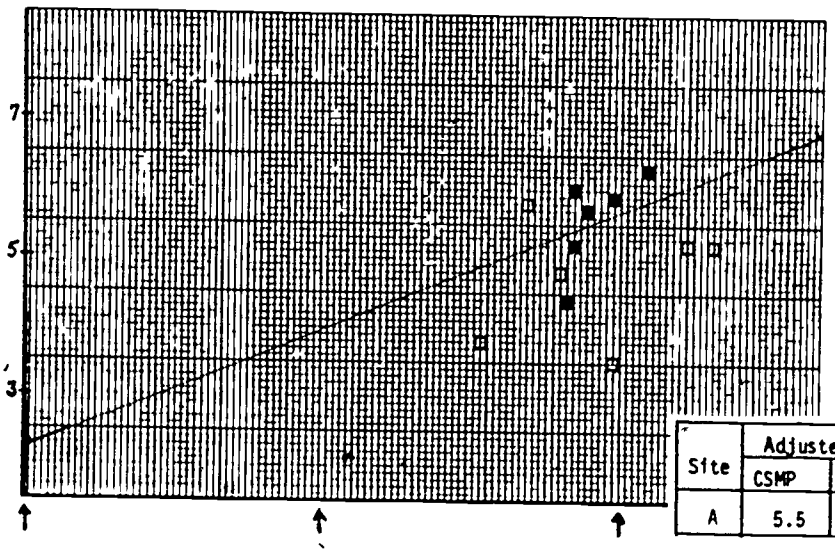
Multiplication

Test Items		Percent Correct C	Percent Correct N	Biserial C	Biserial N
Form A	3 x 125 = ☐	88	90	.78	.48
	☐ x 30 = 900	80	68	.81	.30
	7 x ☐ = 280	81	79	.74	.56
	12 x 500 = ☐	63	57	.50	.41
	30 x 20 x 5 = ☐	55	56	.48	.48
	11 x 273 = 3,003				
	22 x 273 = ☐	69	56	.76	.45
	25 x 32 = 800				
	26 x 32 = ☐	61	38	.62	.46
	(8 x 29) + (2 x 29) = ☐	36	35	.73	.44
	101 x 36 = ☐	42	37	.60	.59
Form B	500 ÷ 2 = ☐	81	79	.82	.76
	360 ÷ 90 = ☐	60	59	.52	.60
	800 ÷ ☐ = 200	77	65	.53	.77
	☐ ÷ 3 = 30	74	53	.71	.79
	1200 ÷ 4 = ☐	82	65	.45	.79
	3,600 ÷ 15 = 240				
	3,615 ÷ 15 = ☐	44	36	.62	.76
	1,200 ÷ 30 = 40				
	1,200 ÷ 15 = ☐	42	35	.58	.68
	(36 x 25) ÷ 12 = ☐	5	8	.26	.67
	36.036 ÷ 36 = ☐	24	17	.61	.66
Number of Students	Form A	64	63		
	Form B	62	66		
KR20 Reliability		.80	.67		
		.74	.83		
Mean Reading Score		20.0	20.0		
Correlation: Scale and Reading		.41			

(C2) Mental Arithmetic

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	5.5	4.6	.10

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
	Form A B	A B
0	05 03	10 08
1	05 02	02 08
2-4	16 19	40 16
5-7	46 31	32 27
8	14 06	10 05
9	14 07	06 02

Comments:

-The CSMP advantage was about the same for the multiplication items of Form A (mean score of 5.9 versus 5.2) as for the division items of Form B (4.9 versus 4.2).

-The second last item was evidently too difficult in its present form. Perhaps something like "12 x ☐ = 25 x 36" would have been better.

(C3) Mental Arithmetic, Site B

Addition

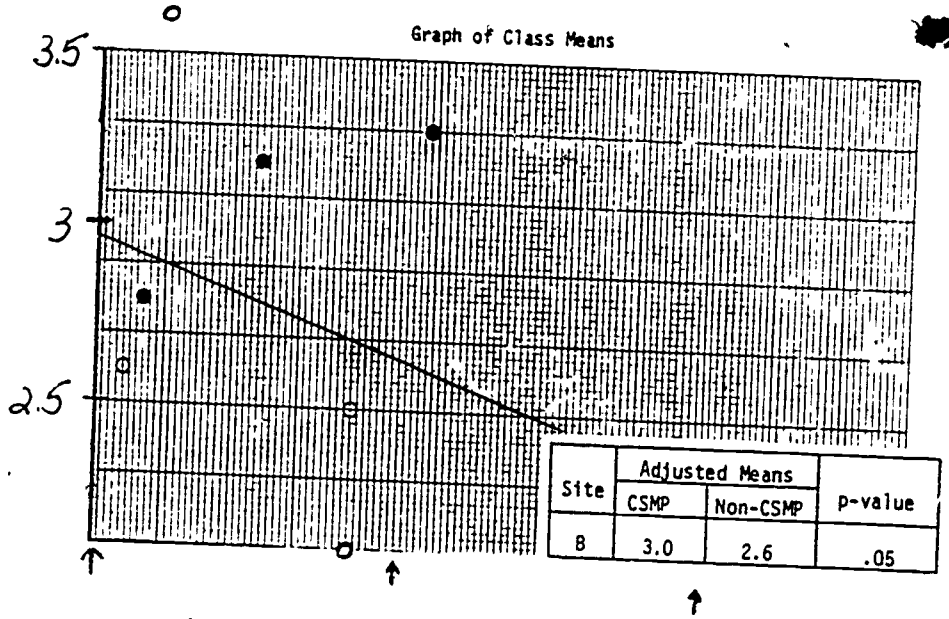
Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
501 + 501 + 501 + 501 = ☐	67	65	.48	.12
☐ + 125 = 250	80	63	.05	.61
9,001 + ☐ = 9,100	60	31	.51	.53
125 + 125 + 225 + 225 = ☐	57	69	.25	.31
4,999 + ☐ = 10,000	43	22	.61	.34
Number of Students	30	49		
KR20 Reliability	.53	.52		
Mean Reading Score	14.3	14.0		
Correlation: Scale and Reading	.36			

(C3) Mental Arithmetic - Addition

(Student page is shown on the facing page.)

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	03	08
1	10	12
2-3	47	60
4	20	10
5	20	10



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
8	3.0	2.6	.05

Comments:

See page A29.

(C4) Mental Arithmetic, Site B

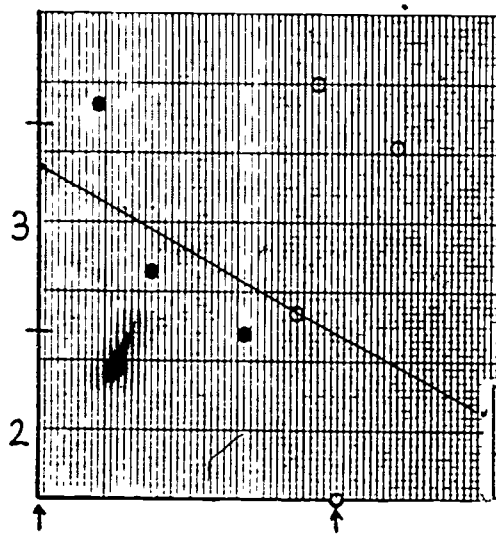
Subtraction

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
459 − 359 = ☐	91	96	.19	.67
7,001 − 6,999 = ☐	53	51	.45	.48
1,000 − 5 = ☐	63	64	.47	.51
700 − 401 = ☐	56	49	.66	.59
☐ − 250 = 150	44	21	.77	.51
Number of Students	32	47		
KR20 Reliability	.68	.62		
Mean Reading Score	13.5	16.2		
Correlation: Scale and Reading	.38			

(C4) Mental Arithmetic - Subtraction

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	2.6	3.0	—

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	03	04
1	19	12
2-3	31	54
4	25	15
5	22	15

Comments:

See page A29.

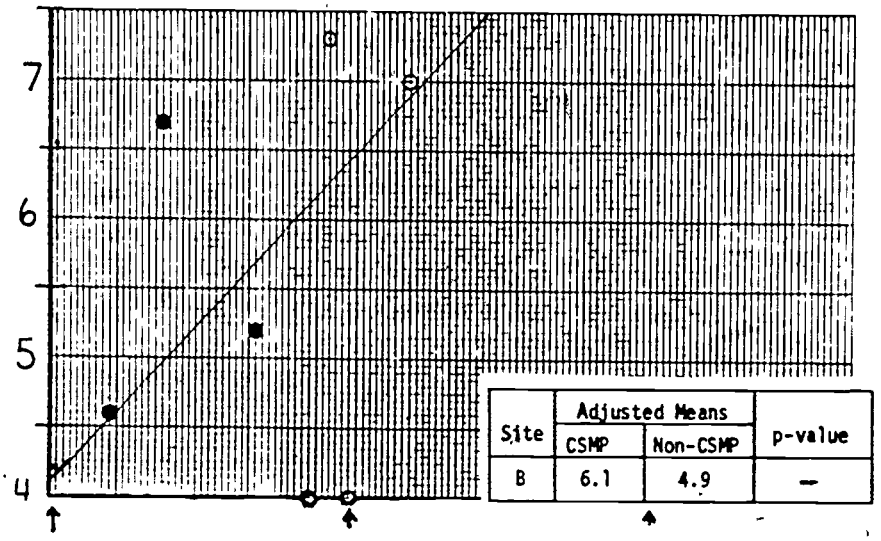
(C5) Mental Arithmetic, Site B
Multiplication

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
7 x 30 = ☐	84	87	.35	.40
3 x 125 = ☐	91	64	.57	.55
☐ x 30 = 900	59	60	.45	.75
7 x ☐ = 280	53	47	.86	.89
☐ x 250 = 500	56	45	.96	.87
12 x 500 = ☐	56	32	.80	.65
30 x 20 x 5 = ☐	53	30	.63	.89
11 x 273 = 3,003				
22 x 273 = ☐	31	36	.48	.89
☐ x 585 = 0	78	72	.76	.67
(8 x 29) + (2 x 29) = ☐	16	11	.36	.10
Number of Students	32	47		
KR20 Reliability	.80	.83		
Mean Reading Score	13.5	16.2		
Correlation: Scale and Reading	.48			

(C5) Mental Arithmetic - Multiplication

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	6.1	4.9	—

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	03	04
1	03	06
2-5	38	61
6-8	38	26
9	15	11
10	03	02

Comments:

See page A29.

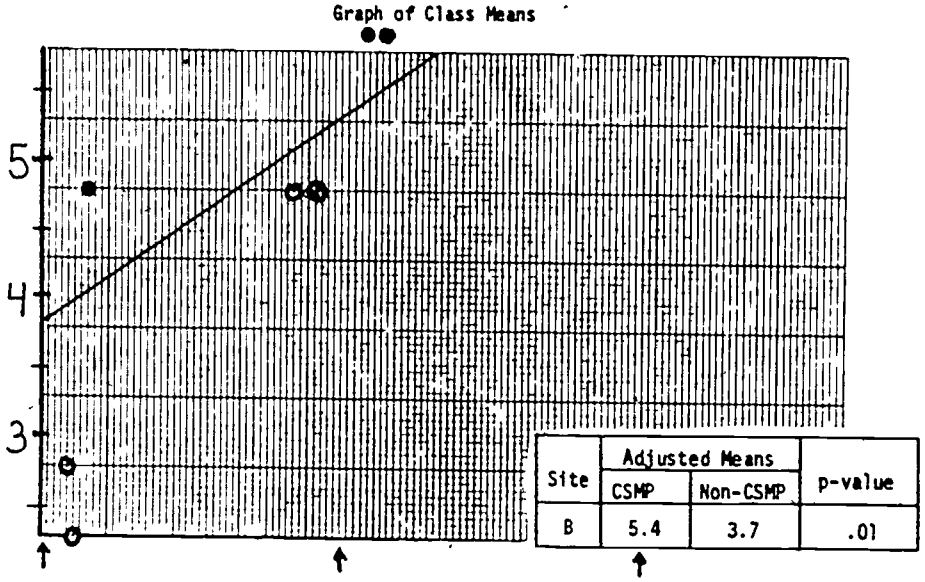
(C6) Mental Arithmetic, Site B

Division

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
210 Divided by 3 = ☐	63	49	.93	.76
500 Divided by 2 = ☐	43	33	.94	.69
700 Divided by 10 = ☐	80	49	.74	.74
800 Divided by ☐ = 200	47	24	85	.75
360 Divided by 90 = ☐	53	29	.79	.64
1,200 Divided by ☐ = 4	50	24	60	.80
☐ Divided by 3 = 30	37	20	.86	.60
3,600 Divided by 15 = 240 3,615 Divided by 15 = ☐	27	15	.68	.68
1,200 Divided by 30 = 40 1,200 Divided by 15 = ☐	13	10	.90	.89
524 Divided by 524 = ☐	63	60	.74	.55
498 Divided by ☐ = 498	70	57	.47	.65
Number of Students	30	49		
KR20 Reliability	.88	.84		
Mean Reading Score	14.3	14.0		
Correlation: Scale and Reading	.62			

(C6) Mental Arithmetic - Division

(Student page is shown on the facing page.)



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	5.4	3.7	.01

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	03	16
1	06	12
2-5	40	44
6-9	38	24
10	00	02
11	13	02

Comments:

-On C5 and C6 combined, there were 11 items administered at Site B which were also given at the other two sites. The mean scores for this common set of items were as follows

	CSMP	Non-CSMP
Site A	7.4	6.8
Site B	5.3	3.8
Site C	3.7	3.8

These mean scores were consistent with the ability levels in the sites; the only inconsistency in the data is the low score in Site C of students who had the very superficial CSMP exposure (which exposure was evidently not sufficient to produce improvement in mental arithmetic).

E: Estimation Category

Two kinds of estimation scales were used. In Site C, there were four scales, on each of which students were to indicate, by marking an 'x', which of several intervals contained the answer to computation problems; short time limits were imposed. These scales were essentially revisions of items of previously used scales. In Site B, there were four scales, on each of which students were to select the most reasonable of three wrong answers to give computation problems. These scales were repetitions from the fifth grade study in 1980 (where their use was not particularly successful.)

(E1) Estimating Intervals, Site C
Addition

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
19 + 29 0 10 50 100 500 1000	80	74	-.01	.09
(Other items used this format)				
257 + 294	78	82	.32	.01
59 + 49	73	63	.27	.71
19 + 19 + 19	71	64	.14	.48
$27\frac{3}{8} + 21\frac{3}{5}$	33	36	.14	.27
$20\frac{1}{2} + 20\frac{1}{2} + 9\frac{1}{2}$	37	35	.07	.31
50.9 + 49.9	42	41	-.05	.21
1.5 + 1.5 + 1.5 + 1.5	09	10	.22	.38
Number of Students	161	147		
KR20 Reliability	.24	.57		
Mean Reading Score	16.1	15.1		
Correlation: Scale and Reading	.18			

(E1) Estimating Intervals - Addition

(Student page is shown on the facing page.)

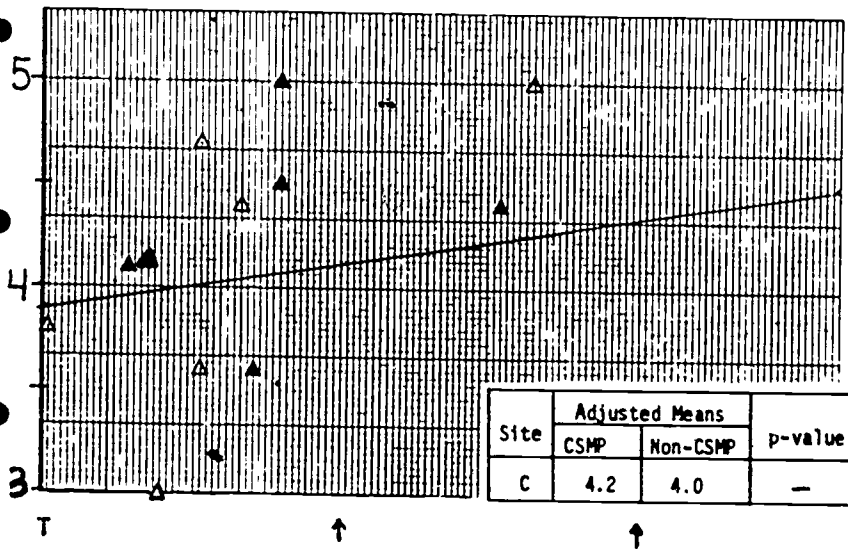
Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	01	03
1	02	07
2-3	27	28
4-6	68	54
7	01	07
8	01	01

Means by Ability Level

	1	2	3	4	All
CSMP	4.3	4.0	4.5	4.1	2.7
Non-CSMP	4.8	4.7	3.8	3.2	2.4
t-Stat.	.8	2.1	2.3	2.3	1.3

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	4.2	4.0	—

Comments:

-The biserials and KR20 Reliability were low, especially for the "CSMP" group, perhaps because of guessing (and it should be noted that rather brief time limits were adhered to on all scales to prevent exact calculations).

-The fraction and decimal items were more difficult than the whole number items.

-Roughly the same percent of students chose the next best "good" answer as chose the correct answer; and for the last three or four subtraction, multiplication and division items an equal number of students did not answer.

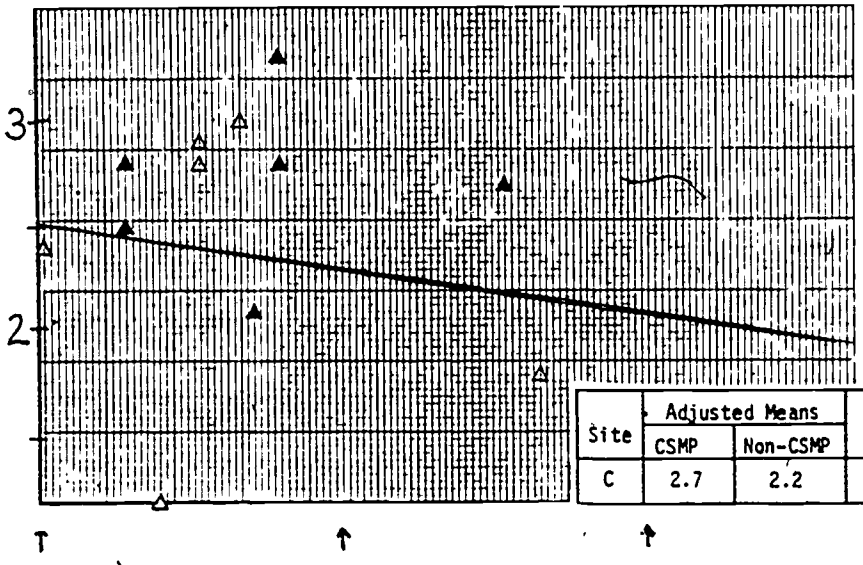
(E2) Estimating Intervals, Site C
Subtraction

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
945 - 855 0 10 50 100 500 1000	44	46	.05	.13
(Other items used this format)				
751 - 249	42	29	.06	.30
105 - 8	41	59	.49	.16
900 - 401	42	35	.30	.30
$60\frac{1}{4} - 50\frac{1}{2}$	05	13	.12	.40
$15\frac{3}{5} - 5\frac{1}{5}$	51	41	.21	.26
100 - 50.5	17	14	.28	.28
20.009 - 10.1	01	05	.84	.49
Number of Students	161	147		
KR20 Reliability	.34	.48		
Mean Reading Score	16.1	15.1		
Correlation: Scale and Reading	.13			

(E2) Estimating Intervals - Subtraction

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	2.7	2.2	.30

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	07	19
1	00	25
2-3	34	39
4-6	58	32
7	01	01
8	00	00

Means by Ability Level

	1	2	3	4	All
CSMP	2.6	3.0	2.9	2.2	2.6
Non-CSMP	2.0	2.9	2.5	2.2	2.4
t-Stat.	1.2	.00	1.4	.0	.9

Comments:

-The percent correct was much lower for the fraction and decimal items, especially those like 60 1/4 - 50 1/2 where the difference was a little less than 10 (see also the last two items).

-The KR20 Reliability was again very low.

(E3) Estimating Intervals, Site C
Multiplication

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
2 x 19 — 0 10 50 100 500 1000	79	69	.44	.79
(Other items used this format)				
40 x 10	47	44	.41	.53
11 x 50	35	40	.36	.32
4 x 29	40	32	.39	.68
$\frac{1}{2}$ x 199	15	12	.46	.17
$\frac{1}{4}$ x 401	30	29	.32	.30
4.9 x 9.9	07	12	.23	.44
125 x 0.5	09	07	.16	.18
Number of Students	161	147		
KR20 Reliability	.49	.54		
Mean Reading Score	16.1	15.1		
Correlation: Scale and Reading	.14			

(E3) Estimating Intervals - Multiplication

(Student page is shown on the facing page.)

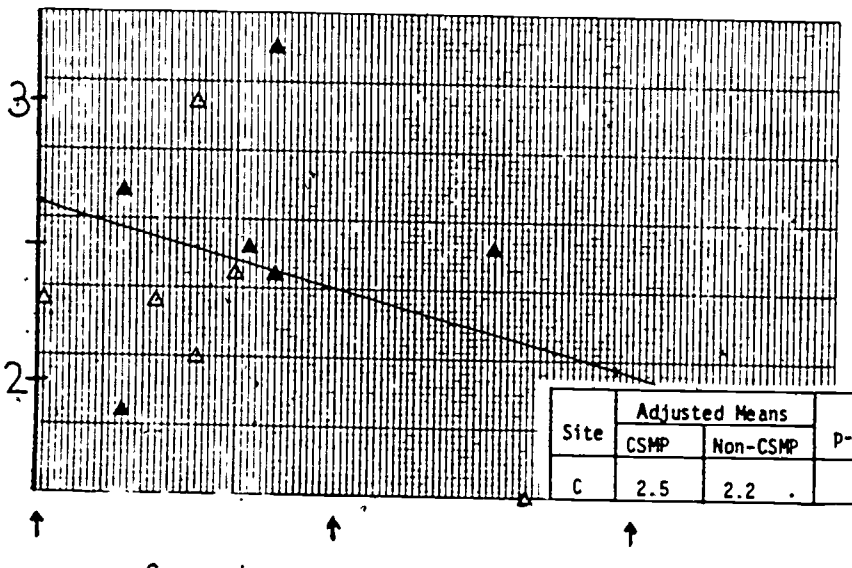
Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	10	18
1	14	12
2-3	46	41
4-6	30	29
7	00	00
8	00	00

Means by Ability Level

	1	2	3	4	All
CSMP	2.8	2.9	2.7	2.1	2.0
Non-CSMP	2.8	2.5	2.4	2.1	1.5
t-Stat.	.1	1.2	.8	.3	2.3

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	2.5	2.2	.20

Comments:

-This scale is also characterized by low biserials and poorer responses to the fraction and decimal items.

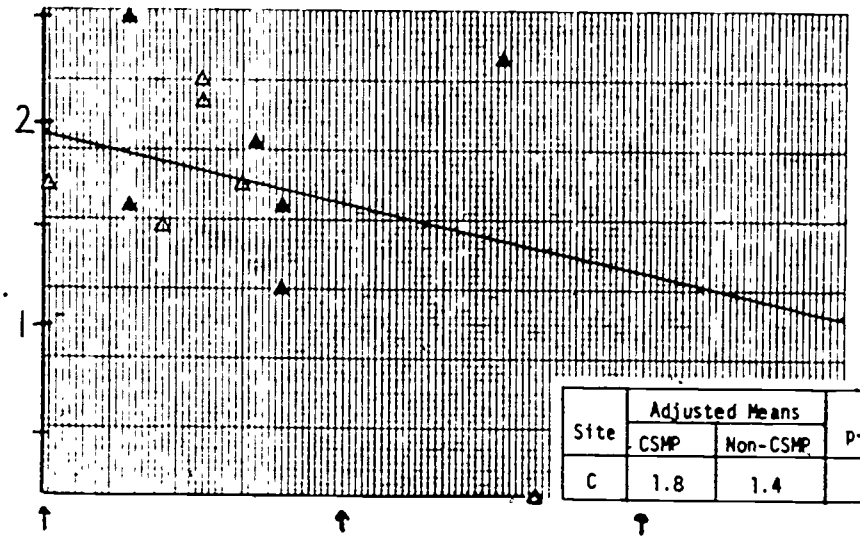
(E4) Estimating Intervals, Site C
Division

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
190 ÷ 10 0 1 10 50 100	32	26	.41	.62
(Other items used this format)				
301 ÷ 50	17	12	.45	.62
300 ÷ 4	32	25	.40	.79
101 ÷ 9	34	22	.69	.80
$10\frac{1}{2} \div 1\frac{1}{2}$	15	13	.36	.64
$1 \div \frac{1}{2}$	27	24	.57	.87
9.5 ÷ 0.5	27	19	.48	.71
100 ÷ 10.5	06	09	.41	.70
Number of Students	161	147		
KR20 Reliability	.64	.62		
Mean Reading Score	16.1	15.1		
Correlation: Scale and Reading	-.03			

(E4) Estimating Intervals - Division

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	1.8	1.4	.30

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	34	53
1	14	11
2-3	32	18
4-6	19	17
7	01	00
8	00	01

Means by Ability Level

	1	2	3	4	All
CSMP	2.2	1.7	2.0	1.9	4.0
Non-CSMP	1.4	1.2	1.4	1.9	3.5
t-Stat.	1.4	1.3	1.6	.0	1.4

Comments:

-There was a generally lower performance on this scale, though the item biserials were considerably higher than in the previous scales.

-Across all four scales (E1-E4), the mean percents correct for whole numbers versus fractions and decimals were as follows

	"CSMP"	Non-CSMP
Whole Numbers (16 items)	51	45
Fractions and Decimals (16 items)	21	17

These percents correct for fractions and decimals were even below the guessing level, indicating a real lack of understanding of them.

-Across all four scales, there was very little relationship between reading ability and scores on these estimation scales. Even at the classroom level the regression lines are rather flat.

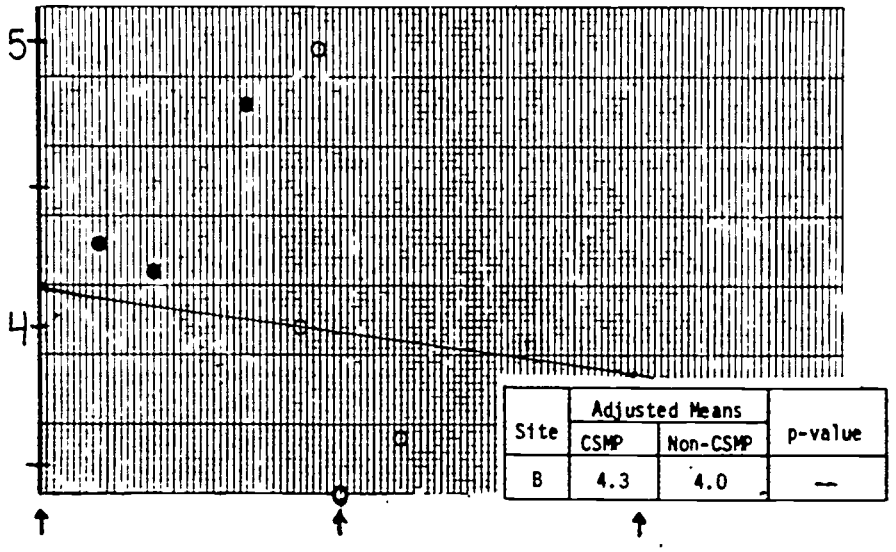
(E6) Closest Wrong Answer, Site B
Addition

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
ADD 26,896 + 31,456 = 47,377 / 51,377 / 58,377	91	89	.19	.50
836 + 31 + 26 + 19 + 27 = 931 / 1,131 / 1,331	69	43	.20	.51
1,022 + 1,713 + 1,991 = 3,740 / 4,740 / 11,740	88	64	-.25	.19
10,276 + 558 + 4 = 10,604 / 15,604 / 19,604	69	45	.51	.26
105 + 97 + 106 + 98 + 104 = 310 / 410 / 510	72	72	.01	.11
5,079 + 5,076 + 5,075 = 15,030 / 15,230 / 17,230	75	70	.64	.50
Number of Students	32	47		
KR20 Reliability	.34	.48		
Mean Reading Score	13.5	16.2		
Correlation: Scale and Reading	.11			

(E6) Closest Wrong Answer - Addition

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	4.3	4.0	—

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	00	00
1	00	04
2-4	47	60
5	22	21
6	31	15

(E7) Closest Wrong Answer, Site B
Subtraction

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
7,907 - 2,249 = 4,744 / 5,644 / 7,744	70	76	.37	.13
78,412 - 5,879 = 7,250 / 23,650 / 72,550	77	61	.47	.45
10,153 - 719 = 940 / 9,340 / 10,040	73	51	.24	.53
1,213 - 888 = 332 / 642 / 1,322	63	43	.55	.50
101,787 - 1,989 = 9,780 / 19,780 / 99,780	80	51	.36	.37
3,105 - 1,986 = 1,162 / 2,162 / 2,862	50	37	.22	.39
Number of Students	30	49		
KR20 Reliability	.53	.57		
Mean Reading Score	14.3	14.0		
Correlation: Scale and Reading	.52			

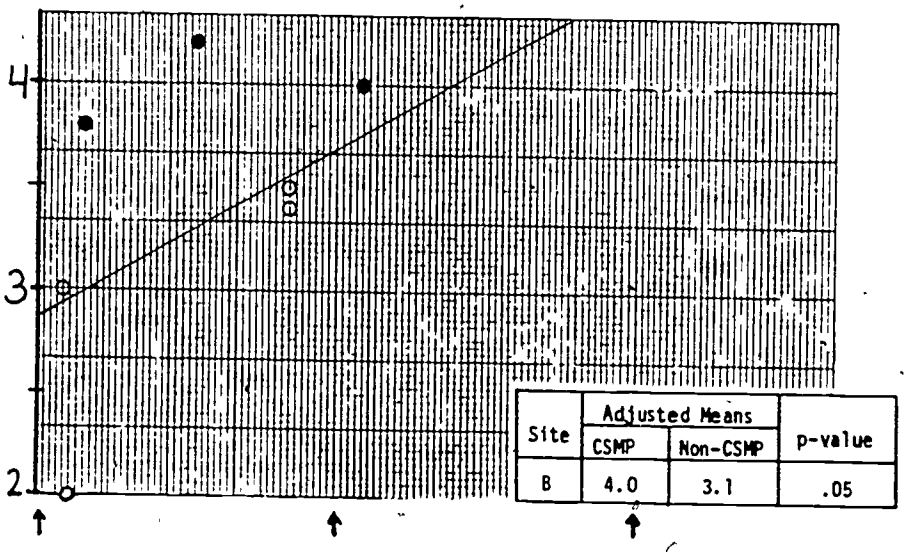
(E7) Closest Wrong Answer - Subtraction

(Student page is shown on the facing page.)

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	00	02
1	03	16
2-4	43	58
5	37	14
6	17	10

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	4.0	3.1	.05

(E8) Closest Wrong Answer, Site B
Multiplication

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
9 x 1,120 = 980 / 1,980 / 10,080	83	74	.79	.60
21 x 123 = 257 / 2,557 / 25,557	73	63	.70	.52
8 x 123,456 = 1,000,100 / 10,000,100 / 100,000,100	40	33	.39	.41
15 x 2,111 = 3,173 / 20,173 / 31,173	57	47	.76	.68
52 x 99 = 1,483 / 5,183 / 9,883	57	43	.70	.53
11 x 989 = 1,900 / 10,900 / 19,900	57	35	.89	.39
Number of Students	30	49		
KR20 Reliability	.78	.67		
Mean Reading Score	14.8	14.0		
Correlation: Scale and Reading	.29			

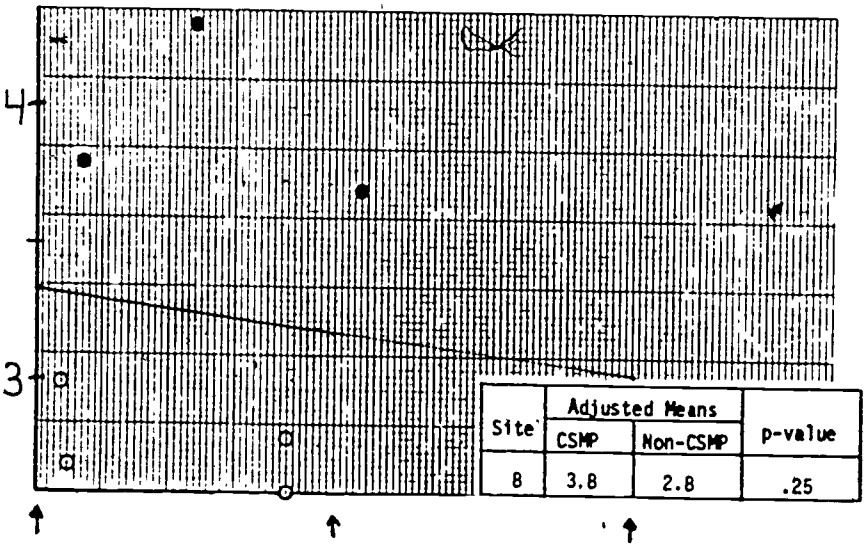
(E8) Closest Wrong Answer - Multiplication

(Student page is shown on the facing page.)

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	10	14
1	07	10
2-4	43	60
5	17	10
6	23	06

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
8	3.8	2.8	.25

(E9) Closest Wrong Answer, Site B
Division

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
1,513 ÷ 498 = 3 / 30 / 300	56	36	.60	.16
181,832 ÷ 9 = 2,000 / 20,000 / 200,000	53	53	.80	.51
980 ÷ 11 = 15 / 40 / 100	28	43	.14	.30
3,641 ÷ 69 = 5 / 50 / 500	50	43	.12	.22
13,980 ÷ 1,402 = 10 / 50 / 100	47	40	.68	.38
2,082 ÷ 39 = 10 / 50 / 100	44	45	.74	.31
Number of Students	32	47		
KR20 Reliability	.63	.49		
Mean Reading Score	13.5	16.2		
Correlation: Scale and Reading	-.04			

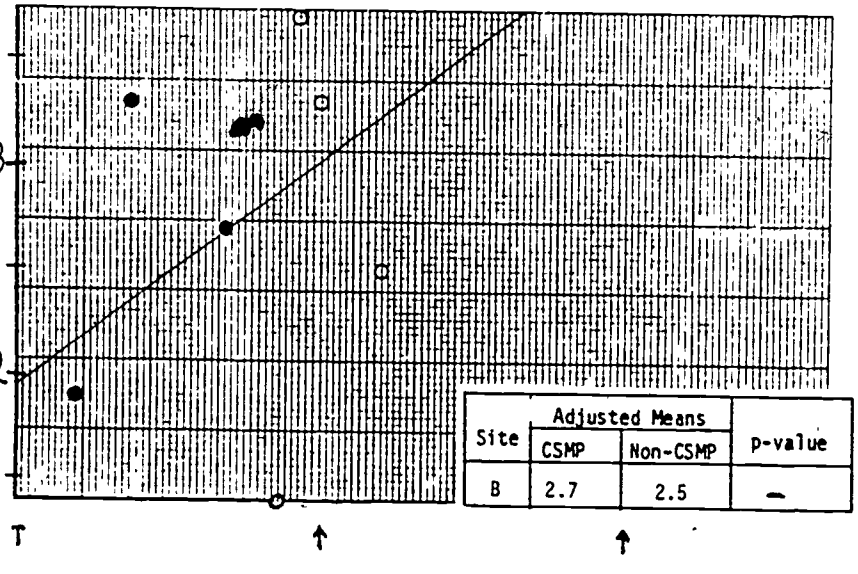
(E9) Closest Wrong Answer - Division

(Student page is shown on the facing page.)

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	06	15
1	25	09
2-4	44	62
5	22	12
6	03	02

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	2.7	2.5	—

L: Logic Category

This is a new category, intended generally to assess students' ability to do logical thinking. L3, L6 and L8 are rather classic types of scales. L2 and L4 were thought to be similar to, though in a different context from, some of the string picture games.

The version of L4 administered at Site A had an additional 4-item problem so that scale scores from that site are not compatible with scores from the other site.

(L2) Candy Boxes, Sites A, B and C

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
I. Then Jane spends exactly 9¢. Which box did Jane buy? ____1____	83 89 89	74 91 82	.85 .80 .71	.76 .47 .68
Then Carol spends exactly 15¢. Which box did Carol buy? _____	84 87 89	77 81 86	.86 .75 .77	.88 .65 .63
Which box did Helen buy? _____	86 79 81	80 85 80	.77 .59 .59	.81 .50 .72
II. Which box did Andy choose? _____	37 21 19	19 17 16	.50 .39 .41	.39 .15 .41
Which box did Bill choose? _____	31 15 17	30 16 20	.60 .35 .43	.52 .45 .27
III. Which boxes could he have chosen? _____				
(Data for students who answered only 1, 2, 3, 6, 9)	23 02 18	32 00 20		
(Data for percent students who answered only 2, 3, 6, 9)	15 13 18	08 10 20		

	CSMP Site A	CSMP Site B	CSMP Site C
Non-CSMP			
Number of Students	124 132	62 96	167 157
KR20 Reliability	.65 .63	.58 .49	.60 .60
Mean Reading Score	20.0 20.0	13.9 15.3	15.8 15.1
Correlation: Scale and Reading	.35	.22	.23

(L2) Candy Boxes

1. These are the boxes of candy:

These are the girls: Maria, Carol, Helen, Jane

These are the facts:

Each girl chooses a box and buys every candy in the box.

Each girl chooses a different box than the other girls.

Maria chooses the 4¢ box. She could spend 4¢ or 8¢ or 12¢ or 16¢, and so on.

2. These are the boxes:

Andy chooses a different box than Bill.

No matter how many candies are in their boxes:

Then Jane spends exactly 9¢. Which box did Jane buy?

Then Carol spends exactly 15¢. Which box did Carol buy?

Which box did Helen buy?

3. This time there are many, many boxes.

Ed is choosing a box.

He chooses a box and looks inside.

It has more than 1 candy and he has to spend exactly 18¢.

Frequency Distribution

Score	% of students					
	CSMP			Non-CSMP		
Site	A	B	C	A	B	C
0	04	37	05	12	32	01
1	04	42	85	08	42	06
2	04	18	12	06	21	12
3	43	03	57	43	05	54
4	19	00	14	18	00	11
5	19	06	09	11	00	09
6	00	06	01	02	00	01

Means by Ability Level

Site B

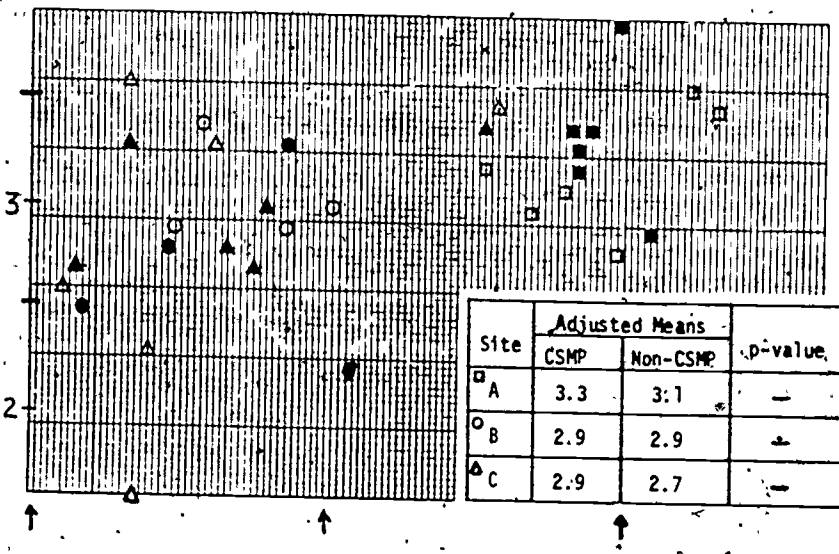
	1	2	3	4	All
CSMP			2.9	2.3	2.9
Non-CSMP			2.6	2.9	2.8
t-Stat.			.7	-1.6	.4

Means by Ability Level

Site C

	1	2	3	4	All
CSMP	3.4	3.0	3.1	2.7	2.9
Non-CSMP	3.4	3.4	2.5	2.5	2.8
t-Stat.	.1	1.7	.3	.5	.4

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
□ A	3.3	3:1	—
○ B	2.9	2.9	—
△ C	2.9	2.7	—

Comments:

-The three problems were intended to be of gradually increasing difficulty. The high percents correct for the three items of the first problem indicate that the students understood the directions and were able to do a fairly easy problem. However, on the second problem 10% of the students combined more than one box, indicating a misunderstanding of the task.

-Few students got the last item "correct", i.e., gave all the possible answers, instead students gave 1, 2, 3, or more answers.

(L3) Order Relations, Sites A, B and C

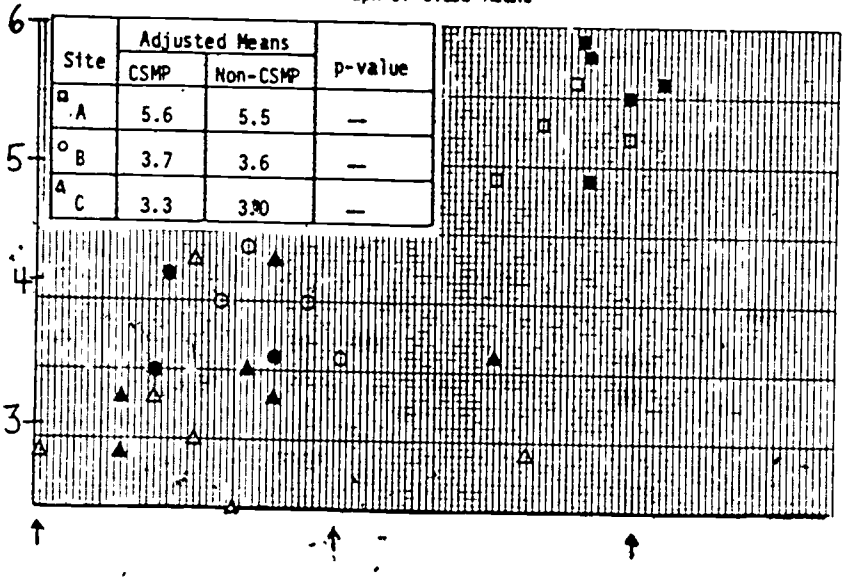
Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
John is taller than Bill. Bill is taller than Tom.	85	78	.57	.44
Who is tallest? John Bill Tom Can't Tell	67	66	.27	.21
	52	53	.23	.22
Dave is shorter than Jim. Jim is shorter than Andy.	88	78	.42	.44
Who is tallest? Dave Jim Andy Can't tell	03	70	.12	.16
	64	50	.28	.12
Paul is taller than John. John is shorter than Bob.	67	51	.49	.40
Who is tallest? Paul John Bob Can't tell	49	27	.59	.13
	28	19	.33	.26
Ann is taller than Barb and Carol.	48	31	.28	.43
Carol is shorter than Barb and Diane.	25	20	.25	.05
Who is tallest? Ann Barb Carol Diane Can't tell	13	09	.03	-.27
Who is shortest? Ann Barb Carol Diane Can't tell	81	84	.50	53
	69	81	.26	-.10
	32	44	.07	.08
The banker is one of these men: Smith, Jones, Brown, Williams, Gates				
The banker is the tallest and fattest man.				
Smith is taller than Jones, but shorter than Brown.				
Brown is fatter than Williams, but thinner than Smith.	47	45		
Who is the banker? Smith Jones Brown Williams Gates Can't tell	17	18	-.01	.21
	14	20	.03	.37
There are 5 children: Bill, Maria, Tony, Helen and Abby.				
Bill is taller than Maria but not as tall as Tony.				
Helen and Maria are taller than Abby.				
Helen is taller than Maria but not as tall as Bill.	73	66	.43	.58
Who is tallest? Bill Maria Helen Abby Tony Can't tell	28	34	.28	.39
	42	32	.39	.35
Who is shortest? Bill Maria Helen Abby Tony Can't tell	69	69	.47	.52
	44	36	.37	.10
	39	31	.05	.26
Sites B and C				
Ellen is not taller than Linda.				
Linda is shorter than Karen.				
Who is shortest? Linda Ellen Karen Can't tell	25	20	.22	-.18
	15	20	.21	.11

CSMP / Non-CSMP	Site A	Site B	Site C
Number of Students	124 / 132	72 / 89	161 / 147
KR20 Reliability	.57 / .63	.39 / .19	.33 / .35
Mean Reading Score	20.0 / 20.0	13.9 / 15.3	16.1 / 15.1
Correlation: Scale and Reading	.34	.38	.26

(L3) Order Relations

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means CSMP	Adjusted Means Non-CSMP	p-value
A	5.6	5.5	—
B	3.7	3.6	—
C	3.3	3.0	—

Frequency Distribution

Score	% of students CSMP			Non-CSMP		
Site:	A	B	C	A	B	C
0	03	01	04	04	01	03
1	00	03	22	02	07	14
2-3	14	44	67	18	35	46
4-5	35	31	45	42	49	31
6	29	13	04	21	09	03
7	19	08	04	13	03	03
8	00	00	00	00	00	00
9	X	00	X	X	00	X

Means by Ability Level

Site B

	1	2	3	4	All
CSMP		4.2	3.8		3.8
Non-CSMP		3.9	3.8		3.6
t-Stat.		0.6	0.0		0.4

Means by Ability Level

Site C

	1	2	3	4	All
CSMP	4.0	3.6	3.3	2.9	3.5
Non-CSMP	3.8	3.3	2.9	2.7	3.1
t-Stat.	0.9	1.2	1.2	0.4	1.7

Comments:

-Items like the ones in L3 are commonly used as a measure of verbal reasoning. The first item is as straight forward as can be imagined; yet a third of the students at Site B, and half at Site C missed the item.

(L4) Identification Sites A, B and C

Test Items		Site A Percent Correct C	Site A Percent Correct N	Site A Biserial C	Site A Biserial N	Site B Percent Correct C	Site B Percent Correct N	Site B Biserial C	Site B Biserial N	Site C Percent Correct C	Site C Percent Correct N	Site C Biserial C	Site C Biserial N
I. What league does each boy play in?	Bill	68	63	55	66	59	49	.42	.36	63	60	48	36
	Tom	74	64	77	80	64	56	.47	.56	68	68	49	41
	Ed	78	70	60	62	73	68	.49	.42	74	71	49	45
	Pete	72	62	71	80	50	52	.56	.38	48	46	59	53
	How many leagues	82	73	84	53	38	33	.66	.70	57	61	.17	.49
II. Which league does each boy play in?	A	64	55	88	85	66	62	.77	.75	54	55	.72	.70
	B	57	45	91	96								
	C	61	45	71	94	48	49	.68	.81	43	46	.73	.77
	D	50	37	92	93	56	46	.80	.68	25	21	.48	.20
	E	49	48	93	99	37	31	.85	.85	30	29	.83	.81
	F	47	41	81	99	41	32	.67	.89	35	31	.86	.83
						33	37	.85	.76	29	25	.77	.85
III. There are 4 girls: Ann Bonny Carla Doris There are 4 days: Monday Tuesday Wednesday Thursday There are 4 sports: Bicycling Swimming Volleyball Horseback Riding These are the facts: Each girl takes one lesson a week in her sport. Each girl plays a different sport. Bonny takes lessons on Tuesday and doesn't take swimming. Ann takes volleyball and doesn't take lessons on Monday. Doris takes lessons on Wednesday and doesn't take bicycling or swimming.		Data Not Available											
IV. Form B, page 2, Site A only Where does each traveler go?	A	25	29	59	46								
	B	33	33	46	62								
	C	29	29	31	62								
	D	23	25	47	65								
Number of Students		A 64 B 62		63 66		64	87			167	157		
KR20 Reliability		87		.88	.89	83		83		.80		.80	
Mean Reading Score		20.0		20.0		14.8		15.6		16.1		15.1	
Correlation: Scale and Reading		.50				.42				.39			

(L4) Identification

I.

These are the 4 boys: Bill Tom Ed Pete

These are the 4 leagues: indoor soccer outdoor soccer indoor hockey outdoor hockey

These are the facts:
- Each boy plays in a different league.
- Bill plays indoors.
- Tom doesn't play hockey.
- Ed doesn't play outdoors and he doesn't play soccer.

What league does each boy play in? (Circle your answers)

II.

There are 3 sports: soccer, hockey and basketball.

For each sport there are 2 leagues: an indoor league and an outdoor league.

How many leagues are there? _____

These are the facts:
- The boys are called A, B, C, and so on.
- Each boy plays on a different league.
- A and C play basketball.
- B and D don't play soccer.
- A, B, and E play indoors.

Which league does each boy play in?

IV.

There are 4 travelers: A, B, C and D

Each traveler goes to a different city.

Each traveler uses a different kind of transportation: car, bus, train and plane.

These are the facts:
- There are no trains through Southtown.
- B always flies.
- The only way to get to Eastburg is by car.
- C travels by bus and doesn't go to Westhill.
- A doesn't travel to Eastburg.
- Only trains go to Northville.
- Planes don't land at Southtown.

Where does each traveler go?

Frequency Distribution

Score	% of students					
	CSMP			Non-CSMP		
Site	A	B	C	A	B	C
0	03	03	18	06	03	05
1	05	06	08	08	09	07
2-7	27	59	52	33	52	64
8-12	47	27	27	37	30	25
13-15	19	06	05	17	08	01

Means by Ability Level

Site B

	1	2	3	4	All
CSMP		5.1	4.5	3.9	6.1
Non-CSMP		7.2	5.1	4.0	5.7
t-Stat.		-1.3	1.2	-.0	0.6

Means by Ability Level

Site C

	1	2	3	4	All
CSMP	7.2	6.5	6.0	4.6	6.1
Non-CSMP	7.7	7.2	5.0	3.6	5.6
t-Stat.	0.2	0.8	1.3	1.1	0.4

Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
□ A	8.3	8.3	—
○ B	6.1	5.6	—
△ C	5.7	5.5	—

Comments:

-For the items in section IV students were performing at the guessing level, even though they were high ability students.

-The students' test booklets showed the information about each player in such a way that students could have used the booklet for keeping track of assignments to teams and indoor/outdoor.

-Typical errors were the violation of one or more rules.

-The scale, although similar to the String Game, elicited no transfer.

-The performance at all three sites is comparable in spite of ability differences.

(L6) Implication, Sites B and C

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Three friends go shopping: Bill, Len and Alice There are two boxes: Blue and Green				
If Bill buys a blue box, he also buys a green box. He does not buy a green box. Does he buy a blue box? Yes No Can't tell (Circle your answer)	15 25	07 28	.02 -.05	.40 .07
Len buys a blue box or a green box. He does not buy a blue box. Does he buy a green box? Yes No Can't tell (Circle your answer)	11 60	16 63	.26 .19	.35 .32
Alice doesn't buy both a blue box and a green box. She buys a blue box. Does she buy a green box? Yes No Can't tell (Circle your answer)	10 57	07 64	-.10 .36	-.09 .22
Number of Students	62 107	96 157		
KR20 Reliability	.06 .23	.23 .29		
Mean Reading Score	13.9 15.8	15.0 15.1		
Correlation: Scale and Reading	.39			

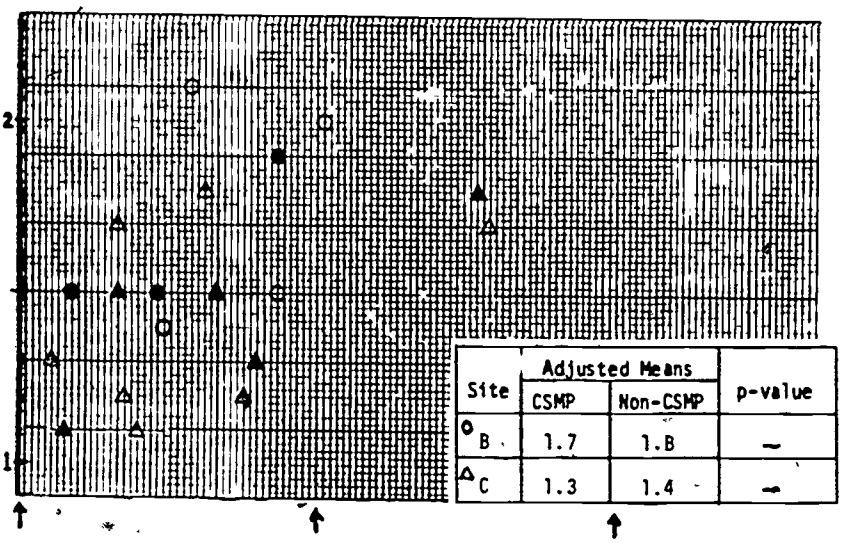
(L6) Implication

(Student page is shown on the facing page.)

Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
Site:	B	C	B	C
0	08	19	10	16
1	14	28	16	24
2	34	45	58	48
3	06	08	16	12

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
○ B	1.7	1.8	—
△ C	1.3	1.4	—

Site B Means by Ability Level

	1	2	3	4	All
CSMP			1.5	1.2	1.7
Non-CSMP			1.7	1.2	1.8
t-Stat.			-.9	-.2	-.5

Site C Means by Ability Level

	1	2	3	4	All
CSMP	1.7	1.5	1.5	1.3	1.5
Non-CSMP	1.6	1.7	1.6	1.3	1.6
t-Stat.	0.0	0.9	0.8	0.1	1.0

(L8) Some/All/None

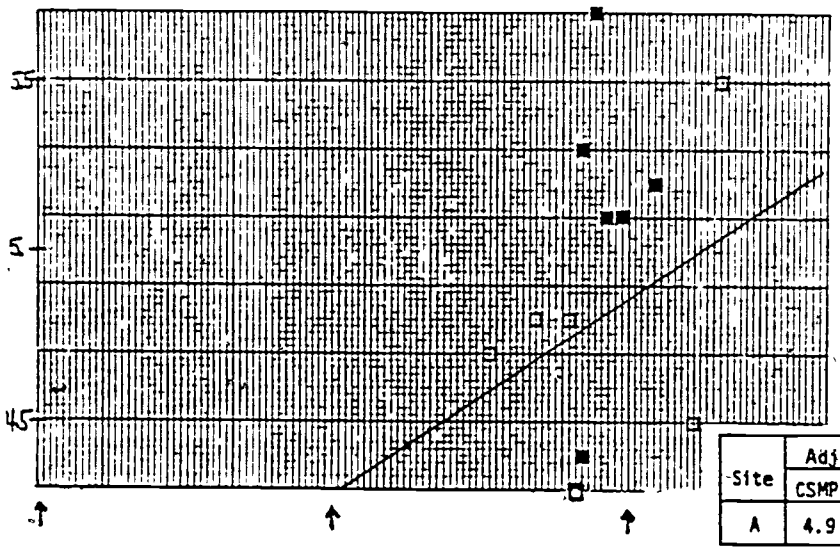
Test Items		Percent Correct C	Percent Correct N	Biserial C	Biserial N
Form A	1. If Matt lives in Texas, then Matt travels by horse. Matt travels by horse. Does Matt live in Texas?	22	14	-.08	-.10
	2. If Ellen went shopping here, then Ellen bought shoes. Ellen went shopping here. Did Ellen buy shoes?	87	91	.83	.56
	3. If fish are pink, then turtles are yellow. Fish are not pink. Are turtles yellow?	03	06	-.18	.45
	4. If it is raining, then the field is purple. The field is not purple. Is it raining?	75	80	.62	.40
	5. If the sun is shining and it is Sunday, then we will go on a picnic. It is not Sunday. Will we go on a picnic?	17	20	-.09	-.14
	6. All mallards are ducks Some ducks are opera singers. Is there a mallard that is an opera singer?	54	41	.55	.47
	7. If the spider is crawling or if the snake is moving, then I will scream. I will not scream. Is the spider crawling?	76	67	.56	.28
	8. If all the houses are green, then we are on Main Street This house is not green. Are we on Main Street?	81	86	.96	.48
	9. Snakes don't ambulate. Some of my pets are snakes. Do any of my pets ambulate?	60	45	.34	.33
Form B					
	1. If Matt lives in Texas, then Matt travels by horse. Matt doesn't live in Texas. Does Matt travel by horse?	25	23	.03	.10
	2. If Ellen went shopping here, then Ellen bought shoes. Ellen didn't buy shoes. Did Ellen go shopping here?	56	58	.62	.51
	3. If fish are pink, then turtles are yellow. Turtles are yellow. Are fish pink?	13	20	-.23	-.02
	4. If it is raining, then the field is purple. It is raining. Is the field purple?	79	82	.65	.55
	5. If it is Sunday and the sun shines, then we will go on a picnic. It is Sunday. Will we go on a picnic?	66	55	.68	.71
	6. If the spider is crawling or if the snake is moving, then I will scream. The snake moves. Will I scream?	80	74	.48	.46
	7. If all the houses are green, then we are on Main Street. This house is green. Are we on Main Street?	56	44	.53	.53
	8. All ducks are opera singers. All mallards are ducks. Is there a mallard that is not an opera singer?	72	70	.54	.52
	9. Snakes don't ambulate. All of my pets are snakes. Do any of my pets ambulate?	79	77	.21	.72
Number of Students	Form A	63	66		
	Form B	61	66		
KR20 Reliability		.60	.46		
		.62	.67		
Mean Reading Score		20.0	20.0		
Correlation: Scale and Reading		.37			

(L8) Some/All/None

If Matt lives in Texas, then Matt travels by horse.
Matt travels by horse.

Does Matt live in Texas? Yes No Can't tell

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	4.9	4.8	–

Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
	FORM A	B	A	B
0	04	03	03	05
1	02	02	03	05
2-4	24	23	44	20
5-6	70	41	47	43
7	00	21	03	20
8	00	10	00	05
9	00	00	00	02

Comments:

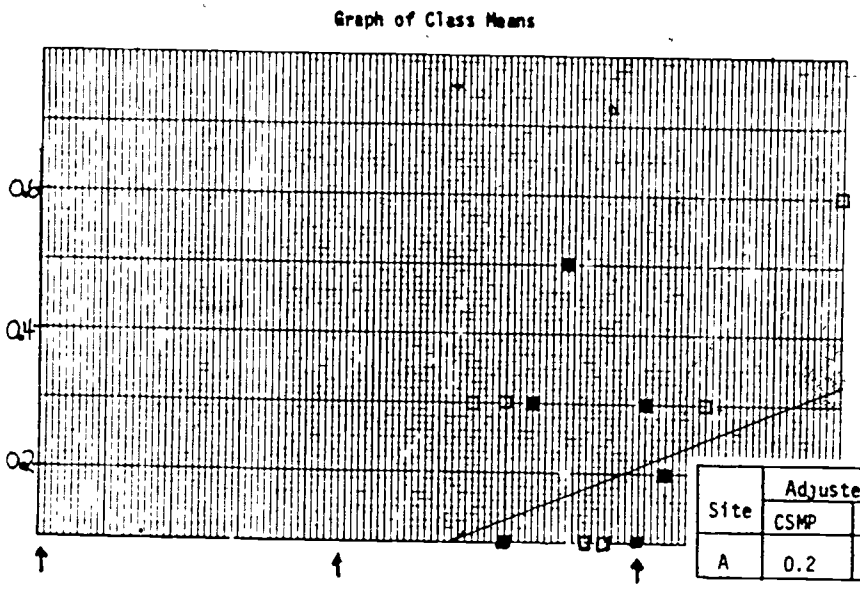
-Items of the type "If A, then B...", when A is not known, are not "natural" examples of reasoning, and both CSMP and Non-CSMP students' scores on these items reflect that.

(L9) Venn Diagrams - 2 String, Site A

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
In Mrs. Jones' class: 11 students wear tennis shoes. 17 students wear glasses. 8 students wear tennis shoes and glasses. 2 students don't wear tennis shoes or glasses. Write your answers in the blanks. How many students are there in Mrs. Jones' class? _____ How many students wear either tennis shoes or glasses but not both? _____ How many students wear glasses but not tennis shoes? _____	05 06 13	06 00 10	.01 .01 .97	1.13 .00 1.00
Number of Students	64	63		
KR20 Reliability	67	48		
Mean Reading Score	20.0	19.8		
Correlation: Scale and Reading	.18			

(L9) Venn Diagrams

(Student page is shown on the facing page.)



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	0.2	0.2	—

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	86	89
1	08	06
2	03	05
3	03	00

Comments:

-Not enough time available to complete the scale may have been a factor in the low rate of success with this scale. Nevertheless, it is suprising that practice with the String Game did not translate into higher scores for CSMP students.

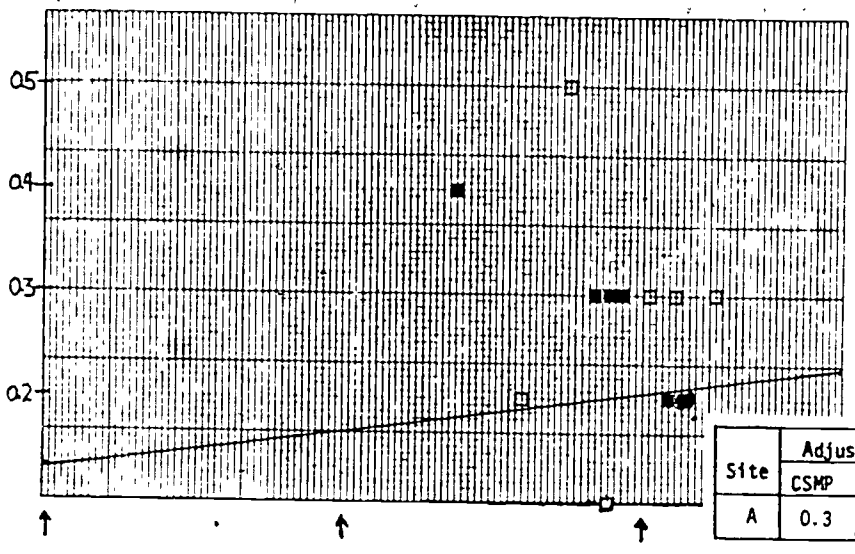
(L10) Venn Diagrams - 3 String, Site A

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
In Mr. Smith's class:				
18 students play baseball.				
13 students play basketball.				
21 students play football.				
No students play all three sports.				
No students play both baseball and basketball.				
7 students play both football and baseball.				
17 students play football but not basketball.				
How many students play baseball only?	18	15	-.09	.61
How many students play football only?	02	02	-.19	.54
How many students play basketball only?	00	03	.00	1.43
Number of Students	62	46		
KR20 Reliability	-.05	.51		
Mean Reading Score	20.1	20.2		
Correlation: Scale and Reading	.18			

(L10) Venn Diagrams

(Student page is shown on the facing page.)

Graph of Class Means



Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	81	84
1	19	12
2	00	02
3	00	02

Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	0.3	0.3	—

Comments:

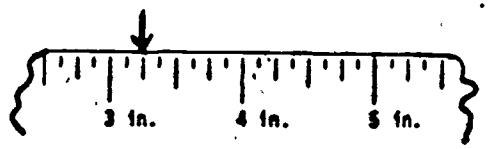
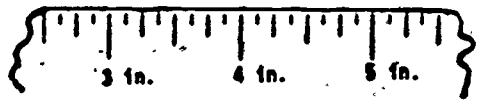
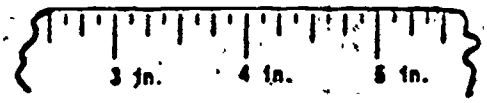
See page 61.

N: Other Number Systems Category

(Fractions and Decimals)

This is the most complicated category to report. The scales will be ordered so that similar kinds of scales are together, rather than by the numerical designation.

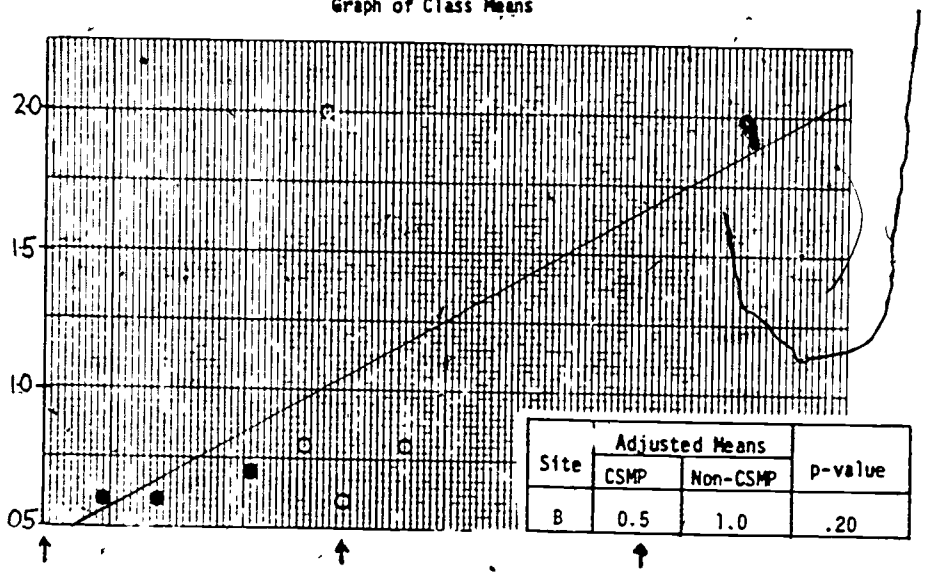
(N3) · Measuring Fractional Inches, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
The arrow is pointing at _____ in. 	09	09	.55	.87
Put an arrow at $4\frac{1}{2}$ in. 	53	55	.53	.23
Put an arrow at $3\frac{3}{4}$ in. 	13	17	.58	.38
Number of Students	32	47		
KR20 Reliability	.53	.45		
Mean Reading Score	13.5	16.2		
Correlation: Scale and Reading	.38			

(N3) Measuring Fractional Inches

(Student page is shown on the facing page.)

Graph of Class Means



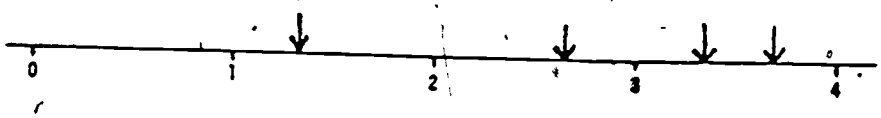
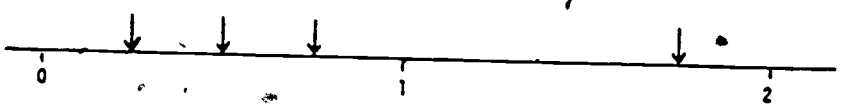
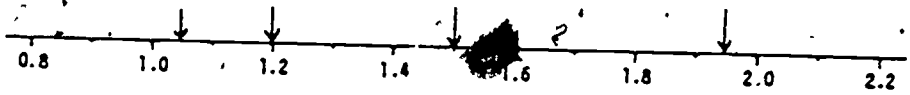
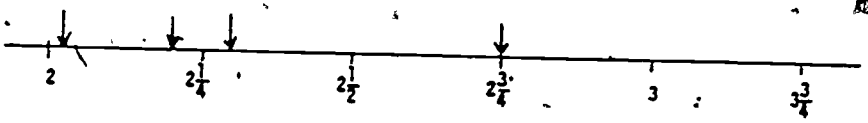
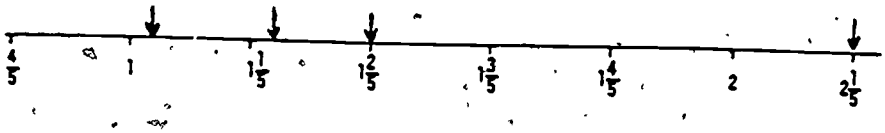
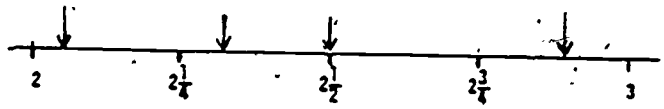
Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	0.5	1.0	.20

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	47	38
1	34	40
2	16	06
3	03	06

Comments:

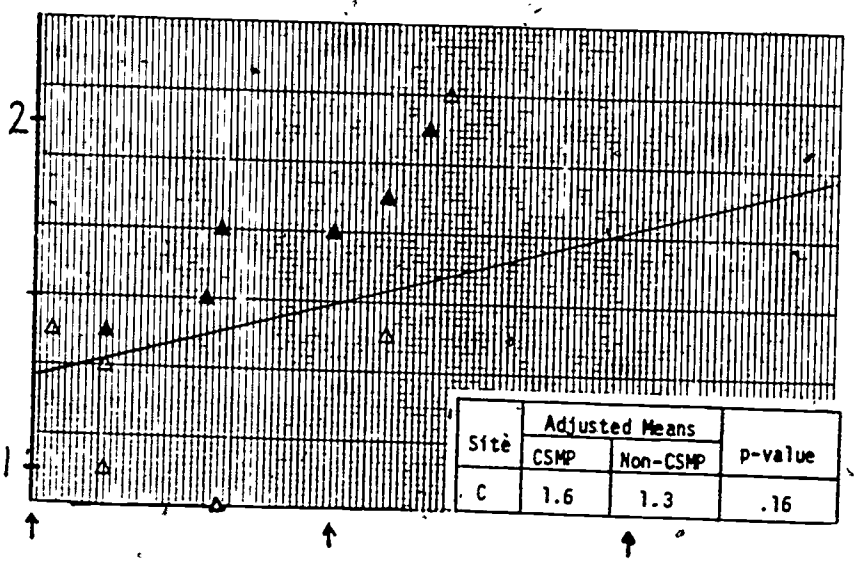
-This scale was repeated from fifth grade, with virtually no improvement from one year to the next, except for one high scoring class. Students especially had trouble with quarters of an inch on a ruler marked with eighths of an inch.

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Circle the arrow that points to $3\frac{1}{3}$ on the number line below. 	64	48	.38	.42
Circle the arrow that points to $\frac{1}{4}$ on the number line below. 	12	24	.28	.28
Circle the arrow that points to $1\frac{1}{2}$ on the number line below. 	09	06	.04	.34
Circle the arrow that points to 2.3 on the number line below. 	14	13	.05	.28
Circle the arrow that points to 1.25 on the number line below. 	04	04	-.09	.15
Circle the arrow that points to 2.05 on the number line below. 	.56	.41	.22	.20
Number of Students	81	80		
KR20 Reliability	.32	.39		
Mean Reading Score	16.1	14.9		
Correlation: Scale and Reading	.27			

(N15) Fractions & Decimals on the Number Line

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	1.6	1.3	.16

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	17	28
1	31	30
2-4	52	41
5	00	01
6	00	00

Means by Ability Level

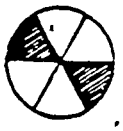
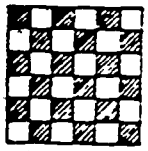
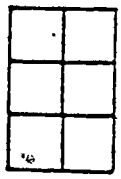
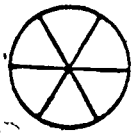
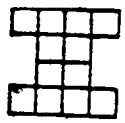
	1	2	3	4	All
CSMP	1.8	1.6	1.9	1.2	1.6
Non-CSMP	2.1	1.7	1.1	1.0	1.3
t-Stat.	0.6	0.5	2.7	0.8	1.4

Comments:

-This was a new scale intended to assess students understanding of the relationship between fractions and decimals.

-Generally poor performance; the second and third items show a real lack of understanding.

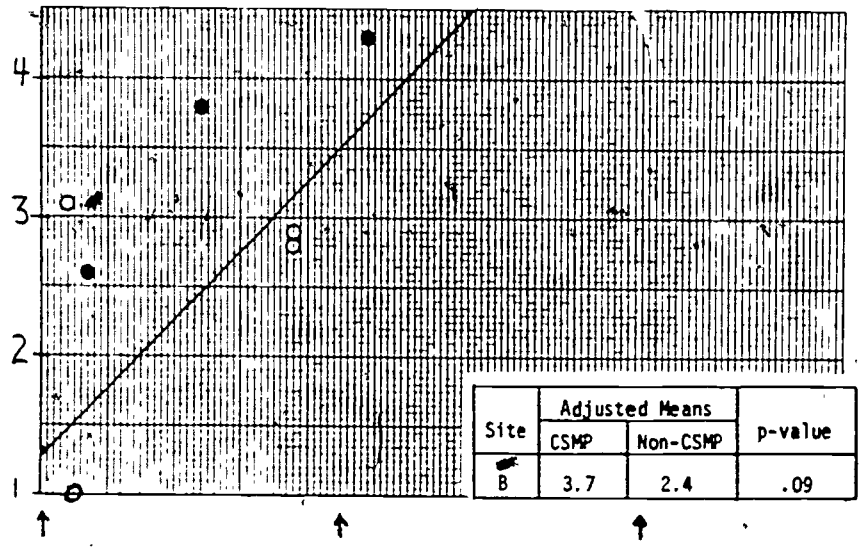
(N5) Fractional Areas, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
 $\frac{1}{3}$ $\frac{1}{2}$ $\frac{3}{4}$ none of these	83	69	.76	.41
 $\frac{1}{4}$ $\frac{1}{3}$ $\frac{1}{2}$ none of these	80	55	.62	.32
 $\frac{1}{4}$ $\frac{1}{3}$ $\frac{2}{4}$ none of these	10	8	.86	.67
 $\frac{1}{4}$ $\frac{1}{2}$ $\frac{3}{4}$ none of these	23	8	-.21	-.40
 $\frac{1}{2}$ $\frac{2}{3}$ $\frac{3}{4}$ none of these	30	12	.57	.31
Shade $\frac{1}{2}$ of the figure. 	90	65	.78	.65
Shade $\frac{2}{3}$ of the figure. 	30	20	.86	.63
Shade $\frac{1}{4}$ of the figure. 	43	14	.59	.53
Number of Students	30	49		
KR20 Reliability	.70	.57		
Mean Reading Score	14.3	14.0		
Correlation: Scale and Reading	.49			

(N5) Eractional Areas

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	3.7	2.4	.09

Frequency Distribution

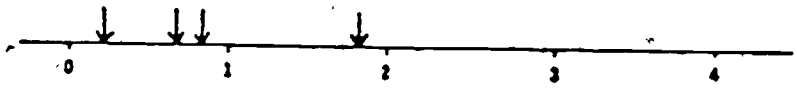
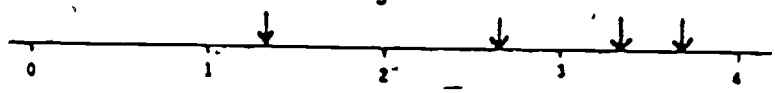
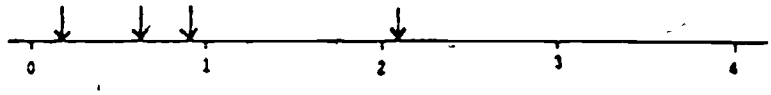
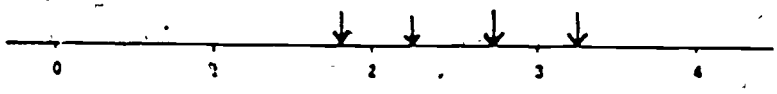
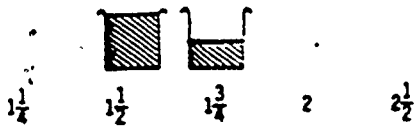
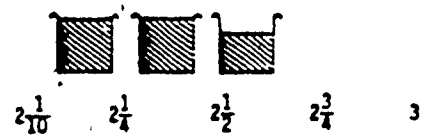
Score	% of students	
	CSMP	Non-CSMP
0	03	14
1	07	08
2-3	33	53
4-6	47	22
7	07	02
8	03	00

Comments:

-This scale was repeated from fifth grade.

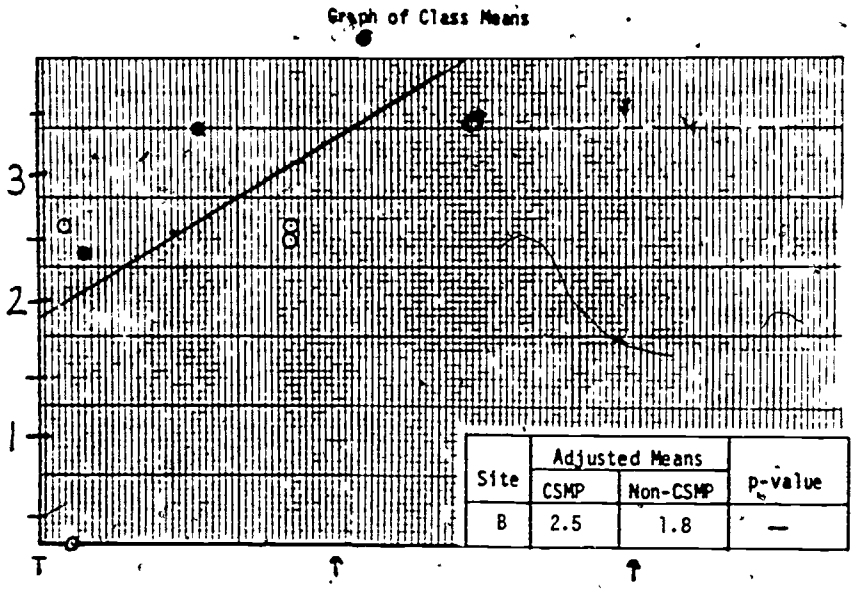
-Performance was quite satisfactory when the fractional representation was on parts out of n for the fraction m/n but did poorly on items where, for example, 2 parts out of 6 was for 1/3.

(N10) Other Representations of Fractions, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Circle the arrow that points to $\frac{1}{4}$ on the number line. 	.27	08	.71	.73
Circle the arrow that points to $3\frac{1}{3}$ on the number line. 	67	55	.68	.34
Circle the arrow that points to $\frac{9}{10}$ on the number line. 	60	27	.69	.41
Circle the arrow that points to $2\frac{3}{4}$ on the number line. 	40	37	.49	.29
Each bucket holds 1 gallon. How many gallons are shown? Circle the best answer. 	77	73	.64	.33
How many gallons are shown? Circle the best answer. 	43	33	.53	.32
Number of Students	30	49		
KR20 Reliability	.74	.52		
Mean Reading Score	14.3	14.0		
Correlation: Scale and Reading	.29			

(N10) Other Representations of Fractions

(Student page is shown on the facing page.)



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	2.5	1.8	—

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	13	10
1	10	22
2-4	53	63
5	10	00
6	13	04

Comments:

-This scale was repeated from fifth grade.

-The CSMP advantage was due mainly to one very low scoring Non-CSMP class.

-The performance on the first item was surprisingly low.

(N6) Equivalent Fractions, Site B

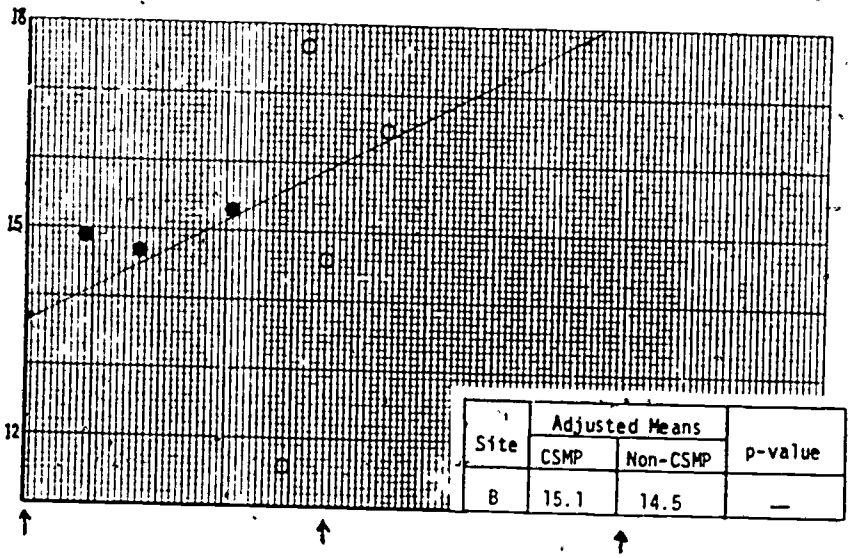
Test Items (See facing page.)	Percent Correct C	Percent Correct N	Biserial C	Biserial N
20 items, as shown below. Statistics not available.				
$\frac{1}{3}$ $\frac{2}{6}$ $\frac{50}{150}$ $\frac{11}{31}$ $\frac{3}{15}$ $\frac{4}{12}$				
$\frac{3}{4}$ $\frac{9}{12}$ $\frac{31}{41}$ $\frac{6}{8}$ $\frac{13}{14}$ $\frac{300}{400}$				
$\frac{1}{5}$ $\frac{20}{100}$ $\frac{5}{1}$ $\frac{11}{15}$ $\frac{5}{25}$ $\frac{2}{10}$				
$\frac{2}{3}$ $\frac{25}{45}$ $\frac{4}{6}$ $\frac{30}{45}$ $\frac{3}{2}$ $\frac{5}{15}$				
Number of Students	32	47		
KR20 Reliability				
Mean Reading Score	13.5	16.2		
Correlation: Scale and Reading	.40			

(N6) Equivalent Fractions

Circle all the fractions that are equal to the one in the box.
There are usually more than one.
The first one is done for you.

Sample $\boxed{\frac{1}{2}}$ $\frac{4}{7}$ $\frac{2}{4}$ $\frac{1}{20}$ $\frac{20}{100}$ $\frac{10}{20}$

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	15.1	14.5	—

Comments:

-This scale was repeated from fifth grade.

(N6[1]) Equivalent Fractions and Decimals, Site A

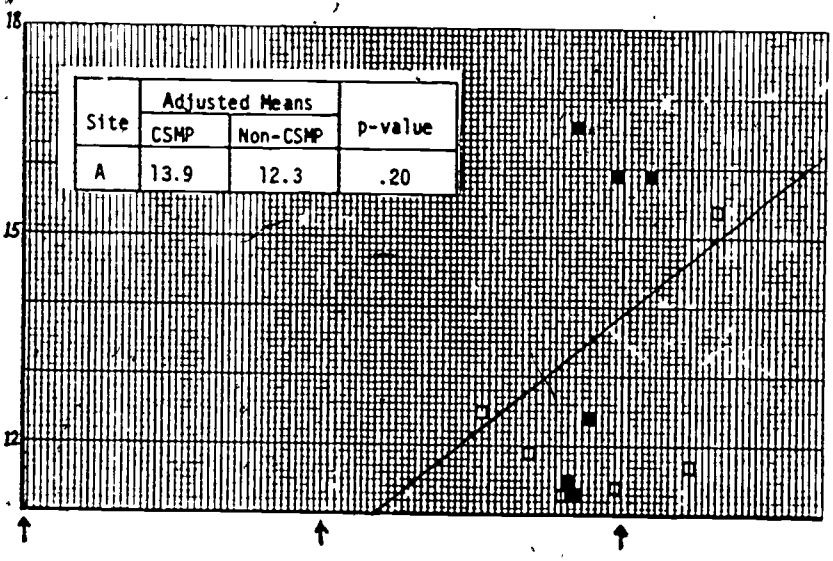
Test Items		Percent Correct C	Percent Correct N	Biserial C	Biserial N
3/4	.34	69	63	.92	.90
	12/36	59	57	.48	.59
	.75	80	57	.94	.71
	75/100	77	67	.83	.87
	7.5	77	73	.80	.82
	4/3	83	75	1.14	.95
1/5	.50	64	60	.90	.81
	20/100	74	63	.81	.84
	.02	69	70	.49	.53
	20/50	75	67	.96	.79
	0.5	70	60	.85	.74
	4/20	67	60	.58	.74
0.6	0.60	70	65	.62	.58
	60/100	66	40	.56	.51
	0.060	77	71	1.02	.94
4/5	12/20	30	13	.42	.51
	6/100	58	41	.81	.58
	3/5	38	14	.55	.54
	0.45	68	58	.68	.65
	16/20	69	71	.47	.86
	0.8	42	33	.45	.53
	80/100	74	61	.78	.84
	8.0	81	74	.80	.81
	5/4	79	74	.85	.85
1/4	0.40	81	67	.94	.83
	25/100	74	67	.93	.91
	0.025	73	62	.69	.56
	10/14	81	75	.97	.87
	0.25	74	57	.81	.77
	5/20	73	71	.65	.87
0.75	0/750	56	54	.32	.63
	75/100	82	66	.99	.88
	0.075	73	56	.88	.84
	15/20	37	32	.47	.57
	1.3/1.4	84	67	.92	.60
	3/4	71	53	.79	.80
Number of Students	Form A	64	63		
	Form B	62	63		
KR20 Reliability		.91	.90		
		.89	.91		
Mean Reading Score		19.7	20.3		
Correlation: Scale and Reading		.46			

(N6[1]) Equivalent Fractions and Decimals

Circle all the numbers that are equal to the one in the box.
There is usually more than one. The first one is done for you.

Sample $\boxed{\frac{1}{2}}$ (0.5) $\frac{3}{4}$ 1.2 (2/4) (0.500) (25/50)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	13.9	12.3	.20

Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
	Form A	B	A	B
0	09	06	14	14
1	00	00	00	00
2-6	03	05	03	00
7-11	22	16	32	38
12-16	50	53	43	33
17	08	10	05	03
18	08	10	03	12

Comments:

-This scale was a revision of N6, changed so that instead of merely equivalent fractions, fractions and decimals were mixed together within each item.

-There was a fairly large difference between four classes scoring around 16 and the other eight which scored around 12, the difference appeared not to be related to ability level and not strongly related to curriculum.

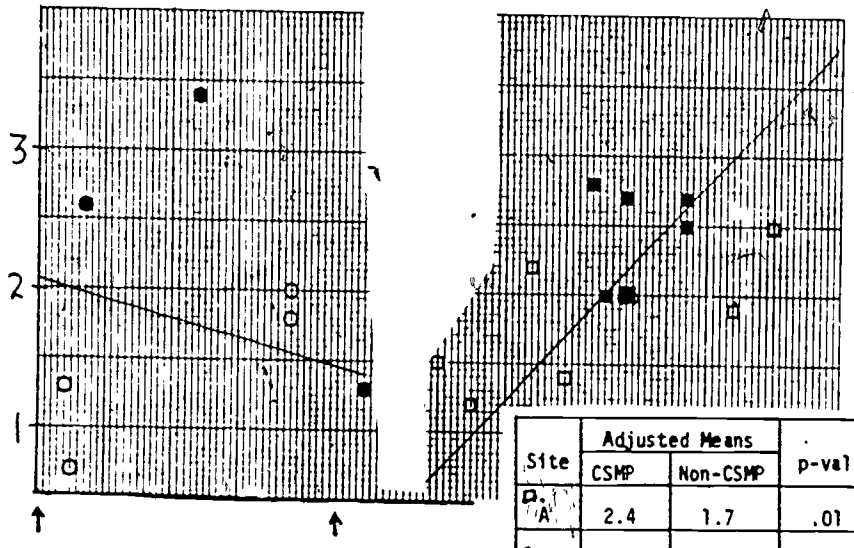
(N7) Fractional Open Sentences - Sites A and B

Test Items (See facing page.)		Percent Correct C	Percent Correct N	Biserial C	Biserial N
Site A	Complete the sentences:				
	$\frac{1}{2} + \square = 1$	89	74	.59	.37
	$\frac{3}{3} \div \square = 1$	26	24	-.07	.31
	$\frac{1}{2} \times \square = 10$	61	32	.41	.38
	$\frac{\square}{12} = 1\frac{1}{2}$	28	32	.62	.43
	$0.5 + \square = \frac{3}{4}$	39	23	.38	.49
Site B					
	$\frac{2}{3} \times 1 = \square$	57	61	.56	.64
	$\frac{1}{2} + \square = 1$	57	33	.50	.77
	$\frac{1}{2} \times \square = 10$	37	02	.70	1.09
	$\frac{1}{2} + 2 = \square$	23	08	.86	.68
	$1 - \frac{1}{4} = \square$	17	06	.96	.61
	$\frac{1}{4} + \square = \frac{1}{4}$	50	37	.65	.70
Number of Students	Site A	61	66		
	Site B	30	49		
KR20 Reliability		.48	.53		
		.77	.70		
Mean Reading Score		20.4	19.7		
		14.3	14.0		
Correlation: Scale and Reading		.39	.26		

(N7) Fractional Open Sentences

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	2.4	1.7	.01
B	2.3	1.4	.25

Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
SITE:	A	B	A	B
0	08	17	18	35
1	13	20	24	18
2	33	27	24	24
3	23	10	24	14
4	20	10	06	06
5	03	03	04	00
6	X	13	X	00

Note: Sites A and B had different sets of items.

Comments:

-At Site B, the scale was a repeat from fifth grade; at Site A about half these items were changed (and made more difficult).

-At Site B the mean percents were 40% correct for CSMP and 25% for Non-CSMP.

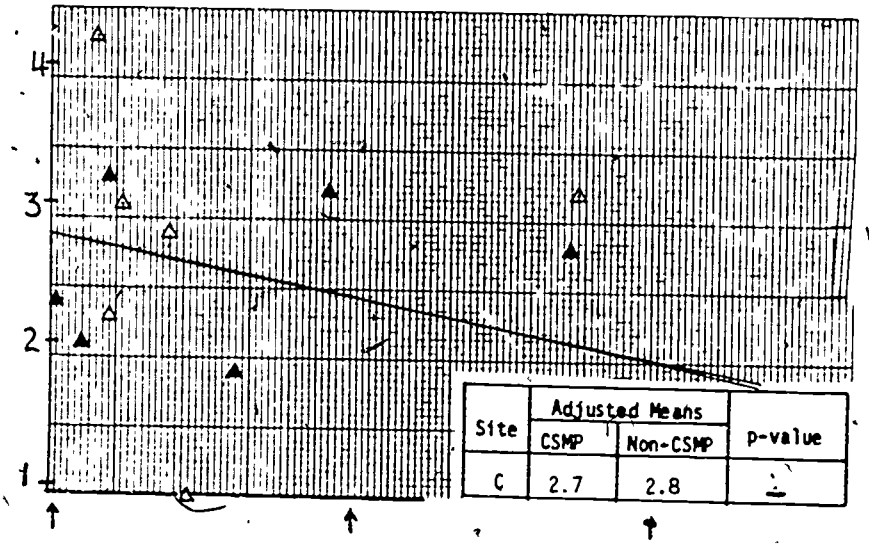
(N16) Fractional Open Sentences, Site C

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
$\frac{2}{3} \times 1 = \square$	62	51	.44	.35
$\frac{1}{2} + \square = 1$	46	31	.58	.76
$\frac{1}{2} \times \square = 10$	04	03	.40	.34
$\frac{1}{4} + \square = \frac{1}{4}$	47	39	.47	.50
$1 - \frac{3}{4} = \square$	05	03	.73	.75
$\frac{1}{2} \div 2 = \square$	09	00	.67	0
$\frac{3}{5} \div \square = 1$	33	15	.37	.71
$\frac{1}{5} - \square = 0$	47	33	.50	.85
Number of Students	81	80		
KR20 Reliability	.64	.67		
Mean Reading Score	15.7	15.1		
Correlation: Scale and Reading	.62			

(N16) Fractional Open Sentences

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	2.7	2.8	

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	19	28
1	07	25
2-3	46	39
4-6	26	08
7	02	00
8	00	00

Means by Ability Level

	1	2	3	4	All
CSMP	3.2	2.9	2.0	2.9	2.7
Non-CSMP	1.9	3.3	3.0	2.5	2.8
t-Stat.	1.9	1.0	1.0	0.4	.2

Comments:

-The first six items of this scale were the same as scale N7 at Site B. The mean percent correct for these six items in Site B was 40 for CSMP versus 24 for Non-CSMP, while at Site C the percents were 29 for CSMP versus 21 for Non-CSMP.

(N12) Decimal Open Sentences, Site A

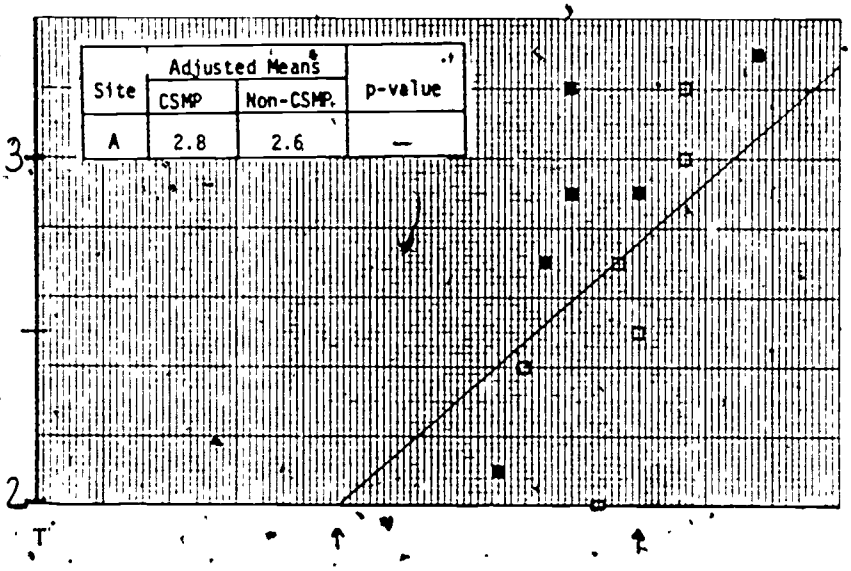
Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
$0.5 + \square = 1$	90	76	.61	.63
$0.8 \div \square = 1$	34	45	.25	.33
$0.5 \times \square = 10$	56	29	.41	.46
$6.5 - \square = 6$	75	70	.55	.66
$\frac{1}{2} + \square = 0.75$	15	24	.05	.35
Number of Students	63	66		
KR20 Reliability	.47	.61		
Mean Reading Score	19.7	20.3		
Correlation: Scale and Reading	.50			

(N12) Decimal Open Sentences

(Student page used the format shown on the facing page)

Graph of Class Means

Site	Adjusted Means CSMP	Adjusted Means Non-CSMP	p-value
A	2.8	2.6	—



Frequency Distribution

Score	% of students CSMP	% of students Non-CSMP
0	06	15
1	10	08
2	21	23
3	35	30
4	26	18
5	02	06

Comments:

-This was a new scale.

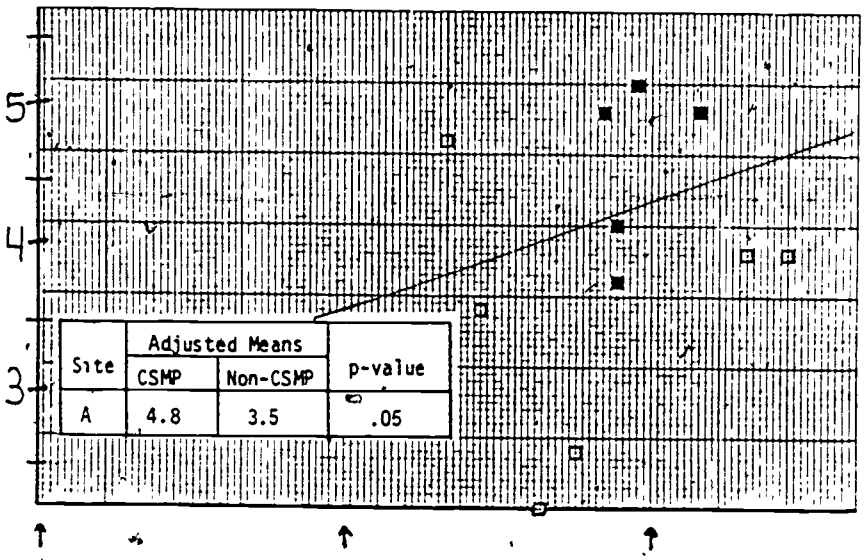
(N14) Fraction and Decimal Computation, Site A

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
$\frac{4}{5} - \frac{1}{5} = \square$	90	89	.71	.60
$\frac{1}{2} + \frac{2}{3} = \square$	33	24	.24	.63
$\frac{5}{7} + \frac{7}{8} = \square$	36	26	.60	.33
$5 - \frac{1}{2} = \square$	69	50	.84	.51
$6.5 + 11 = \square$	66	44	.80	.61
$2 \times 6.5 = \square$	69	42	.95	.67
$6.5 \times 10 = \square$	69	38	.87	.77
$6.5 \div 2 = \square$	38	17	.64	.52
Number of Students	61	66		
KR20 Reliability	.81	.74		
Mean Reading Score	204	19.7		
Correlation: Scale and Reading	.44			

(N14) Fraction and Decimal Computation

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	4.8	3.5	.05

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	05	12
1	11	12
2-3	13	32
4-6	49	34
7	11	08
8	10	02

Comments:

-This was a new scale. Although straight computation of decimals was being assessed in the last four items, the horizontal format was used to avoid giving the students the decimals "lined-up" and ready for rote operations.

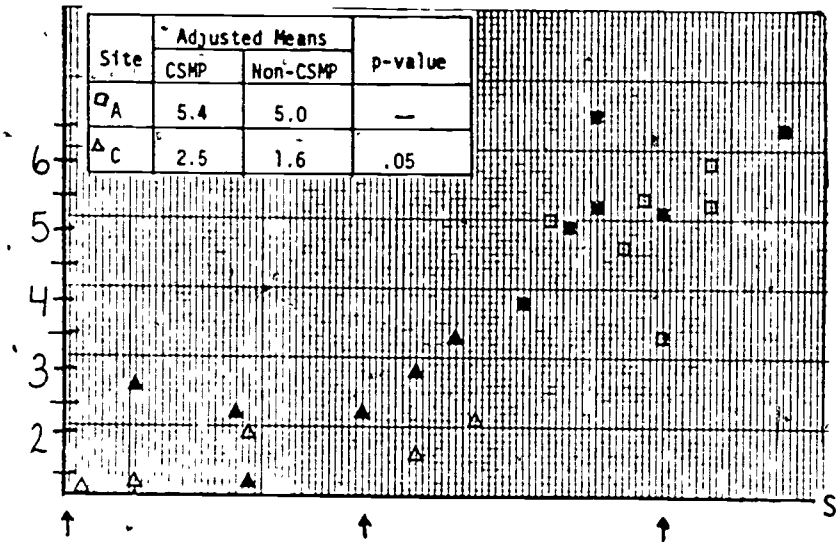
(N134) Approximations with Fractions, Sites A and C

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Sample: $\frac{3}{4} + \frac{3}{4}$ — CHECK ONE. Less than 1 / Exactly 1 / More than 1 ✓				
$\frac{7}{12} + \frac{5}{12}$	76 43	68 45	.92 .28	.46 .38
$\frac{7}{8} \times \frac{7}{8}$	54 06	42 12	.56 .13	.42 .23
$1\frac{5}{8} - \frac{1}{128}$	54 44	52 39	.63 .01	.17 .23
$\frac{1}{2} + \frac{1}{4}$	81 29	77 32	.84 .18	.67 .34
$1\frac{1}{2} - \frac{2}{4}$	56 23	47 34	.59 .24	.53 .36
$8\frac{1}{2} \div 8$	52 39	44 36	.64 .25	.36 .14
$70 - 69\frac{1}{8}$	56 30	53 30	.52 .34	.39 .24
$1\frac{1}{2} \times \frac{2}{3}$	37 27	38 25	.60 .19	.42 .24
$2\frac{1}{2} \div 3$	75 23	47 26	.75 .46	.38 .25
	—			
Number of Students — Site A / Site C	63 86	66 77		
KR20 Reliability	.81 .42	.65 .48		
Mean Reading Score	19.7 16.1	20.3 14.9		
Correlation: Scale and Reading	.28	.34		

(N13) Approximations with Fractions

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means CSMP	Adjusted Means Non-CSMP	p-value
□ A	5.4	5.0	—
△ C	2.5	1.6	.05

Frequency Distribution

Score	% of students CSMP		Non-CSMP	
Site	A	C	A	C
0	07	12	03	15
1	02	16	02	10
2-4	10	59	39	57
5-7	30	13	25	18
8	08	00	05	00
9	06	00	03	00

Site C Means by Ability Level

	1	2	3	4	All
CSMP	3.0	2.7	2.6	1.8	2.5
Non-CSMP	3.3	2.1	1.3	1.3	1.7
t-Stat:	.2	1.0	3.0	1.1	2.6

Comments:

-This was a new scale.

-The graph of class means reveals a probable floor effect due to guessing, which may also account for the low biserials in Site C.

-This was one of the few scales at Site C in which the brief exposure to CSMP may have caused an improvement on MANS performance.

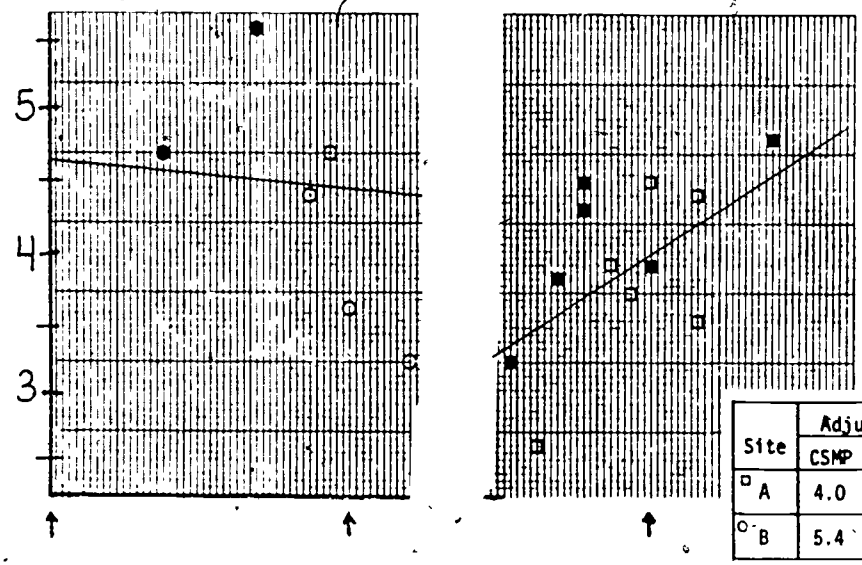
(N4) Decimal Magnitude, Sites A and B

Test Items				Percent Correct C	Percent Correct N	Biserial C	Biserial N
Site A							
Which is Larger (Circle your answer)							
	6.1	or	6.01	83	58	1.09	.65
	4.999	or	5.1	83	83	.85	.42
	0.9	or	0.111	82	58	1.03	.81
	0.01	or	$\frac{1}{1000}$	71	56	.80	.73
	1.75	or	$\frac{3}{2}$	78	77	.60	.15
Site B							
Which is larger?							
	6.1	or	6.01 (Circle one)	78	53	.16	.07
	1.5	or	0.58 (Circle one)	75	34	.55	.24
	4.077	or	4.155 (Circle one)	66	57	-.19	.16
	4.999	or	.5.1 (Circle one)	75	36	-.04	.29
	0.9	or	0.111 (Circle one)	44	11	.18	.26
Number of Students			Site A Site B	63 69	66 80		
KR20 Reliability				.81 .32	.67 .42		
Mean Reading Score				19.7 13.5	20.3 16.2		
Correlation: Scale and Reading				.46 ± .01			

(N4) Decimal Magnitudes

(Student page is shown on the facing page)

Graph of Class Means



Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
Site	A B	A B
0	08	02
1	02	09
2	06	28
3	10	14
4	18	11
5	56	36

Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
□ A	4.0	3.7	—
○ B	5.4	3.3	.01

Note: Sites A and B had different sets of items.

Comments:

-At Site B, the scale was a repeat from fifth grade; at Site A, two of the items were revised. On the three common items, the mean percents correct at Site A were 83 for CSMP versus 66 for Non-CSMP; at Site B they were 66 for CSMP versus 33 for Non-CSMP. Thus, the CSMP students at Site B performed as well as the Non-CSMP students at Site A.

-At Site B, the graph of class means shows a negative relationship with reading and several of the biserials were very low.

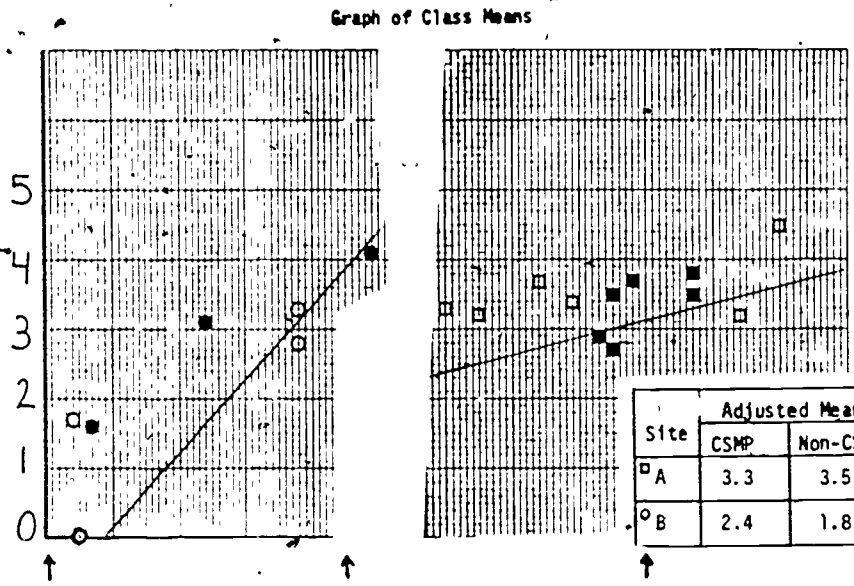
(N8) Which Fraction is Larger, Sites A and B

Test Items		Percent Correct C	Percent Correct N	Biserial C	Biserial N
Which is larger?		Site A Site B			
	$\frac{1}{2}$ or $\frac{1}{3}$	84 67	77 45	.67 1.11	.92 .95
(Site B only)	$\frac{3}{4}$ or $1\frac{1}{4}$	80	61	.40	.44
	$\frac{5}{2}$ or $\frac{5}{4}$	64 53	68 35	64 .98	67 .85
	$\frac{3}{4}$ or $\frac{5}{10}$	75 47	74 16	.60 .71	103 .70
(Site B only)	$\frac{1}{100}$ or $\frac{1}{2}$	60	41	.87	.59
(Site A only)	0.5 or $\frac{4}{7}$	45	52	.41	.46
(Site A only)	$\frac{4}{100}$ or $\frac{3}{50}$	57	70	67	91
Number of Students	Site A Site B	61 30	66 49		
KR20 Reliability		.69 .83	.80 .76		
Mean Reading Score		20.4 14.3	15.7 14.0		
Correlation: Scale and Reading		.18 .59			

(N8) Which Fraction is Larger

Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
Site	A	B	A	B
0	07	10	10	22
1	16	23	09	32
2	11	03	05	06
3	20	07	17	18
4	26	27	22	12
5	26	30	36	10



Site	Adjusted Means CSMP	Adjusted Means Non-CSMP	p-value
□ A	3.3	3.5	—
○ B	2.4	1.8	—

Note: Sites A and B had different sets of items.

Comments:

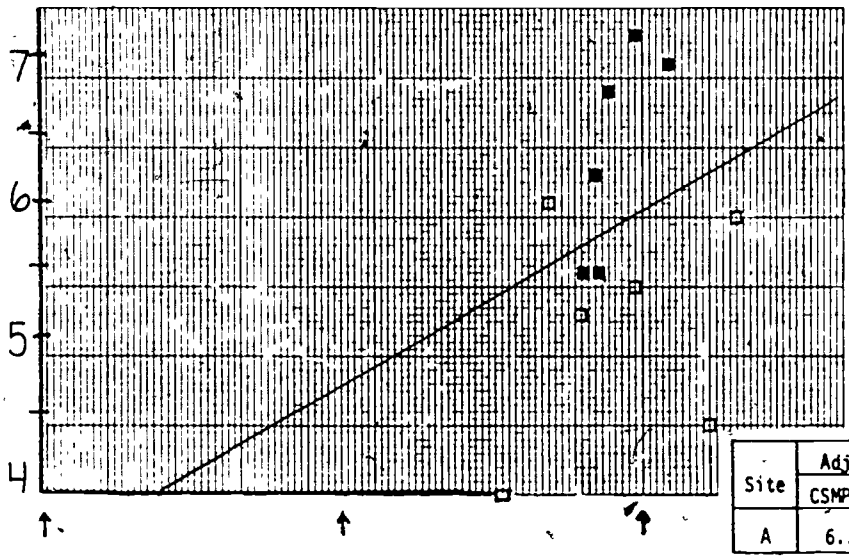
-Like the previous scale dealing with decimals, the Site B scale was a repeat from fifth grade, with two items revised for Site A.

(N11) Ordering Fractions and Decimals, Site A

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Sample; A number that is larger than $\frac{1}{4}$ but smaller than $\frac{3}{4}$ — Fractional Answer $\frac{1}{2}$ — Decimal Answer 0.6				
(Other items used this format.)	FRACT/DEC	F/D	F/D	F/D
Form A				
A number that is larger than $\frac{1}{5}$ but smaller than $\frac{4}{5}$	83/70	90/57	.90/.87	.64/.42
A number that is larger than $\frac{1}{2}$ but smaller than 1.0	77/90	51/35	.81/1.00	.55/.5
A number that is larger than 0.30 but smaller than 0.40	48/70	37/54	1.00/.97	.71/.82
A number that is larger than $\frac{1}{4}$ but smaller than $\frac{1}{2}$	58/53	40/32	.86/.97	.76/.50
A number that is larger than $\frac{1}{4}$ but smaller than 0.4	38/50	10/17	.79/.95	.73/.32
A number that is larger than 0.2 but smaller than 0.3	41/56	16/25	1.02/1.03	.76/.85
A number that is larger than 0.42 but smaller than 0.43	19/23	10/19	.69/.76	1.01/.64
Form B				
A number that is larger than 0.4 but smaller than 0.9	58/82	48/76	.48/.57	69/.70
A number that is larger than $\frac{1}{3}$ but smaller than $\frac{7}{8}$	46/45	58/44	.65/.8	74/.61
A number that is larger than 0.20 but smaller than $\frac{3}{4}$	48/50	48/45	.74/.87	85/.66
A number that is larger than 0.8 but smaller than 1.0	31/50	44/50	.91/.55	.96/.90
A number that is larger than $\frac{1}{4}$ but smaller than $\frac{1}{3}$	08/18	18/15	.80/.79	.69/.78
A number that is larger than 0.6 but smaller than $\frac{2}{3}$	06/10	11/11	1.05/1.15	.73/.75
A number that is larger than $\frac{7}{8}$ but smaller than 1.0	23/19	21/24	.82/.99	.81/.81
Number of Students — Form A / Form B	64/62	63/66		
KR20 Reliability	.91/.82	.81/.86		
Mean Reading Score	20.0	20.0		
Correlation: Scale and Reading	.30			

(N11) Ordering Fractions and Decimals

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	6.3	5.0	.02

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
	FORM A B	A B
0	12 06	08 12
1	02 10	06 11
2-7	38 63	67 47
8-13	41 19	17 28
14	07 02	02 02

Comments:

-This was a new scale. The particular items chosen were intended to be fairly difficult and the mean percent correct across the 28 items was about 40.

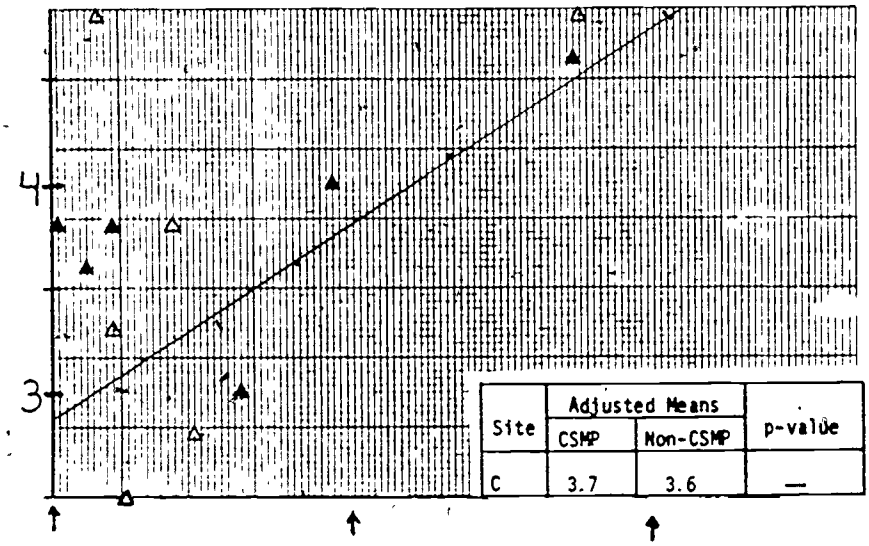
(N17) Fraction and Decimal Order, Site C

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Which is larger?				
$\frac{1}{2}$ or $\frac{1}{3}$ (Circle one)	23	38	.39	.50
(Other items followed this format)				
$\frac{3}{4}$ or $1\frac{1}{4}$	69	56	.37	.09
$\frac{5}{2}$ or $\frac{5}{4}$	21	35	.40	.60
1.5 or 0.58	52	39	.23	.40
6.01 or 6.1	34	44	.40	.55
0.9 or 0.111	30	25	.38	.80
0.5 or $\frac{4}{7}$	55	55	.19	.24
1.75 or $\frac{3}{2}$	62	61	.06	.02
0.01 or $\frac{1}{1000}$	27	14	.19	.15
Number of Students	86	77		
KR20 Reliability	.49	.57		
Mean Reading Score	15.7	15.1		
Correlation: Scale and Reading	.24			

(N17) Fraction and Decimal Order

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	3.7	3.6	—

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	07	12
1	03	03
2-3	35	29
4-6	50	47
7	02	08
8	03	01

Means by Ability Level

	1	2	3	4	All
CSMP	4.6	3.7	3.4	3.8	3.8
Non-CSMP	5.4	3.6	3.3	3.1	3.6
t-Stat.	.3	.0	-.2	1.3	.3

Comments:

-This scale was a new scale administered only at Site C, but was essentially a combination of items similar to those in N4 and N8. There were 4 items in common to the three sites. The mean percent correct on these four common items were:

	CSMP	Non-CSMP
A	78	65
B	61	35
C	27	36

Again the performance by CSMP students at Site B is very strong; but at Site C, the brief CSMP exposure did not help.

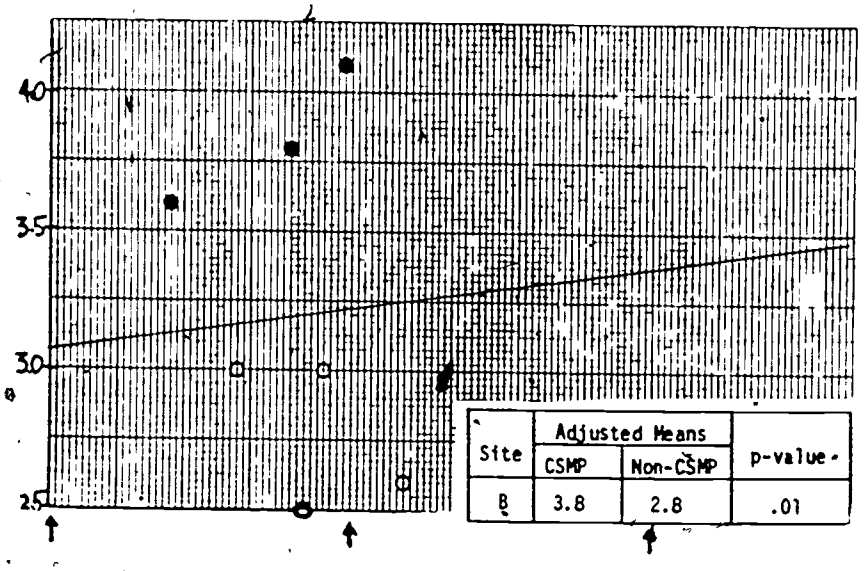
(N1) Decimal Gas, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
1. Peter has 6.5 gallons. Then he spills 1.2 gallons. How much gas will he have left? _____	91	80	.87	.64
2. Tom has 6.5 gallons. He buys 3.5 more gallons. How much gas will he have then? _____	88	63	.13	.30
3. John has 6.5 gallons. He uses up four gallons. How much gas will he have left? _____	58	39	.73	.59
4. Bill has 6.5 gallons. He buys another half gallon. How much gas will he have then? _____	31	11	.93	.69
5. Ron has 6.5 gallons. Next week he will use ten times this much. How much gas will he use next week? _____	47	38	.69	.65
6. Joe has 6.5 gallons. He sells each gallon for $2. How much money will he get altogether? _____	38	10	.73	.39
7. Ken has 6.5 gallons of gas. He gives away half of it. How much gas will he have left? _____	25	10	.91	.39
Number of Students	64	87		
KR20 Reliability	.75	.64		
Mean Reading Score	14.5	15.6		
Correlation: Scale and Reading	.42			

(N1) Decimal Gas

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	3.8	2.8	.01

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	00	11
1	06	13
2-3	48	48
4-5	19	24
6	11	03
7	16	01

Means by Ability Level

	1	2	3	4	All
CSMP	4.7	4.4	3.7	2.3	3.7
Non-CSMP	4.0	3.1	2.4	1.3	2.5
t-Stat.	0.8	2.1	2.5	3.0	4.2

Comments:

-This scale was repeated from last year where a similar large difference in favor of CSMP was found.

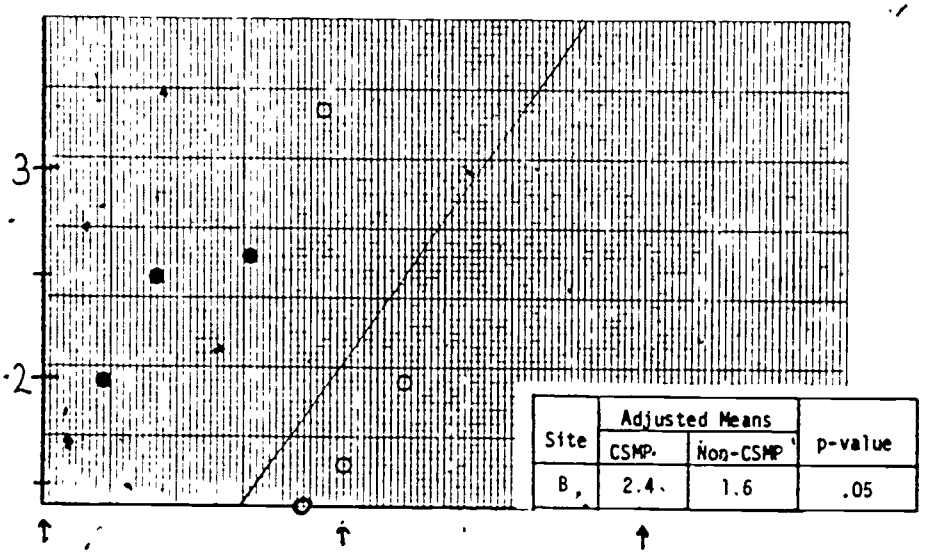
(N9) Fractional Word Problems, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Complete the sentences:				
$\frac{1}{2}$ of a 40-pound bag of dog food is _____ pounds.	72	45	.20	.41
$\frac{1}{4}$ of a 200-page book is _____ pages.	66	38	.35	.26
$\frac{1}{3}$ of a dozen eggs is _____ eggs.	38	9	.58	.22
$\frac{3}{4}$ of a dollar is _____ cents.	44	32	.53	.32
$\frac{2}{3}$ of a 30-ounce bottle is _____ ounces.	38	38	.41	.20
Number of Students	32	47		
KR20 Reliability	.56	.41		
Mean Reading Score	13.5	16.2		
Correlation: Scale and Reading	.29			

(N9) Fractional Word Problems

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	2.4	1.6	.05

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	06	21
1	25	26
2	16	34
3	34	11
4	06	06
5	13	02

Comments:

-This scale was repeated from fifth grade. The performance by Non-CSMP classes seems rather poor given the nature of the items (e.g., 3/4 of a dollar answered correctly by only 32% of the students).

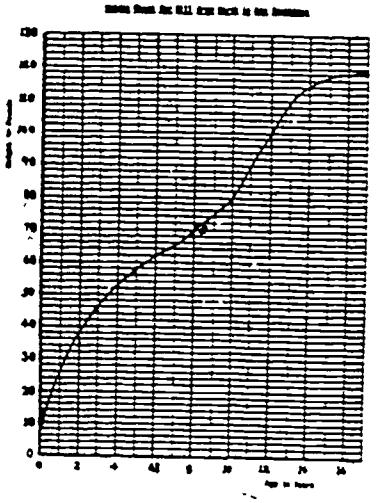
0: Organization and Interpretation of Data Category

Only one scale was used, in Site B, and it was a repetition from the fifth grade 1980 study.

(01) Weight Graph, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Sample. How much did Bill weigh at 12 years of age? _____				
1. How much did Bill weigh at 8 years of age? _____	94	91	.54	.92
2. How old was Bill when he reached 80 pounds? _____	98	91	.13	.79
3. How much did Bill weigh at 13 years of age? _____	89	87	.44	.71
4. How much did Bill weigh at 2 years of age? _____	30	14	.60	.49
5. How much did Bill weigh at 7 years of age? _____	25	22	.18	.36
6. How much did Bill weigh at $5\frac{1}{2}$ years of age? _____	59	48	.55	.45
7. How old was Bill when he reached 90 pounds? _____	83	68	.59	.48
8. How old was Bill when he reached 50 pounds? _____	45	44	.62	.57
9. How much do you think Bill will weigh when he gets to be 18? _____	19	13	.23	-.03
10. For how many years was Bill between 50 and 70 pounds? (Circle one) $3\frac{1}{2}$ 4 years $4\frac{1}{2}$ years 5 years $5\frac{1}{2}$ years	11	8	.14	.02
Number of Students	64	87		
KR20 Reliability	.60	.65		
Mean Reading Score	14.5	15.6		
Correlation: Scale and Reading	.35			

(01) Weight Graph



(Questions are shown on the facing page.)

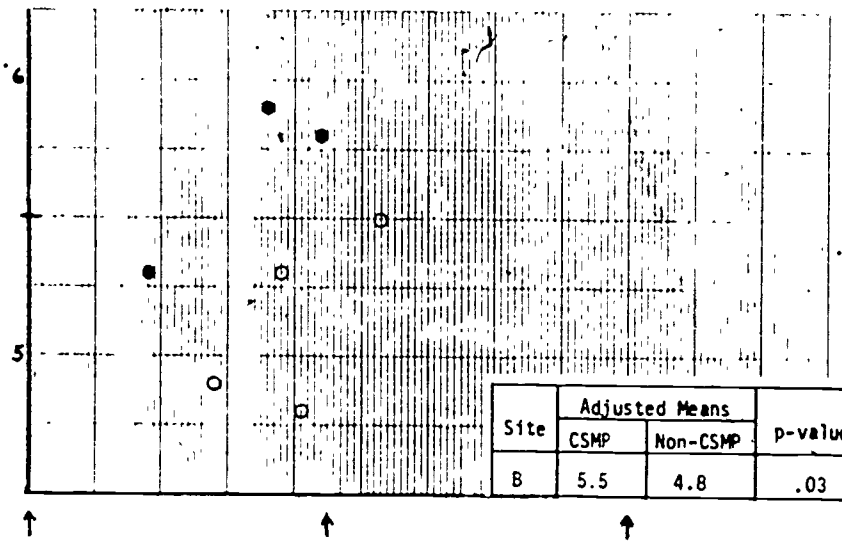
Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	00	05
1	02	01
2-4	27	33
5-8	69	62
9	02	00
10	00	00

Means by Ability Level

	1	2	3	4	All
CSMP		6.6	5.2	4.5	5.5
Non-CSMP		5.5	4.9	4.3	4.8
t-Stat.		1.9	.5	.4	2.2

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	5.5	4.8	.03

P: Probability Category

Two scales administered at Site B were repetitive from fifth grade. Two new scales were created and administered at Site A.

(P1) 100 Outcomes, Site B

Test Items			Percent Correct C	Percent Correct N	Biserial C	Biserial N
(A range of answers was allowed for a)-d), i.e., for (a) 11-13 was counted as correct, for (b) 14-16, and so on. But students were not told a range was allowable.)	Game 1	a) Black	21	26		
		b) White	36	41		
		c) Shaded	21	22		
		d) Not white	23	19		
		b<a and b<c	48	55		
		a=c	50	43		
		a=2b or c=2b	28	25		
		d=100-b or d=a+c	40	30		
	Game 2	a) Black	45	44		
		b) White	33	22		
		c) Shaded	50	47		
		d) White or shaded	18	19		
		c<b	61	63		
		c<a	56	71		
		a=3c	31	26		
		b=6c	26	20		
		b=2a	36	32		
		d=100-a or d=b+c	20	30		
	Game 3	a) Black	35	40		
		b) White	43	45		
		c) Shaded	35	26		
		a<c, b<c	60	62		
		a=b	40	41		
		c=2b or c=2a	36	29		
If you want black to win, which game should you play? (Circle your answer)		Game 1				
		Game 2	36	33		
		Game 3				
Number of Students			50	58		
Mean Reading Score			13.9	15.0		
Correlation: Scale and Reading			.42			

(P1) 100 Outcomes

Game 1. Joe plays the game with marbles and a bag. He closes his eyes and takes a marble out. Then he puts it back.

SUPPOSE JOE PLAYED THE GAME 100 TIMES

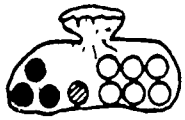
About how many times would he get a black marble? _____

About how many times would he get a white marble? _____

About how many times would he get a shaded marble? _____

About how many times would he get a marble that is not white? _____

Game 2. He plays the same game with different marbles.



SUPPOSE JOE PLAYED THE GAME 100 TIMES

About how many times would he get a black marble? _____

About how many times would he get a white marble? _____

About how many times would he get a shaded marble? _____

About how many times would he get a marble that is white or shaded?

Game 3. Joe plays the game by spinning the spinner.

SUPPOSE JOE PLAYED THE GAME 100 TIMES

About how many times would it point to the black part? _____

About how many times would it point to the white part? _____

About how many times would it point to the shaded part? _____

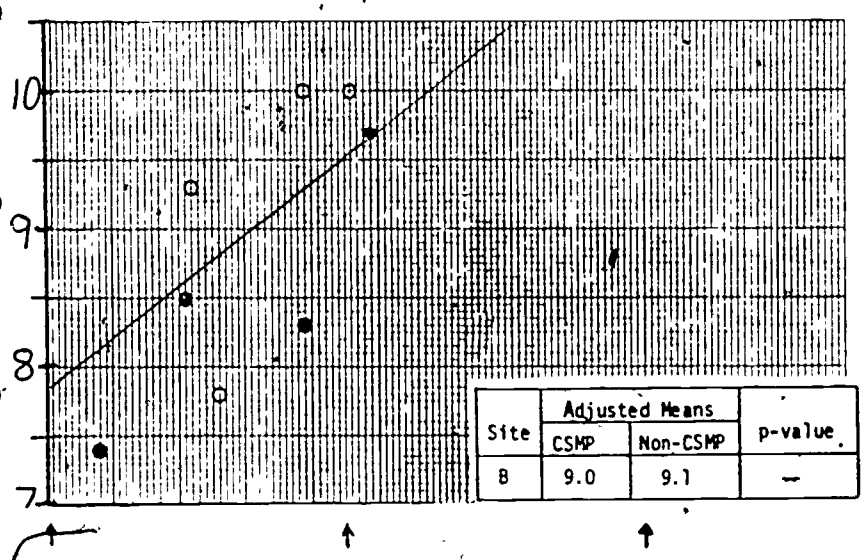
Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	05	05
1-4	30	20
5-9	25	31
10-14	18	24
15-19	13	15
20-23	03	04
24	05	03

Means by Ability Level

	1	2	3	4	All
CSMP	9.4	9.6	8.6	5.9	9.2
Non-CSMP	14.4	12.3	7.0	6.5	9.1
t-Stat.	-.8	-.9	.7	-.4	.0

Graph of Class Means

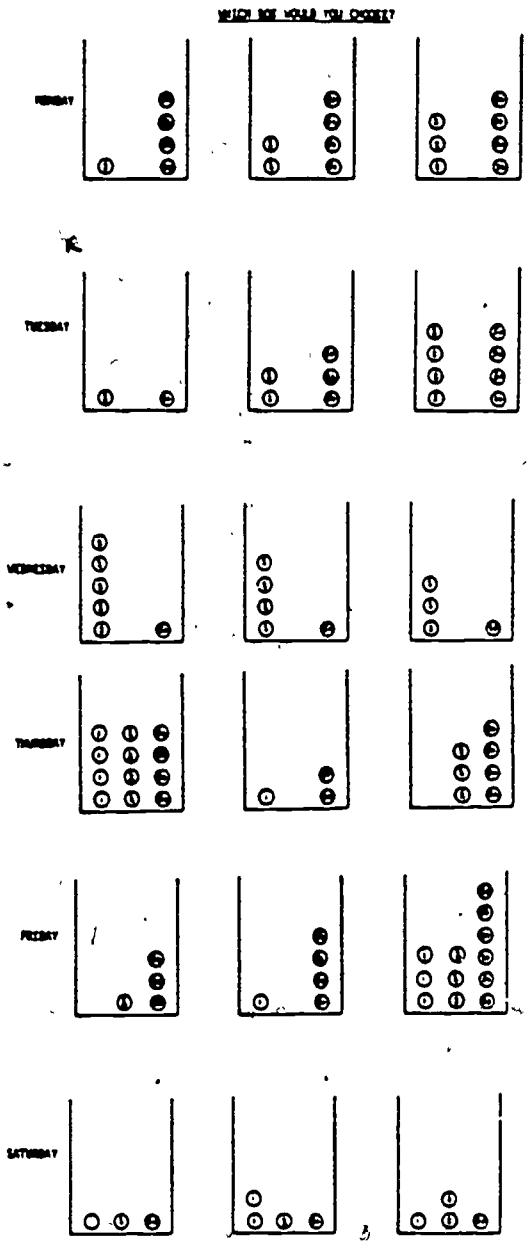


Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	9.0	9.1	—

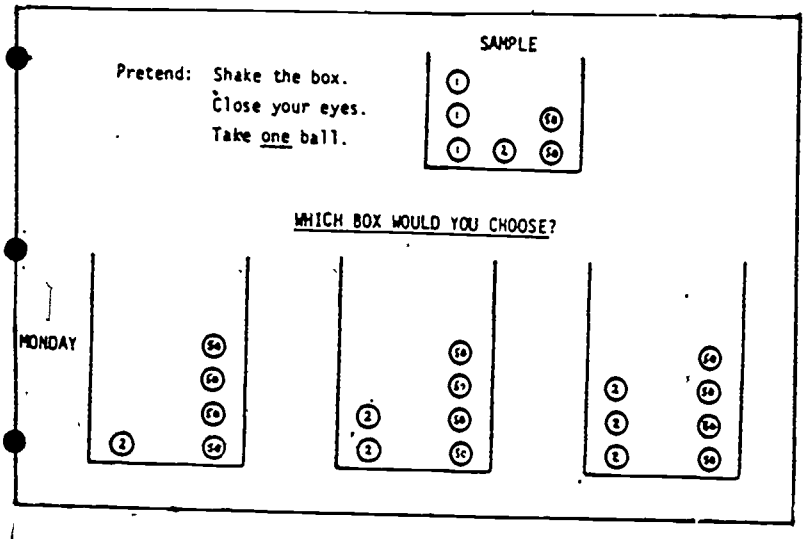
Comments:

-Non-CSMP students improved somewhat from their fifth grade performance; CSMP students very little.

(P3) Which Box, Site B

Test Items (See facing page.)	Percent Correct C	Percent Correct N	Biserial C	Biserial N
				
MONDAY	67	56	.93	1.00
TUESDAY	65	49	.63	.69
WEDNESDAY	64	51	.78	.83
THURSDAY	65	47	.80	.93
FRIDAY	57	40	.84	.69
SATURDAY	64	52	.50	.81
Number of Students	72	89		
KR20 Reliability	.82	.86		
Mean Reading Score	13.9	15.3		
Correlation: Scale and Reading	.33			

(P3) Which Box



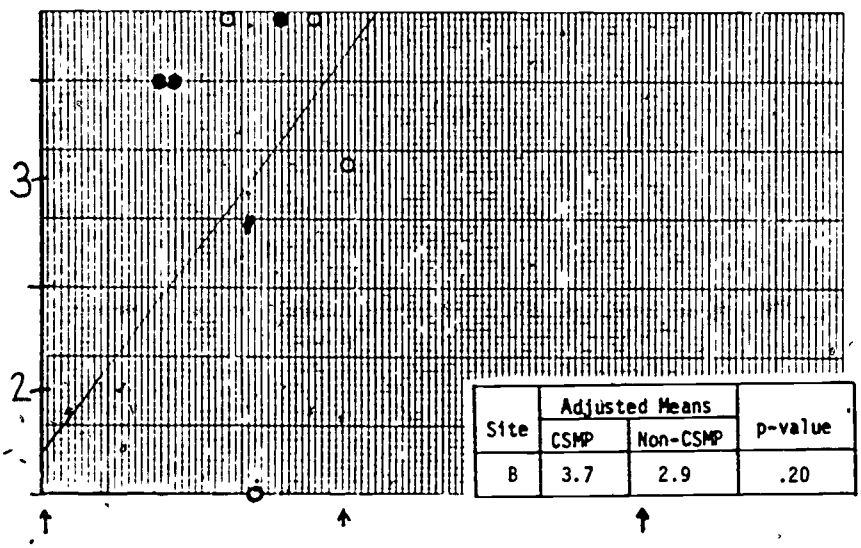
Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	11	25
1	08	10
2-4	35	29
5	15	16
6	31	20

Means by Ability Level

	1	2	3	4	All
CSMP	4.2	5.0	3.6	2.5	3.8
Non-CSMP	4.4	3.6	2.6	2.0	3.0
t-Stat.	-.2	-2.2	.5	.6	2.4

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	3.7	2.9	.20

Comments:

-The CSMP advantage was due mainly to one very low scoring Non-CSMP class.

-The frequency distributions were somewhat U-shaped; many students got no more than one correct but also many students got all six correct.

(P4) Dependent Outcomes, Site A

Test Items (See facing page.)	Percent Correct C	Percent Correct N	Biserial C	Biserial N
(These items were scored for the exact answer except for the last item which was scored for a range of 5.) Form A				
	45	22	.64	.71
	44	19	.72	.83
	78	49	.77	.65
I.	20	25	.15	.30
	77	59	.54	.30
	02	05	.19	.59
	61	41	.58	.46
	52	25	.49	.73
II.	08	05	.38	.13
	13	14	.37	.63
	03	13	-.20	21
Form B				
	48	29	.55	.77
	76	56	.86	.76
I.	61	50	.56	.85
	26	11	.71	.57
	40	33	.64	.41
	02	00	-.39	0
	53	53	.43	.46
	44	27	.66	.70
II.	77	50	.49	.75
	29	27	.79	.83
	00	00	0	0
Number of Students	120	129		
KR20 Reliability	.73	.75		
Mean Reading Score	20.0	20.0		
Correlation: Scale and Reading	.29			

(P4) Dependent Outcomes

Rules

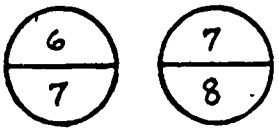
I. Spin 2 spinners.

Add together the numbers the 2 spinners point to.

You win if they add to 15 or more.

Play the game 100 times.

If you played with these spinners:



How many times do you think you would win out of 100?

_____

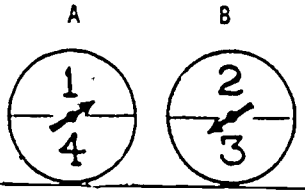
II. **Rules**

Spin 2 spinners.

You win if Spinner A points to a larger number than Spinner B.

Play the game 100 times.

If you played with these 2 spinners:



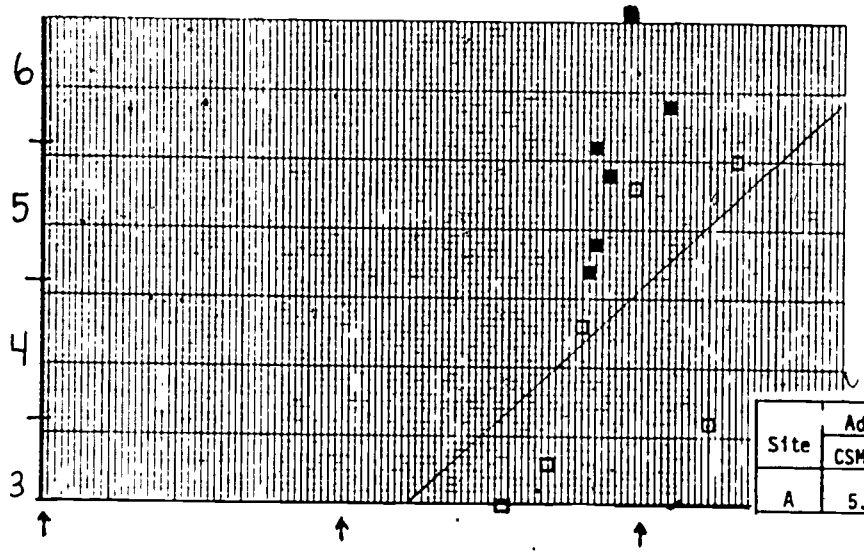
How many times do you think you would win out of 100?

_____

Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
	Form A	B	A	B
0	11	03	14	17
1	05	15	25	17
2-5	56	48	46	45
6-9	28	34	15	21
10	00	00	00	00
11	00	00	00	00

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	5.4	4.0	.01

Comments:

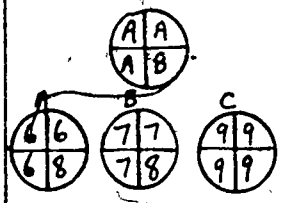
-There were five items where it could be deduced that every result would be a win (or a loss); for example, the spinners in the third item had to point to numbers which added to at least 15. The mean percents correct for these four items were 74 for CSMP versus 53 for Non-CSMP.

-There were four items in which the spinners were divided disproportionately, for example the sixth item. The mean percents correct for these four items were 4 for CSMP and 5 for Non-CSMP. Answers almost always underestimated the multiplicative effect (i.e., very few answers to the sixth item reflected the small probability (1/16) of winning.

-There were seven other items in which only one spinner mattered, for example the seventh item where the result of the first spinner determines whether there is a win. On these seven items, the mean percents correct were 34 for CSMP versus 28 for Non-CSMP.

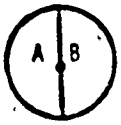
-An incorrect strategy used by some students was to match only the upper numbers and the lower numbers but not upper with lower.

(P5) Conditional Probability, Site A

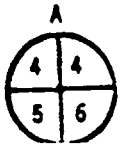
Test Items (See facing page.)		Percent Correct C	Percent Correct N	Biserial C	Biserial N
(Common to Both Forms) Game 1 (See next page)	If you play 100 times-- How many times do you think you would get 4? _____	65	66	.61	.44
	How many times do you think you would get 5? _____	46	42	.71	.62
	How many times do you think you would get 6? _____	52	41	.59	.64
Form A Game 2 	How many times do you think you would get 6? _____	16	21	.53	.29
	How many times do you think you would get 7? _____	22	17	.605	.40
	How many times do you think you would get 8? _____	44	53	.17	.10
	How many times do you think you would get 9? _____	48	53	.58	.67
Form B Game 2 (See next page)	How many times do you think you would get 6? _____	52	58	.61	.44
	How many times do you think you would get 7? _____	56	53	.82	.71
	How many times do you think you would get 8? _____	43	48	.52	.46
(These items were scored with a range of allowable answers, i.e., 45-55 for item 1.)					
Number of Students	Form A	63	66		
	Form B	61	66		
KR20 Reliability		84	73		
		76	.45		
Mean Reading Score		20.0	20.0		
Correlation: Scale and Reading		.25			

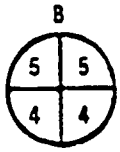
(P5) Conditional Probability

Rules to play Game 1.

1. First spin this spinner 

2. Then: if you get A, spin Spinner A OR if you get B, spin Spinner B

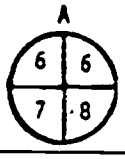


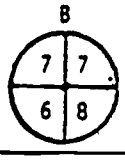


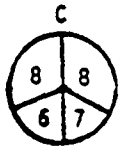
Rules to play Game 2

1. First spin this spinner 

2. If you get A, spin Spinner A OR if you get B, spin Spinner B OR if you get C, spin Spinner C



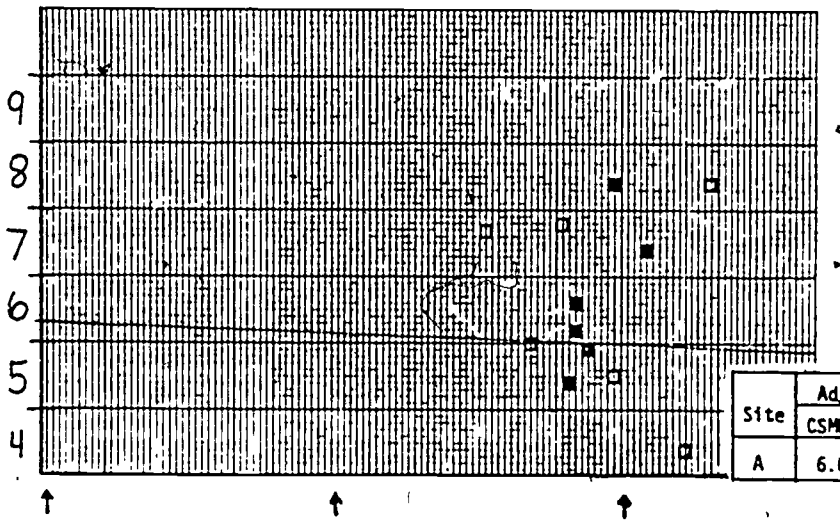




Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
	Form A	B	A	B
0	08	07	03	02
1	01	02	06	03
2-6	50	41	50	43
7-11	35	50	37	50
12-15	05	00	04	02
16-19	01	X	00	X

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
A	6.0	6.1	—

Comments:

-A range of answers was allowed for each item.

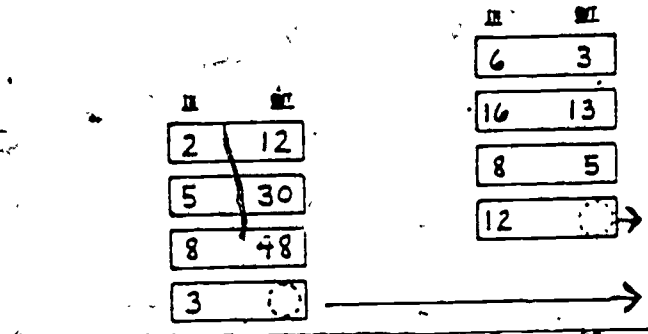
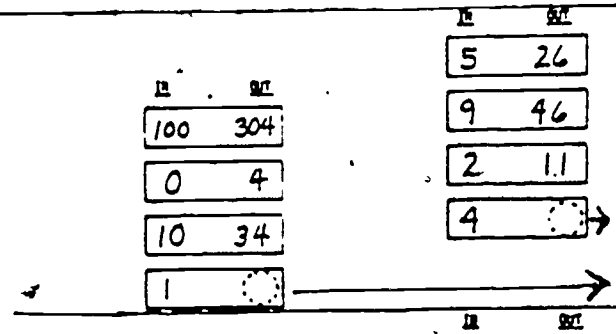
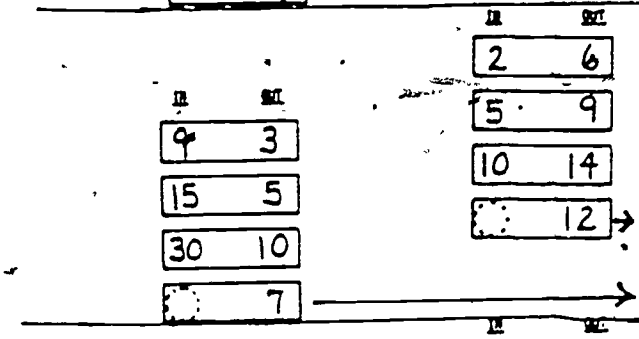
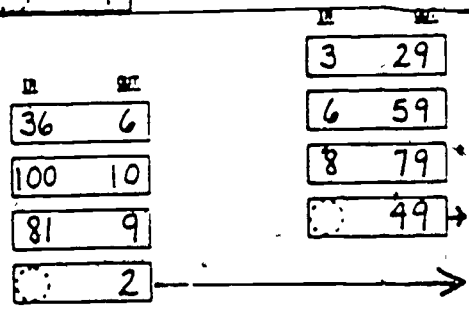
-In Game 2 of Form A it was impossible to get 7 because Spinner C could never be "chosen". Only about half the students got this answer right, a possible indication of the task being misunderstood. In fact all four questions of this game were poorly done.

-Although the student page is shown, the scale was scored for additional information, i.e., whether the percent given was greater for 4, than 5, for a total of 19 possible Form A and 15 possible Form B. The frequency distribution shows the range of students' answers.

R: Number Relations Category

Three of the scales R1, R2 and R5 were either repetitions or revisions of previously used scales. R6 and R7 were new scales.

(R1) Solving Number Rules, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
	78	67	.86	.47
	72.	57	.91	.81
	78.	67	.84	.76
	44	24	.78	.45
	80	66	.75	.69
	36	17	.61	.56
	67	53	.63	.74
	53	38	.51	.34
Number of Students	64	87		
KR20 Reliability	.82	.76		
Mean Reading Score	14.5	15.6		
Correlation: Scale and Reading	.42			

(R1) Solving Number Rules

(Items from the student page are shown on the facing page.)

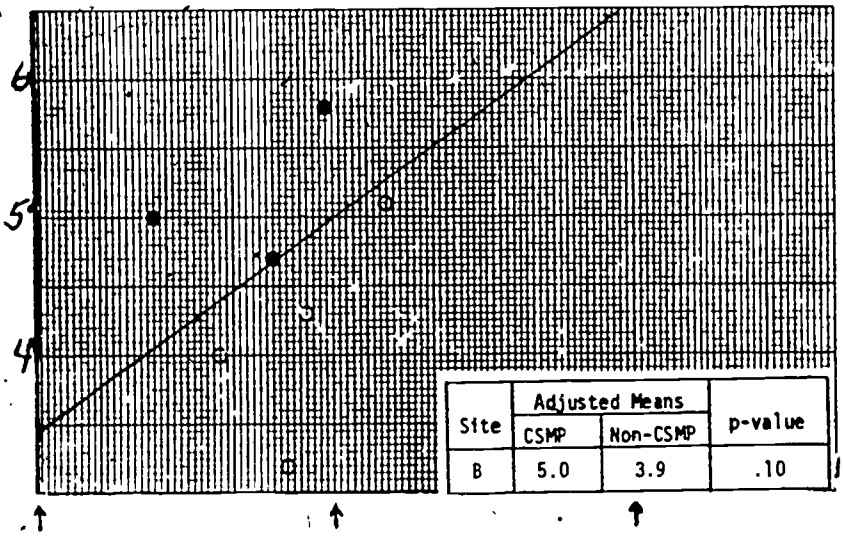
Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	06	09
1	05	10
2-3	17	25
4-6	38	42
7	16	09
8	18	05

Means by Ability Level

	1	2	3	4	All
CSMP	6.5	6.2	4.8	2.9	5.0
Non-CSMP	5.9	4.4	3.5	3.7	3.9
t-Stat.	1.0	2.0	1.9	-1.1	2.8

Graph of Class Means

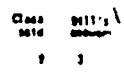
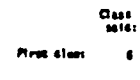
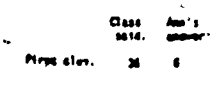
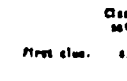
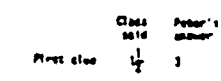
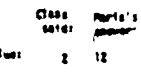
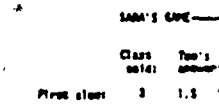
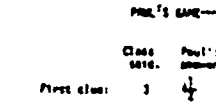


Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	5.0	3.9	.10

Comments:

-For the two Number Relationships scales administered at Site B (this one and R2, page A121) both CSMP and Non-CSMP students improved by about 50%. In both years, the CSMP advantage in this category was significant.

(R1[1]) Solving Number Rules, Site C

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Form A — BILL'S GAME → 	17	27	.38	.46
MARY'S GAME → 	52	44	.31	.42
ANN'S GAME → 	19	23	.61	.64
SUSAN'S GAME → 	05	06	.77	.60
PETER'S GAME → 	05	05	.33	-.01
Form B — PAULA'S GAME → 	47	46	.40	.16
JAN'S GAME → 	04	10	.05	.41
SARA'S GAME → 	04	00	.76	00
PAUL'S GAME → 	07	11	.71	.18

(One item in Form B was not scored because of an error in the item.).

	Form A	Form B
Number of Students	93	77
	68	70
KR20 Reliability	56 .42	53 .24
Mean Reading Score	15.8	14.9
Correlation: Scale and Reading	.24	

(R1[1]). Solving Number Rules

(Student page is shown on the facing page.)

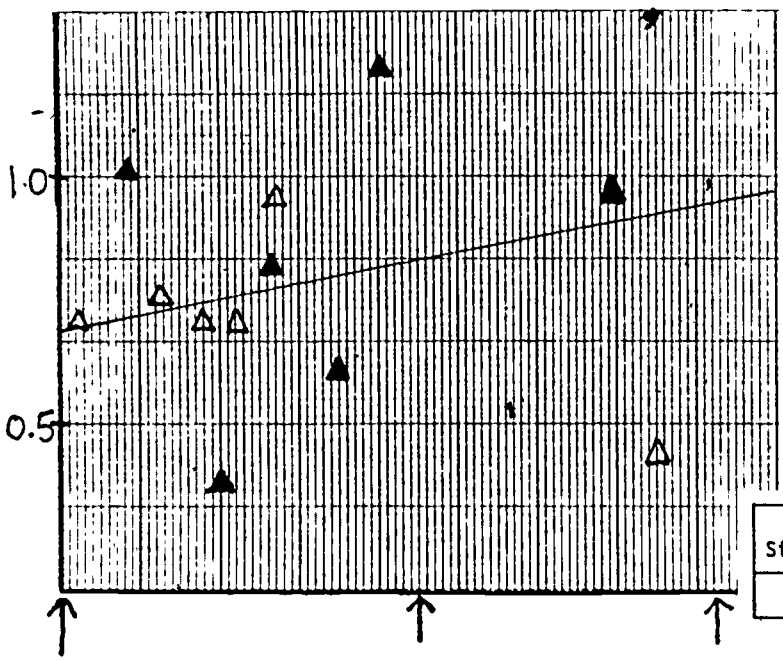
Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
	Form A	B	A	B
0	38	51	40	46
1	38	37	29	44
2	17	09	19	07
3	04	03	00	03
4	02	00	08	00
5	01	X	04	X

Means by Ability Level

	1	2	3	4	All
CSMP	1.4	0.8	1.0	0.7	.9
Non-CSMP	1.1	0.9	0.7	0.6	.8
t-Stat.	1.2	-0.9	.9	.3	.8

Graph of Class Means



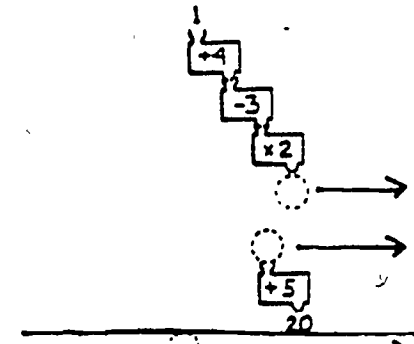
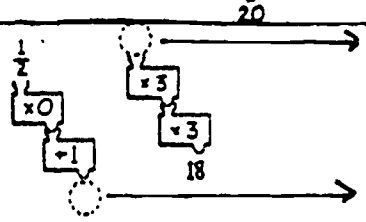
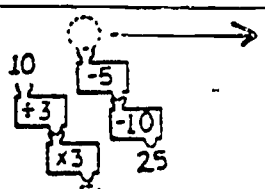
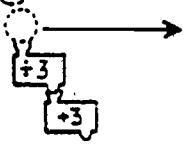
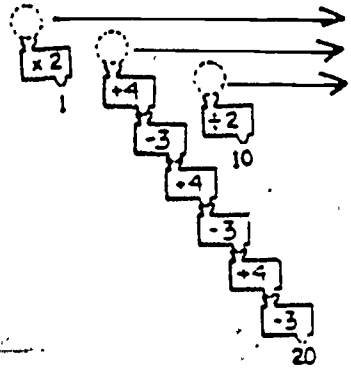
Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	0.8	0.7	—

Comments:

-The format and instructions were somewhat different from those of the previous scale (R1) and were changed to make the task simpler. However, on the five common items the mean percents correct at Site B (R1) were 61 for CSMP versus 46 for Non-CSMP; at Site C they were only 28 and 30. It's hard to explain the Non-CSMP difference between sites.

-The preformance on the fraction and decimal items was extremely poor.

(R2) Using Number Machines, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
	97	84	.32	.46
	95	91	.25	.71
	75	67	.54	.66
	53	46	.50	.32
	69	55	.61	.79
	14	05	.58	.16
	48	38	.62	.68
	61	51	.76	.69
	48	17	.67	.19
	28	06	.62	.40
Number of Students	64	87		
KR20 Reliability	.74	.71		
Mean Reading Score	14.5	15.6		
Correlation: Scale and Reading	.47			

(R2) Using Number Machines

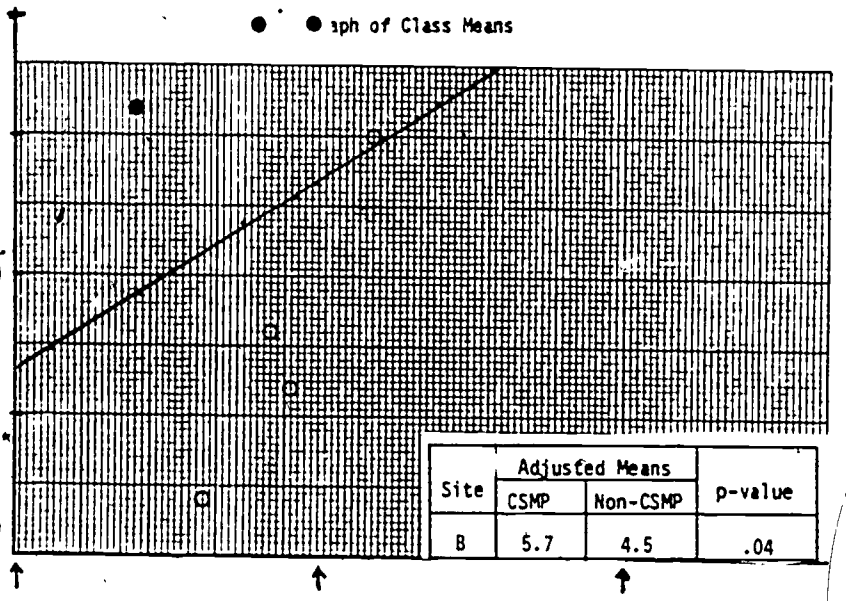
(Items from student page shown on the facing page.)

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	00	05
1	02	03
2-4	32	39
5-8	55	52
9	08	01
10	03	00

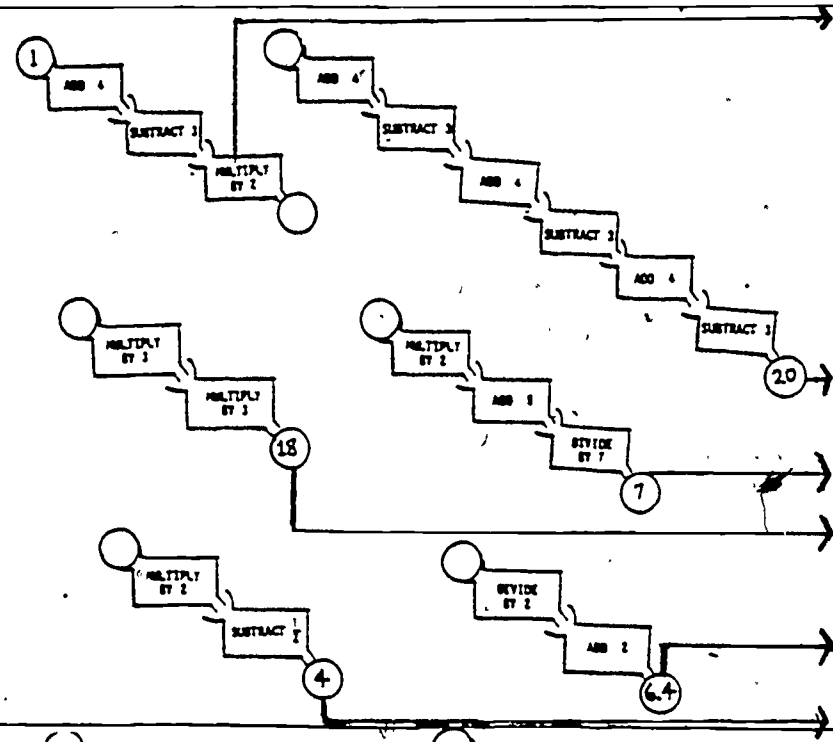
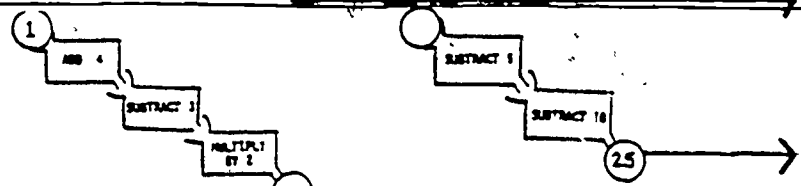
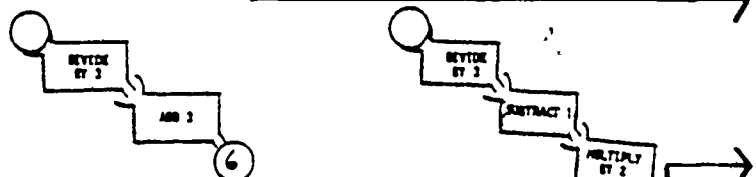
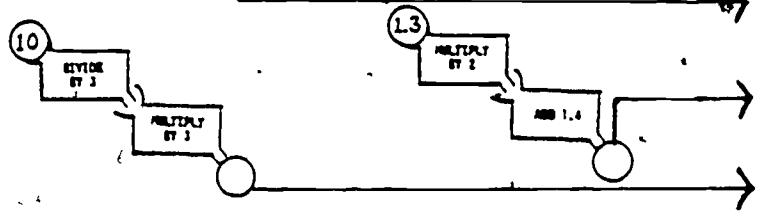
Means by Ability Level

	1	2	3	4	All
CSMP	7.4	6.6	5.5	4.0	5.8
Non-CSMP	6.7	4.9	4.3	3.2	4.6
t-Stat.	1.0	2.0	1.6	1.1	3.3



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	5.7	4.5	.04

(R2[1]) Using Number Machines, Site C

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Form A				
	84	84	-.01	.23
				.1
	12	16	-.10	.18
	06	01	.69	-.15
	38	30	.21	.18
	02	00	.58	00
	01	00	.28	00
Form B				
	46	49	.42	.58
	90	86	.34	.42
	19	14	.79	.86
	32	27	.57	.48
	30	14	.11	.49
	03	04	.12	.28
Number of Students	Form A	93	77		
	Form B	48	70		
KR20 Reliability		.22	.19		
		.52	.61		
Mean Reading Score		16.1	15.1		
Correlation: Scale and Reading		.34			

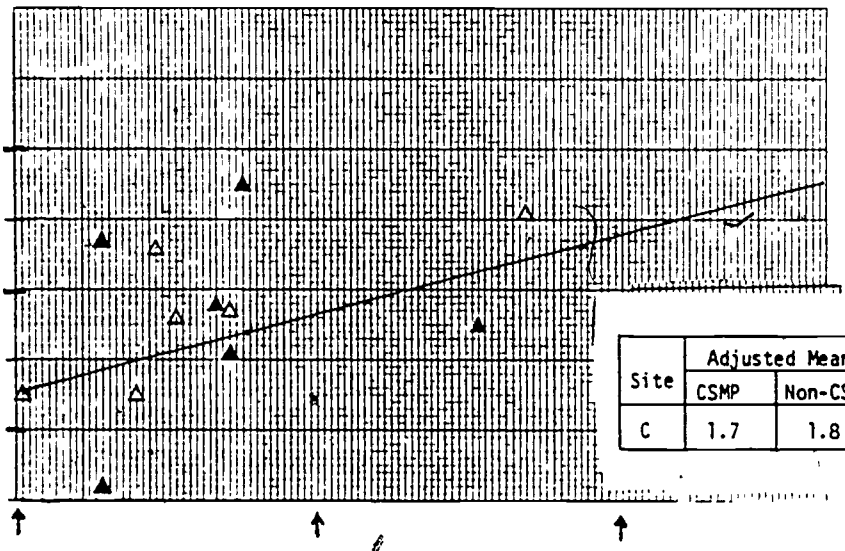
(R2') Using Number Machines

(Items from student page shown on the facing page.)

Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
	FORM A	B	A	B
0	10	07	13	11
1	48	25	48	30
2	34	34	34	30
3	06	16	05	16
4	02	12	00	09
5	00	06	00	03
6	00	00	00	01

Graph of Class Means



Means by Ability Level

	1	2	3	4	All
CSMP	2.2	2.1	1.8	1.3	1.8
Non-CSMP	2.5	2.6	1.7	1.3	1.8
t-Stat.	.1	.1	.3	.3	.1

Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
C	1.7	1.8	—

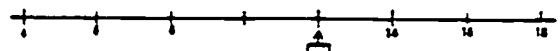
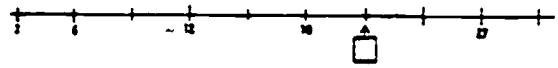
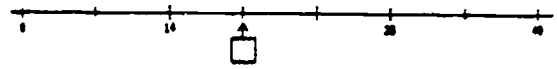
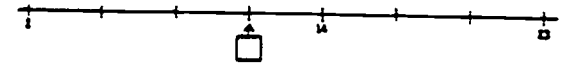
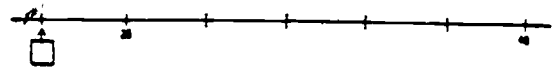
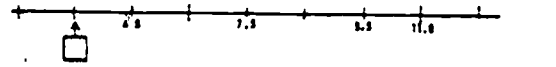
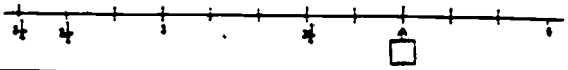
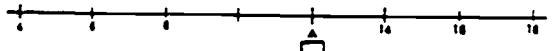
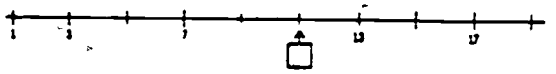
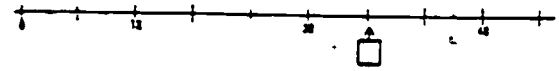
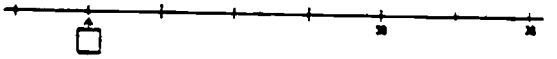
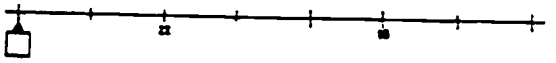
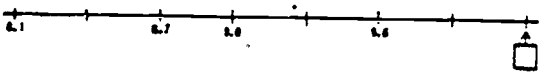
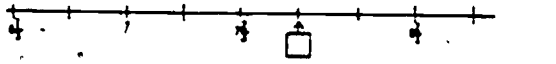
Comments:

-On the five items common to this scale and the last one (R2), the mean percents correct at Site B were 66 for CSMP versus 52 for Non-CSMP; Site C they were 43 and 41.

-Performance on the fraction and decimal items was very poor.

-The reliability for Form A was very low, probably because Form A was so much harder than Form B (see also the frequency distributions).

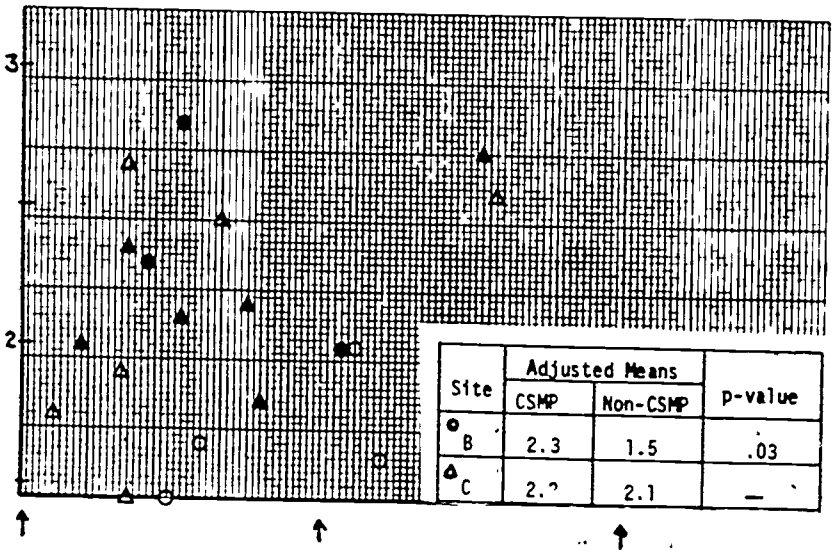
(R5) Labelling Number Lines, Sites B and C

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Form A				
Sample 				
	92 85	96 90	.03 .41	.68 .40
	76 66	76 61	.66 .28	.28 .52
	47 26	37 23	.72 .53	.31 .56
	23 08	11 09	.68 .15	.63 .63
	08 01	00 03	.58 .41	.00 .21
	18 09	15 12	.63 .22	.37 .21
Form B				
Sample 				
	91 85	76 75	.28 .33	.36 .34
	64 59	70 50	.52 .32	.76 .30
	24 11	09 10	.50 .48	.97 .51
	29 25	26 28	.21 .33	.19 .10
	18 14	19 18	.52 .43	.69 .33
	35 25	33 24	.34 26	.05 .55
Number of Students	36 84	45 79		
KR20 Reliability	.60 .45	.48 .47		
Mean Reading Score	14.9	15.2		
Correlation: Scale and Reading	.31	.18		

(R5) Labelling Number Lines

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
○ B	2.3	1.5	.03
△ C	2.?	2.1	—

Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
Sites	A	B	A	B
0	05	06	04	07
1	16	24	09	16
2	32	35	50	42
3	16	15	28	19
4	18	18	02	07
5	13	02	07	07
6	00	06	00	02

Site B Means by Ability Level

	1	2	3	4	All
CSMP	3.3	3.2	2.4	1.8	2.6
Non-CSMP	3.0	2.5	2.4	2.2	2.3
t-Stat.	.4	1.1	-.2	-1.1	1.4

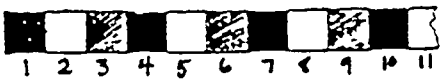
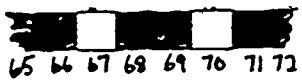
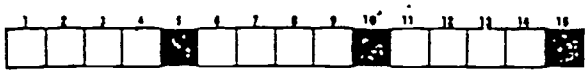
Site C Means by Ability Level

	1	2	3	4	All
CSMP	2.4	2.1	2.2	2.0	2.2
Non-CSMP	2.5	2.5	2.0	1.6	2.1
t-Stat.	.1	1.5	.6	1.5	.1

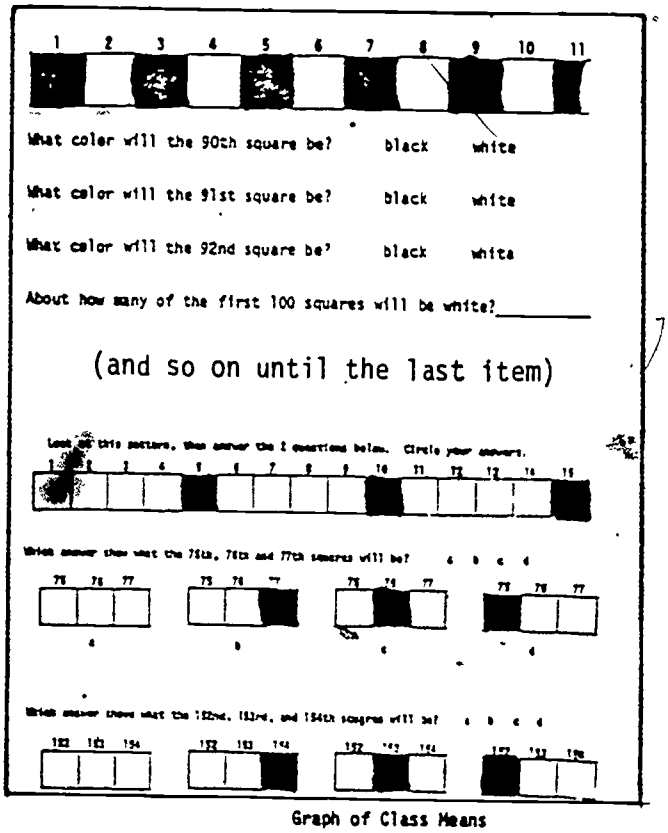
Comments:

-It is hard to explain the higher scores in Site C for Non-CSMP students for Non-CSMP students in Site B.

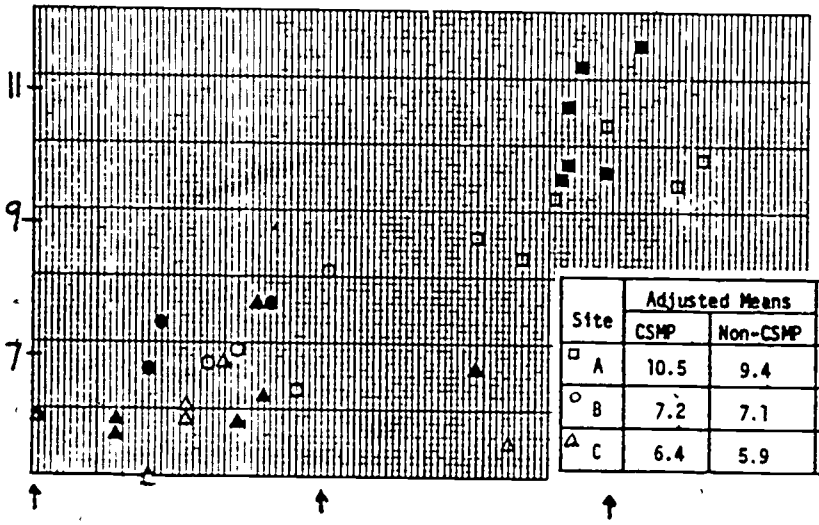
(R6) Colored Squares Site A, B, and C

Test Items (See facing page.)		Site A Percent Correct C	Site A Percent Correct N	Site A Biserial C	Site A Biserial N	Site B Percent Correct C	Site B Percent Correct N	Site B Biserial C	Site B Biserial N	Site C Percent Correct C	Site C Percent Correct N	Site C Biserial C	Site C Biserial N
	90th square	85	75	.50	.51	53	63	.16	.18	54	46	.24	.10
	91st square	85	82	.46	.61	58	69	.27	.20	41	53	.31	.23
	92nd square	83	80	.58	.61	57	62	.27	.35	60	53	.31	.22
About how many of the first 100 squares will be white?		87	78	.31	.36	36	54	.22	.11	40	49	.11	.04
	90th square	50	38	.23	.38	63	60	.02	.26	50	55	.22	.32
	91th square	49	32	.31	.37	53	53	.21	.63	40	44	.24	.38
	92nd square	50	33	.36	.39	64	52	.15	.50	38	45	.32	.38
About how many of the first 100 squares will be white?		30	27	.19	.40	15	17	.48	.19	10	05	-.15	.19
	36th square	75	74	.23	.56	68	73	.09	.03	47	54	.27	.19
	60th square	65	55	.22	.31	51	45	.09	.10	45	53	-.04	.09
	65th square	56	69	.31	.33	49	53	.07	.37	50	49	.21	.33
	1st square be?	35	29	.38	.32	36	15	.10	.05	23	09	.12	.36
	5th square be	44	43	.30	.17	33	29	.12	.35	30	27	.25	.12
	101th square	45	42	.38	.20	44	20	.05	.14	20	22	.07	.43
	105th square	42	28	.34	.25	19	27	.26	.10	19	19	-.12	.25
													
Which answer shows what the 75th, 76th and 77th squares will be?		53	43	.61	.42	21	11	.36	.24	14	12	.34	.27
Which answer shows what the 152nd, 153, and 154th squares will be?		40	46	.51	.32	19	15	-.04	.35	16	12	.07	.21
(See next page.)													
Number of Students		124	132			72	89			161	147		
KR20 Reliability		.70	.71			40	.54			.43	.52		
Mean Reading Score		20.0	20.0			15.0	15.2			16.1	15.1		
Correlation: Scale and Reading		.16				.11				.17			

(R6) Colored Squares



Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
□ A	10.5	9.4	.05
○ B	7.2	7.1	—
△ C	6.4	5.9	.30

Frequency Distribution

Score	% of students					
	CSMP			Non-CSMP		
Sites	A	B	C	A	B	C
0	01	01	01	02	01	02
1	00	00	01	02	00	01
2-8	15	69	80	23	67	79
9-15	67	29	18	66	31	18
16-17	17	00	00	07	00	00

Site B

Means by Ability Level

	1	2	3	4	All
CSMP		7.9	7.5	7.0	7.3
Non-CSMP		7.9	6.9	7.0	7.2
t-Stat.		.0	.6	.0	.2

Site C

Means by Ability Level

	1	2	3	4	All
CSMP	7.6	6.2	6.1	6.0	6.4
Non-CSMP	6.5	5.7	6.4	5.7	6.0
t-Stat.	1.7	.9	.5	.4	1.2

Comments:

-For the second and third patterns, students at Site A didn't do much better (or did worse) than students at the other two sites (though they were much higher in ability). It may be that the strategy of simply matching the one's digits was used; it happens to work in these two patterns--but not in fourth pattern, where Site A did better.

(R7) Dependent Outcomes, Site A

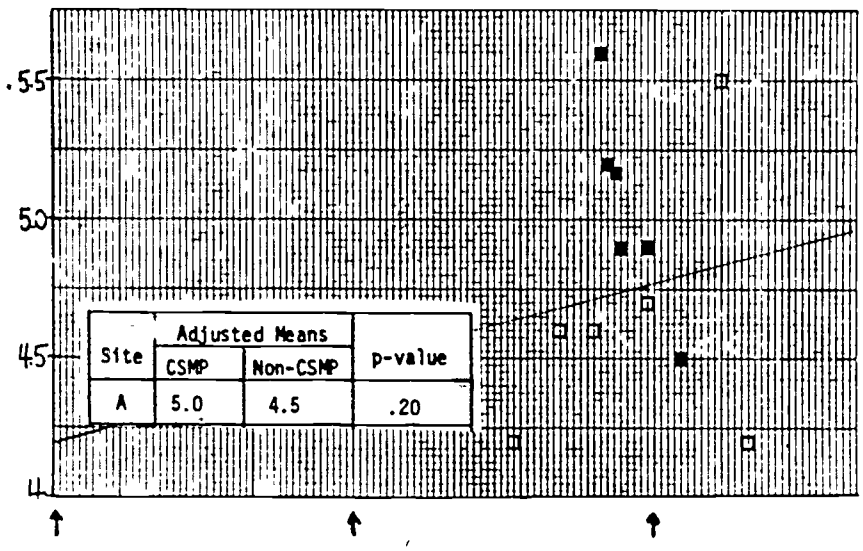
Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Some boys played a game. Everyone got at least 2 points. There were no fractions.				
A got three times as many points as C.				
B got half as many as C.				
C got 2 more points than D.				
E got half as many as D.				
F got more than twice as many as D and less than twice as many as C.				
Who won the game? _____	85	77	.87	.65
Who was second? _____	72	64	.64	.53
Who was third? _____	79	80	.83	.54
Who was fourth? _____	66	62	.84	.58
Who was fifth? _____	35	40	.24	.38
Who was last? _____	18	19	.71	.75
All Correct				
Suppose A got 18 points				
How many did C get? _____	69	55	.80	.63
How many did E get? _____	52	35	.63	.59
How many could F have gotten? _____ (Give all possible answers)	04	08	.38	.58
(Scored if students wrote 9, 10, and 11.)				
Suppose E got more than 5 points and B got less than 10 points.				
How many could D have gotten? _____ (Give all possible answers)	01	02	.19	.11
(Scored if students wrote 12, 14, and 16.)				
Number of Students	124	132		
KR20 Reliability	.77	.73		
Mean Reading Score	20.0	20.0		
Correlation: Scale and Reading	.37			

(R7) Dependent Outcomes

(Student page is shown

on facing page.)

Graph of Class Means



Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	09	08
1	02	03
2-4	27	41
5-7	52	36
8	10	08
9	02	04
10	00	00

Comments:

-This scale required students to organize a set of data in which pairwise relationships are given. The problem lends itself to, but does not require, the use of an arrow diagram.

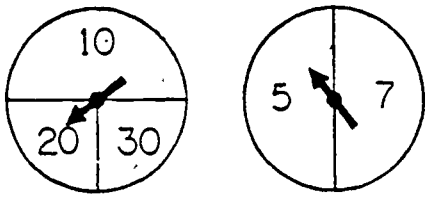
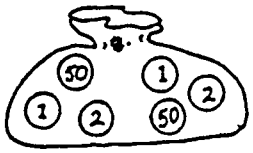
U: Elucidation Category

U3 was in the same format as U1, i.e., a set of problems, for each of which students were to list as many numbers as possible which fit the stated criteria. U3 was merely a revision of U1, using different problems. U2 was a new scale, though it could also be thought of as merely one more new problem, albeit more complicated than any of the individual problems of U1 and U3.

U1 - Elucidation. . . . . .page A132 Site B-Repetition from 5th grade.

U2 - Rules for Getting to 12. . . . . A134 Sites A and B. New.

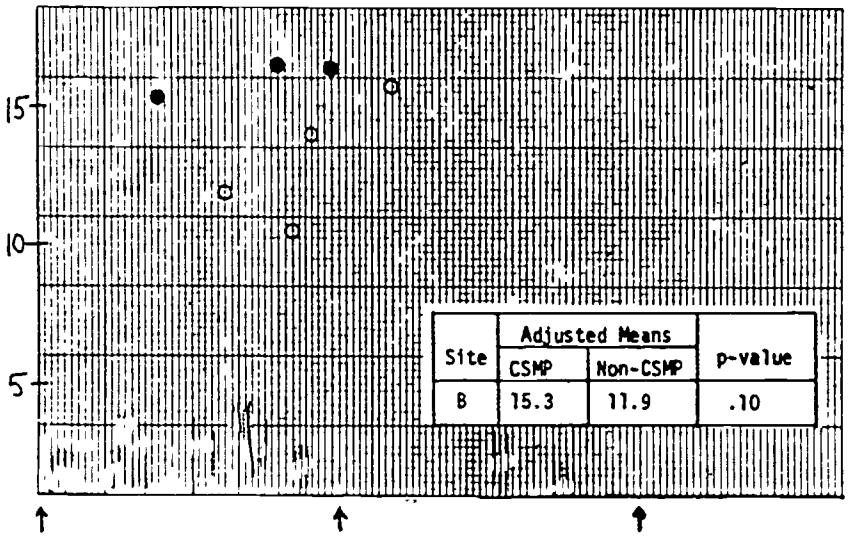
U3 - Multiple Answers . . . . . A136 Sites A and C-New problems, but repetition of the format of U1.

Test Items	Percent Correct C	Percent Correct N
Spin both spinners at the same time. Your score is the total from the two spinners.  What are the possible total scores? 25, (5 other possible correct answers)		
Start at zero. Counting by? End up at 24. What could you be counting by? 1, (7 other possible correct answers)		
Close your eyes. Pick out three balls. Add to get a total score.  What are the possible total scores? 52, (6 other possible correct answers)		
Multiple of 2 Multiple of 3 Smaller than 50 For what numbers are all three statements true? 24, (7 other possible correct answers)		
Mean score out of 25:	13.3	11.8
Number of Students	63	85
Mean Reading Score	14.5	15.6
Correlation: Scale and Reading	.40	

(U1) Elucidation

(Student page is shown on the facing page except that students were not told for each problem how many answers were possible.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	15.3	11.9	.10

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0-2	02	06
3-5	03	09
6-9	14	26
10-16	30	31
17-21	27	20
22-25	22	08

Means by Ability Level

	1	2	3	4	All
CSMP	20.0	17.2	15.5	12.2	15.4
Non-CSMP	18.1	15.8	10.6	10.1	11.9
t-Stat.	.9	.6	2.3	.8	3.1

Comments:

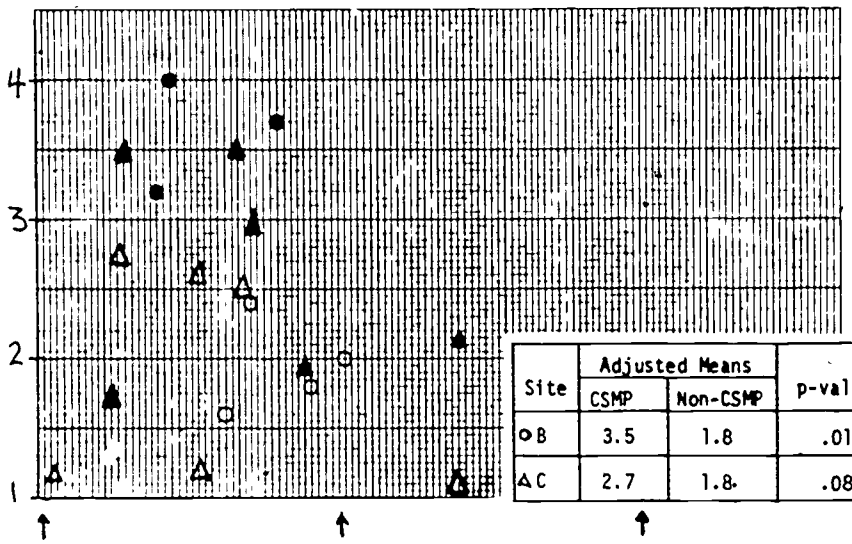
-This scale was repeated from last year.

(U2) Getting to 12, Sites B and C

Test Items	Percent Correct C	N
Rules 1. Always start at zero 2. Only use these numbers: 2, 3, 5, 7 3. Only use these operations: +, -, x, ÷ 4. Always end up at 12.		
Solutions Start at zero, +7, x2, -2 Start at zero, +5, +3, ÷2, x3 etc.		
Mean: number correct minus number wrong		
Site B	3.7	1.8
Site C	2.6	1.8
Number of Students — Site B	72	89
Number of Students — Site C	49	108
Mean Reading Score	13.9	15 3
Mean Reading Score	15.8	15.1
Correlation: Scale and Reading	.30	.01

(U2) Getting to 12

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
○ B	3.5	1.8	.01
△ C	2.7	1.8	.08

Frequency Distribution

Score	% of students			
	CSMP		Non-CSMP	
Sites:	B	C	B	C
0	10	25	34	38
1	10	13	10	16
2-3	29	27	38	27
4-5	28	22	16	15
6-7	18	13	02	02
8	04	00	00	02
9	01	01	00	01

Means by Ability Level

Site B

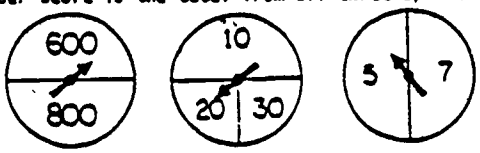
	1	2	3	4	All
CSMP		4.7	4.3	2.0	3.6
Non-CSMP		2.2	2.0	.7	1.8
t-Stat.		2.8	3.7	2.1	5.9

Site C

Means by Ability Level

	1	2	3	4	All
CSMP	2.6	2.7	2.5	2.8	2.7
Non-CSMP	2.4	1.5	2.0	1.7	1.8
t-Stat.	.0	.4	1.1	2.1	3.1

(U3) Multiple Answers, Sites A and C

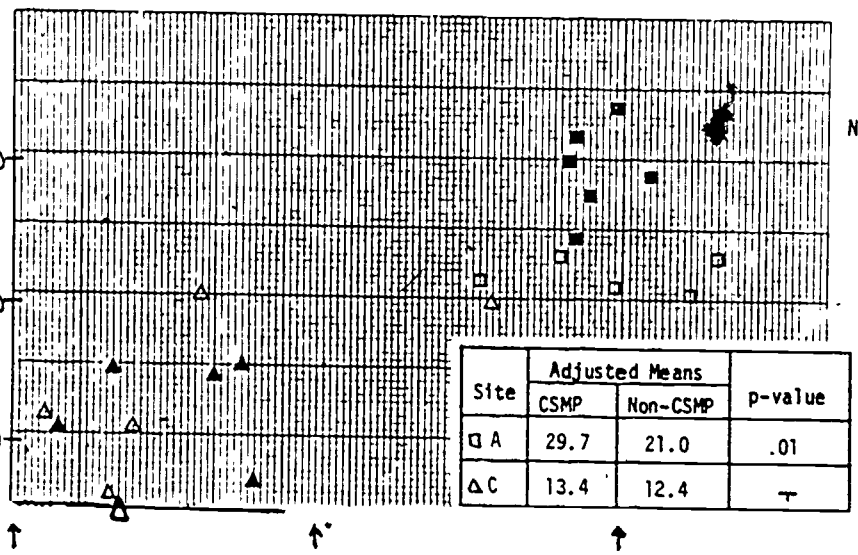
Test Items	Mean Score C	Mean Score N	KR20		Frequency Distribution	
	Site A C	A C	A	C	CSMP A C	Non A C
Spin all three spinners at the same time. Your score is the total from all three spinners.  What are the possible total scores? eg. 625 (Maximum number possible 11)	9.3 4.9	8.6 3.7	.95 .91	.95 .93	0 10 36 1 02 13 10 03 05 11 87 26	17 55 02 21 00 05 78 17
Start at zero. Count by some number. End up at 60. (Maximum number possible 11) What could you be counting by? eg. 5	6.8 4.6	5.5 4.7	.80 .49	.67 .49	0 08 - 08 1 00 04 10 08 05 11 01 01	06 08 02 05 01 00 01 00
Close your eyes. Pick out three balls. Add to get a total score.  What are the possible total scores? eg. 93 (Maximum number possible 9)	6.6 3.9	6.0 3.5	.85 .78	.83 .84	0 10 27 1 00 11 8 33 09 9 34 05	09 38 03 11 25 09 23 04
Multiple of 2 Multiple of 3 Smaller than 50 For what numbers are all three statements true? (Maximum number possible 7) eg. 24	4.6 2.5	3.1 2.4	.88 .75	.85 .76	0 14 31 1 17 27 7 52 10	34 37 10 24 26 06
Digits must add to 5. Between 200 and 1000 What are the possible numbers? eg. 311 (Maximum number possible 9)	3.6 1.2	1.9 2.5	.89 .70	.90 .75	0 44 68 1 04 28 9 14 00	76 77 12 22 02 01
Number of Students	124 168	136 157				
Mean Reading Score	20.0 15.8	20.0 15.1				
Correlation: Scale and Reading	.30	.34				

(U3) Multiple Answers

(Student page is shown on the facing page. Samples of correct answers as shown, appeared on the student pages but maximum number possible was not shown to students.)

For convenience, partial frequency distribution is shown on the left hand page.

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
□ A	29.7	21.0	.01
△ C	13.4	12.4	—

Site C

Means by Ability Level

	1	2	3	4	All
CSMP	16.8	16.1	12.8	9.3	13.6
Non-CSMP	16.3	16.7	11.5	10.2	13.3
t-Stat.	.6	−.4	.3	−.8	.2

Comments:

-KR20's were done for each separate problem and are given beside the data for each problem.

-The time factor may have affected students' scores on the last items.

W: Word Problem Category

The list of scales, below, is self-explanatory except for scale W5. That scale consisted of miscellaneous, interesting-looking word problems, often with a strong component of logical reasoning. It was used at all 3 sites, but the items differed slightly from site to site so the scale scores from the 3 sites are not directly comparable.

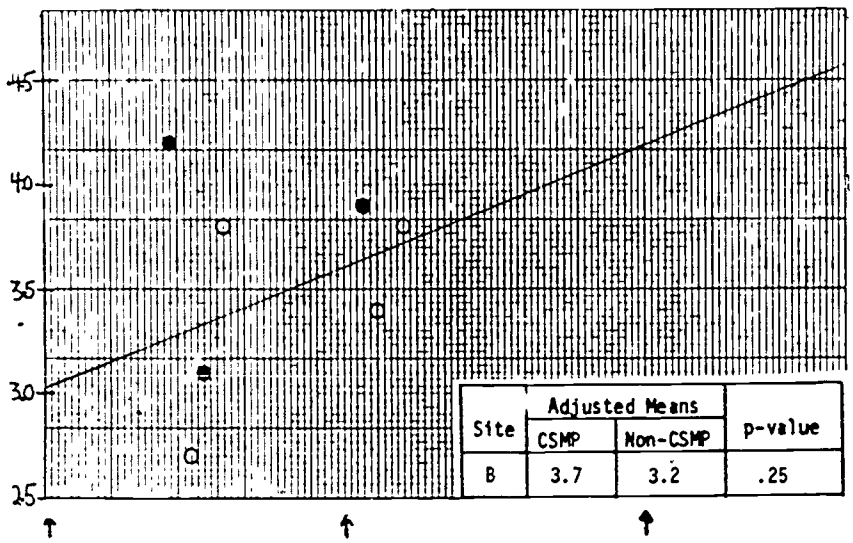
(W2) 2-Step Word Problems, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
1. Shirts cost $10 each and ties cost $5 each. Peter bought 2 shirts and 3 ties. What was his total cost?_____	84	83	.61	.39
2. Joan starts with $40. Each week she spends $2. How much will she have left after 5 weeks?_____	53	39	.79	.61
3. The cost of gum is 3 pieces for 10¢. How many pieces can we buy for 40¢?_____	55	59	.61	.58
4. Pam gets 50¢ each week. She always spends 30¢ and saves the rest. How much will she save in 4 weeks?_____	55	43	.73	.83
5. On Saturday Amy and Susan made $13 selling lemonade. On Sunday they made $5. They put their money together and divided it evenly. How much did each girl get?_____	65	62	.72	.62
6. Jim has $10 in his bank now. Each week he will add $5 to his bank. In how many weeks will he have $30 in his bank?_____	45	33	.90	.64
7. John has 5¢ more than Tom. Ann has 3¢ less than Tom. If John has 20¢, how much does Ann have?_____	21	20	.74	.47
Number of Students	38	46		
KR20 Reliability	.82	74		
Mean Reading Score	142	143		
Correlation: Scale and Reading	.13			

(W2) 2-Step Word Problems

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	3.7	3.2	.25

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	11	09
1	08	15
2-3	29	32
4-5	21	26
6	18	09
7	13	09

Site B

Means by Ability Level

	1	2	3	4	All
CSMP			3.2	1.0	3.1
Non-CSMP			1.2	2.0	1.9
t-Stat.			2.5	-1.3	2.7

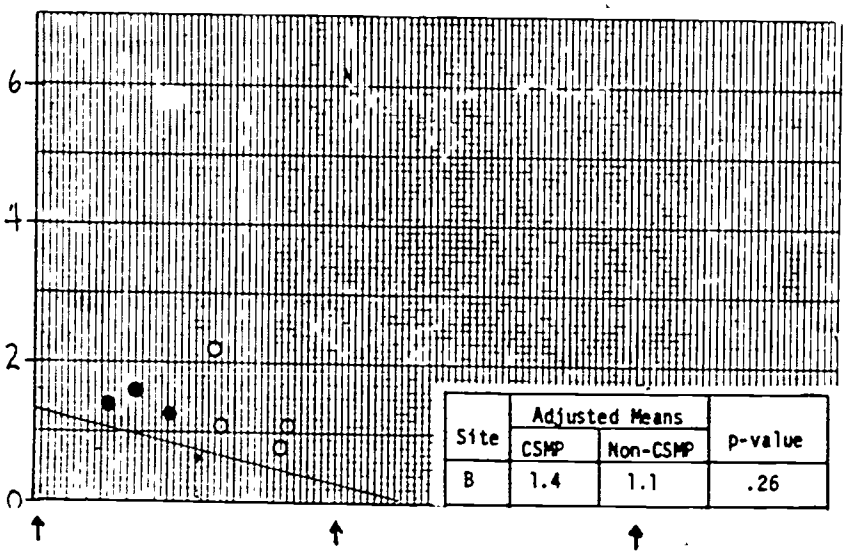
(W3) 3-Stage Word Problems, Site B

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
1. Shirts cost $10 each and ties cost $5 each. Altogether Joe spent $35 for shirts and ties. He bought 2 shirts. How many ties did he buy?_____	68	65	.32	.53
2. Joe puts boxes into piles. Each box is 1/2 foot high. Each pile is 5 feet high. How many boxes does he need to make 3 piles?_____	18	9	.65	.76
3. Bill loads 6 boxes in 2 hours. John loads 4 boxes in 2 hours. Together, how many boxes do they load in 6 hours?_____	21	12	.59	.39
4. Mary has 4 more marbles than Pete. Pete has 2 more marbles than Lisa. Lisa has 3 more marbles than Ed. If Mary has 20 marbles, how many does Ed have?_____	24	19	.55	.58
5. Monday, Tom ran 13 miles. Tuesday, he ran 8 miles. Wednesday, he ran some more. His average for the three days was 10 miles. How many miles did he run on Wednesday?_____	15	5	1.02	.70
Number of Students	24	43		
KR20 Reliability	.66	.59		
Mean Reading Score	13.8	15.0		
Correlation: Scale and Reading	—			

(W3) 3-Stage Word Problems

(Student page is shown on the facing page.)

Graph of Class Means



Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
B	1.4	1.1	.26

Frequency Distribution

Score	% of students	
	CSMP	Non-CSMP
0	24	35
1	40	33
2	18	26
3	09	04
4	03	00
5	06	02

Means by Ability Level

	1	2	3	4	All
CSMP		1.8	.6	1.0	1.0
Non-CSMP		1.6	.8	.7	1.0
t-Stat.		.2	-.4	.7	.8

(W5) Word Problems, Sites A, B, and C. (Form A)

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
(— indicates items were not administered at this site.)				
Form A				
Every chess club member played every other member just once. After a new member joined, 8 more games had to be played. How many members are in the club now? a) 20 b) 16 c) 12 d) 9 e) 8	36 21 25	43 35 21	36 -.02 .31	.49 -.12 .18
Jose has 300 stamps in his collection. If one-third of the stamps are from Canada, how many are from Mexico? a) 100 b) 150 c) 200 d) Can't tell	44 47 43	48 48 53	19 -.30 29	40 -.09 22
Steve has 7 bills. Some of them are $1 bills and some are $2 bills. Altogether he has $10 in bills. How many $2 bills does he have? a) 2 b) 3 c) 4 d) 5	56 .21 —	49 .26 -	.62 -.02 —	44 .09 —
In ring toss, you get 25 points for each ring on the peg but you lose 10 points for each ring off the peg. When Bob played, the wind blew two of his rings off the peg. How much did his score go down because of the wind? a) 20 b) 30 c) 50 d) 70 e) Can't tell	02 - -	00 -	.78 - -	00 - -
Three-fourths of Tim's field is planted in corn. One half of the corn is sweet corn. What portion of the field is planted in sweet corn? a) 3/2 b) 3/8 c) 1/2 d) 1/8	33 . 15	35 17 19	.48 -.15 .11	.42 -.35 .25
In Mrs. Jones' class: 12 students wear tennis shoes 18 students wear glasses. 9 students wear tennis shoes and glasses 3 students don't wear tennis shoes or glasses. How many students are there in Mrs. Jones' class? _____	- 00 00	- 00 01	- .00 .00	- .00 .03
Alice has 8 cents more than Julie. Alice and Julie have 40 cents between them. How much does Julie have? _____	31 - -	14 - -	.80 - -	.24 - -
Three years from now, Bill will be twice as old as Bob. Two years from now, Ed will be 5 years old. How old is Ed now? _____	84 - -	79 - -	.35 - -	.38 - -

	Site A	Site B	Site C
Number of Students	64 63	38 46	68 70
KR2C Reliability	.61 .55	-.26 -.08	.28 .24
Mean Reading Score	20.0 20.0	13.9 15.3	16.1 15.1
Correlation: Scale and Reading	.30	.16	.17

(See page A147 for statistics and comments.)

(W5) Word Problems, Sites A, B, and C. (Form B)

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Form B				
Don bought a bag of 20 new marbles. He now has 75 marbles. We want to know how many marbles Don had before he bought the new ones? a) 20+75=n b) 75=20+n c) n+20=75 d) n=75-20 Mark a number sentence that cannot be used to solve this problem.	52 29 18	61 28 29	.42 .06 .04	.61 .16 .01
A jar holds 1/2 as much as a pitcher. If the jar holds 8 pints, then how much does the pitcher hold? a) 16 pints b) 12 pints c) 4 pints d) 2 pints	77 32 35	48 35 34	.64 .03 .30	.65 .06 .23
The boy scouts reserved 4 rows with 7 seats in each row. Only 18 scouts came to the game. How many seats in the scout section were not filled? a) 46 b) 28 c) 10 d) 8	92 59 46	85 51 32	.73 .63 .31	.47 .20 .23
Jill took tickets at the movies. Adult tickets were $1.00 and children's tickets were 50¢. 40 adults and 60 children bought tickets. How much money did they collect? a) $100 b) $70 c) $60 d) $50	79 38 31	76 35 27	.44 .03 .28	.58 .08 .38
Ellen bought 12 pepper plants at a sale price of 3 plants for 40¢. They usually cost 25¢ each. How much did she pay for the plants? a) $4.80 b) $3.00 c) $1.60 d) $1.20	56 32 11	50 12 9	53 .25 .11	.70 -.05 .55
Altogether Mary and Sally have 36 candies. Mary has 3 times as many as Sally has. How many candies does Sally have? a) 6 b) 9 c) 12 d) 27 e) Can't tell Site A only.	19 - -	30 - -	.44 - -	.52 - -
One day Terry found some marbles. The next day he found twice as many marbles. The third day he found one more. That gave him 16 altogether. How many did he find the first day?_____ Site A only.	52 - -	39 - -	.48 - -	.52 - -

	Site A	Site B	Site C
Number of Students	62 66	34 43	43 77
KR20 Reliability	.67 .73	.46 .13	.19 .36
Mean Reading Score	20.0 20.0	13.9 15.3	16.1 15.1
Correlation: Scale and Reading	.30	.16	.04

(W5) Word Problems

(Combined student pages from all sites are shown on pages A144 and A146; no site was given all the items.)

Site	Adjusted Means		p-value
	CSMP	Non-CSMP	
□A	3.5	3.3	—
○B	1.4	0.9	.02
△C	1.1	1.1	—

No graph is presented because of different items in all three sites.

Means by Ability Level

Site B	1	2	3	4	All
CSMP		1.6	1.5	1.1	1.4
Non-CSMP		1.2	1.5	1.2	1.4
t-Stat.		.8	.11	-.4	.3

Means by Ability Level

Site C	1	2	3	4	All
CSMP	1.2	1.0	1.3	1.2	1.2
Non-CSMP	1.3	1.3	1.1	1.0	1.2
t-Stat.	-.5	1.0	.8	.9	.2

Comments:

-At all three sites Form A was considerably harder than Form B.

-The "Venn Diagram" item (#6) which was administered at sites B and C was the last item on the last page. While the difficulty level of the item might have contributed to students' poor performance, the time factor cannot be ruled out.

(W6) Amount of Information

Test Items	Percent Correct C	Percent Correct N	Biserial C	Biserial N
Form A				
1. Mrs. Smith bought 3 cases of pickles. Each case contains 6 jars. How many pickles did Mrs. Smith buy?				
2. My cow weighs 4 times as much as my goat. My goat weighs 3 times as much as my dog. My cow weighs 600 pounds. How much does my dog weigh?				
3. Three boys spent an average of $10 each. How much did the 3 boys spend altogether.				
4. Al has twice as many pencils as Ed. Paul has 3 more pencils than Ed. Who has more pencils, Al or Paul?				
Form B				
1. There are 96 boys in the school. There are 89 girls in the school. How many buses will be needed for the school picnic?				
2. A car goes 55 miles per hour. It goes 15 miles for each gallon of gasoline. How long will it take the car to go 165 miles?				
3. Pat and Leslie have 30 books altogether. Pat has 8 more books than Leslie has. How many books does Pat have?				
4. A man needed 9 fence posts on each side of his square garden. The fence posts were 6 feet apart. How many fence posts did he use?				
Number of Students				
KR20 Reliability				
Mean Reading Score				
Correlation: Scale and Reading				

(W6) Amount of Information

(Because of the unusual nature of this scale, and the scoring required as a result, the usual summary statistics are not available at this time. The data are being reanalyzed.)

Samples

a) Ties cost $5 each.
Bob bought 3 ties.
How much did he spend on ties?

- ☐ Need to know more _____
- ☑ Exactly the right amount of information
- ☐ Too much information (cross out the extra information)

b) A box is 10 inches long.
It is 8 inches wide.
What is the volume of the box?

- ☑ Need to know more How high the box is _____
- ☐ Exactly the right amount of information
- ☐ Too much information (cross out the extra information)

c) Tom bought 12 apples at 10¢ each.
~~He also bought 4 candy bars.~~
How much did he spend on apples?

- ☐ Need to know more _____
- ☐ Exactly the right amount of information
- ☑ Too much information (cross out the extra information)

APPENDIX B

Interviews

CSMP/Non-CSMP Sixth Grade Students

Interview Study

Rationale

In order to observe students' difficulties both in understanding the task demands of several of the new scales and in solving items in those scales, CSMP and Non-CSMP students were interviewed at the time the scales were piloted.

A brief discussion of the procedures used in the interview study and a brief summary of the results of the study are presented in CSMP Evaluation Report Ladue Sixth Grade, 1981 (Report #4) pages 43-64. This appendix will present an amplification of the results described in those pages.

In this section, a sample of the student page for each interview task will be reproduced and the purpose of the scale will be discussed. Following that the various levels of students' success with each scale will be presented and samples of students' verbatim records (enclosed in boxes to aid readability) will be included to show how students at each of the levels solved the items. Following that there will be a brief summary which will relate students' interview performance to the data from the administration of the scales under the testing conditions. A description of the sample is also included.

In all, eleven tasks were presented to the 30 students; nine of the tasks corresponded to the MANS scales in the test booklets and two were novel tasks which were being administered on a more experimental basis. Sampling of scales was done because of time limitations and an average of 4 to 5 scales were administered to each student.

In all, thirty students were interviewed.

Number of Students Interviewed

where x = CSMP students and y = Non-CSMP students

	MALE	FEMALE	TOTAL
Above Average Ability	5 / 4	4 / 3	9 / 7
Below Average Ability	3 / 3	4 / 4	7 / 7
Total	8 / 7	8 / 7	30

All students were interviewed individually by one of two interviewers. Interviews were conducted in empty classrooms or offices and took place while the rest of the class was doing the MANS tests.

The eleven tasks and the pages in Appendix A where summary data on the scales can be found are as follows:

1. Pre-Algebra: (A1) Algebraic Symbols - Appendix A, pages A6-7; (A2) Solving Equations - Appendix A, pages A8-9; (A3) Summation Operator - Appendix A, pages A10-11; (A4) Multiplying Summations - Appendix A, pages A12-13; (A5) Functions - Appendix A, pages A14-15.

2. Logic: (L4) Identification - Appendix A, pages A54-55 and (L9-L10) Venn Diagrams - Appendix A, pages A60-63. (Note: In this report the logic tasks will follow the probability tasks.)

3. Probability: (P4) Dependent Outcomes - Appendix A, pages A110-111 and (P5) Conditional Probability - Appendix A, pages A112-113. (Note: In this report a discussion of the probability tasks will preceed a discussion of the logic tasks.)

4. Geometry: Figure Comparisons - Ladue Report, pages 52-63.

5. Patterns: Pattern Recognition/Generation - Ladue Report, page 64.

Students' performance for each of these categories will be discussed in turn.

The data will follow the format shown below.

- Scale Name

  Rationale of the Scale

  Number of Students Interviewed

  Description of students' levels of performance

  (Number of students (CSMP/Non-CSMP) at each level.)

Student Verbatim Transcript	Mans items student solved.

Discussion

Results

Overall, students, both CSMP and Non-CSMP, displayed several different levels of success with the tasks: some students showed that they understood the task, and were able to correctly solve it; some students had understood what was required for solving the task but made errors in computation or strategy; other students appeared not to a) understand what was required of them and b) as a result made errors both in computation and in strategy.

For all the tasks only a few (4-10) students were interviewed and the CSMP/Non-CSMP balance was rarely 50/50 so conclusions about CSMP/Non-CSMP performance cannot be unequivocal. As far as understanding the tasks and completing the tasks, both groups performed about the same across all tasks; however CSMP students generally tended to fall into the higher ability levels more frequently than the lower ability levels whereas Non-CSMP students were found in the lower ability levels more frequently than CSMP students.

MANS SCALE STUDENT INTERVIEWS

1. Pre-Algebra

(A1) Algebraic Symbols

Students were given written examples of the use of algebraic terminology (a letter represented a number; for example: 2a means 2 times a. If a = 6, 2a = 2 x 6 = 12). The purpose of the scale was to determine how well students could solve equations by substituting the numbers for letters when one or two variables were present.

Sample:

In these problems, letters stand for numbers.

A/Samples: 2a means 2 times a. If a = 6, 2a = 2x6 = 12.

3bc means 3 times b times c. If b = 2 and c = 5, 3bc = 3x2x5 = 30.

Problems

If c = 4 and d = 3, then 5cd = _____

If c = 2, f = 2 and g = 3, then 4efg = _____

If $y = \frac{1}{2}$, then 14y = _____

N = 6: 2 CSMP, 4 Non-CSMP

There were three levels of ability shown:

- Level 1: Students appeared to understand the samples and made no errors in computation. (1 CSMP, 1 Non-CSMP)

Example:

CSMP - 5^2 means 5 x 5 = 25

6^2 would be 12--no, no, 36

4^2 would be 16

If d = 8, then d^2 would be 64.

6^2 = _____

4^2 = _____

If d = 8, then d^2 = _____

and the Non-CSMP student's solution was equally straightforward.

Level 2: Students appeared to understand the samples and initially made no errors in computation but subsequently began to make errors.

(1 CSMP student)

Example:

6^2 equals 6 x 6 equals 36	6^2 = _____
4^2 equals 4 x 4 equals 16	4^2 = _____
If d = 8, then d^2 equals 8 x 8 = 64	If d = 8, then d^2 = _____
if a = 2 and b = 3, then a^3 b^2 = (long pause)	If a = 2 and b = 3, then a^3b^2 = _____
2 x 2 x 2 x 3 x 3 = (long pause) 144	If c = 1, then c^5 = _____
If c = 1, then c^5 = 1	If d = 5, then $2d^2$ = _____
If d = 5 then $2d^2$ = 5 x 5 x 5 -- 5 x 5 = 25	

Level 3: Students made errors which indicated they did not begin to understand the operations required.

(3 Non-CSMP students)

Example:

5^2 means 5 x 5 (reads sample)	6^2 = _____
6 x 2 would be 12 and 4 x 2 would be 8	4^2 = _____
If d = 8, then d x 2 would be 16	If d = 8, then d^2 = _____
If a = 2 and b = 3, then a^3 is 2, so 2 x 3 = 6	If a = 2 and b = 3, then a^3b^2 = _____
and b = 3. 3 x 2 = 6, then it would be 12.	If c = 1, then c^5 = _____
If c = 1, then c x 5 = 5.	

Discussion

The interviews show that when students incorrectly solved the one variable equations, it was because they multiplied by "2" instead of squaring. In the two variable equations students lost track of how many times to multiply or incorrectly combined operations. Thus students who incorrectly solved "If d = 5, then $2d^2$ = ?" usually omitted a step and said "25" or "10".

(A2) Solving Equations

This scale, a variant of A1, required students to solve simple equations. Unknowns were represented by letters and instead of substituting a given value, students had to solve for the value.

Samples:

d + 13 = 14, so d = _____

e - 4 = 5, so e = _____

6 x f = 12, so f = _____

N = 8: 3 CSMP, 5 Non-CSMP

There were three levels:

Level 1: Students correctly solved all items.

(2 CSMP, 1 Non-CSMP)

Example:

d + 13 = 14 so d must be 1

e - 4 = 5 so e must be 9

6 x f = 12 so f must be 2 'cause 6 x 2 = 12

g ÷ 4 = 8, so g = 32 because 32 ÷ 4 = 8

7 x h + 1 = 15 so h must be 2 because 7 x 2 = 14 + 1

3 x y - 6 = 15 so y = 3 x 7 because 3 x 7 is 21 minus 6 is 15

d + 13 = 14, so d = _____

e - 4 = 5, so e = _____

6 x f = 12, so f = _____

g ÷ 4 = 8, so g = _____

(7 x h) + 1 = 15, so h = _____

(3 x i) - 6 = 15, so i = _____

Level 2: Students correctly solved almost all items but made simple computation errors.

(1 Non-CSMP)

Example:

d + 13 = 14, so d = 1?	d + 13 = 14, so d = _____
e - 4 = 5, so e = 9?	e - 4 = 5, so e = _____
6 x f = 12, so f = 2	6 x f = 12, so f = _____
d ÷ 4 = 8, so d, 2	g ÷ 4 = 8, so g = _____

Level 3: Students correctly solved the first few items but made errors which indicated they did not understand the algebra concepts involved.
(1 CSMP, 3 Non-CSMP)

Example:

(Solved items 1-5 correctly) Then (3 x i) (long pause) (3 x i) - 6 = 15, so i is (long pause) 21? I don't... and 2ks, 5 + 7 = 1, no I mean (long pause).	(j x j) + 1 = 26, so j = _____ k + 2 + k + 1 = 11, so k = _____

Discussion

The first three problems called for comparatively simple computations (addition, subtraction, multiplication) but solution of the item with a division sign elicited an incorrect solution by division strategy. The more complex items, involving two operations, caused students to lose track of their operations and unknowns. The difficulty which students had in the interviews is paralled by the difficulty others had in the testing situation.

(A3) Summation Operator

Students were introduced to a novel summation sign (∑ called "an anvil" or "a funny thing" and were given two examples which showed "how the 'funny thing' worked" and were also given three practice samples. They were then expected to solve other items using the same summation operations.

N = 9: 5 CSMP, 4 Non-CSMP

Level 1: Students experienced difficulty/confusion with the first few items which was resolved when the interviewer used socratic type questioning.

(3 CSMP, 3 Non-CSMP)

Example:

> Well, it has a box up here and two circles stuff. (Yeah, right. What are you going to call that?) That. (Okay, but what are you going to call that strange symool?) 2 to 6, you mean? (Yeah, but you're going to have to say something. What are you going to call it? Got a name for it?) The shorthand. (Okay, 2 shorthand 6 is a short way of writing 2 + 3 + 4 + 5 + 6...how about this one?) From 6 + 7 + 8 + 9, the last--the first and the last would be 6 to 9; 2 shorthand 7 = would be, um, it would be 2 to 8.

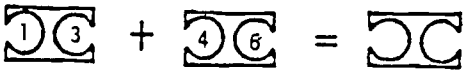
$$\sum_{2}^{7} + 8 = \sum$$

Level 2: Students experienced no difficulty with the first few items but then had difficulty with items which was still not resolved via socratic techniques, i.e., students discarded the operations shown in the samples and used a perseverative addition/subtraction strategy.

(2 CSMP)

Example:

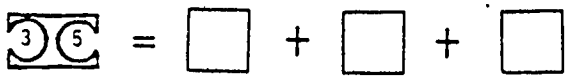
(Does the samples correctly, and the first item, skips the second, and then solves the third as follows).
I'm trying to figure, to figure out how to put it into one of these things. The answer is 21 but I'm trying to figure out how to put it into (21?)
This number here stands for 1 + 2 + 3 + 6 and this is 4 + 5 + 6 which is 15 and 15 + 6 is 21.



Level 3: Student appears not to understand the samples and items.
(1 Non-CSMP)

Example:

2 ⌒ 6 is a short way of writing 2 + 3 + 4 + 5 + 6 so 5 + 6 + 7 + 8 can be written 5 + 8. (No, can be written 5 ⌒ 8). So 3 + (silence) can be written as, I guess 3 + 8, 3 + (silence) 3 + (silence) 1. Can the middle one be anything? (No, take a look at this one. Now, 2 + 3 + 4 + 5 + 6 and 5 + 6 + 7 + 8 has got to be 5 ⌒ 8 so 3 ⌒ 5 has got to be what/)
Let's see. (Silence) 3 + 5, I mean 3. I know the first one's 3 and the last one's 5 but the middle one is...there has to be a pattern...



Discussion

While some students "cracked the code" for using the operator in almost all cases, other students were confused about the symbol. For some students, even practice and coaching did not erase their confusion. Even when students were not confused about the general use of the operator there were occasions (4 ⌒ 9 - 5 ⌒ 9) when they were confused about whether to subtract the 4 from the 5, the 5 from the 4 or insert a zero). The test data show that there was a similar confusion. When the task was "linear" i.e., adding from 1 to 6 (1 ⌒ 3

+ 4 ☐ 6 =) students were usually successful but "non-linear" operations (where there was no straightforward continuation of an already established pattern to "copy") gave students difficulty (as the results of 1 ☐ 7 + 6 ☐ a = showed).

(A4) Multiplying Summations

This scale extends the use of the novel operator which was introduced to students in the previous scale.

N = 5: 1 CSMP; 4 Non-CSMP

Level 1: Students began correctly then became confused.
(1 CSMP, 1 Non-CSMP)

Example:

4 ☐ 7 equals 4 ☐ 7 plus 4 ☐ 7 and then 2 ☐ 7 plus 2 ☐ 8 equals 2 ☐ 7 plus 1 with a two up there and 3 ☐ 6 + 4 ☐ 7 equals 3 ☐ 7 3 ☐ 7 plus (silence) plus 1 plus (I don't know).

$$\overset{2}{(4 \square 7)} = \square + \square$$

Level 2: Students began incorrectly, but then through socratic questioning correctly solved the items.
(1 CSMP, 1 Non-CSMP)

Example:

2 $\overset{3}{\square}$ 5 equals (read the samples) Okay. Got it. 4 $\overset{2}{\square}$ 7 = 4 ☐ 7 + 4 ☐ 7 (and continued.)

$$\overset{3}{(2 \square 5)} = (2 \square 5) + (2 \square 5) + (2 \square 5)$$

$$\overset{2}{(4 \square 7)} = \square + \square$$

Level 3: Students seemed confused and were unable to solve any items. (2 Non-CSMP)

Example:

2 5ths mi...equa...2 5ths equals 2 5ths plus 2 5ths plus 2 5ths. (Alright, what do you make of that now? The way you read it, it sounded like nonsense.) It does, ha, ha. (O.K. Is there something you didn't read?) Ah, the three over. (O.K. the three over) ah, um, ha (So if you'd of said 3 over 2 5ths equals 2 5ths plus 2 5ths 2 5ths plus 2 5ths) ah, (Alright, does that make sense to you then?) Yeah. (Alright...O.K. so 3 8 plus 3 8 would be 2 over 3 8 O.K.?) Yeah 2 over 4 7 would be 4 7 47. (Alright, O.K.) and 2 7 plus 28 would be a, ha, um aw, 2 over 27 plus 1, no plus 8 (Alright) 3 6 plus 4 7 um, 2 over 3, 3 7 plus, gosh I needa use the seven. (Alright go ahead and put that down.) Oh, (O.K. But you're not real sure.) Yeah.

$$\overset{3}{\left(\frac{2}{5}\right)} = \left(\frac{2}{5}\right) + \left(\frac{2}{5}\right) + \left(\frac{2}{5}\right)$$

$$\left(\frac{3}{8}\right) + \left(\frac{3}{8}\right) = \left(\frac{\square}{3}\right)\left(\frac{\square}{8}\right)$$

$$\overset{2}{\left(\frac{4}{7}\right)} = \left(\frac{\square}{\square}\right) + \left(\frac{\square}{\square}\right)$$

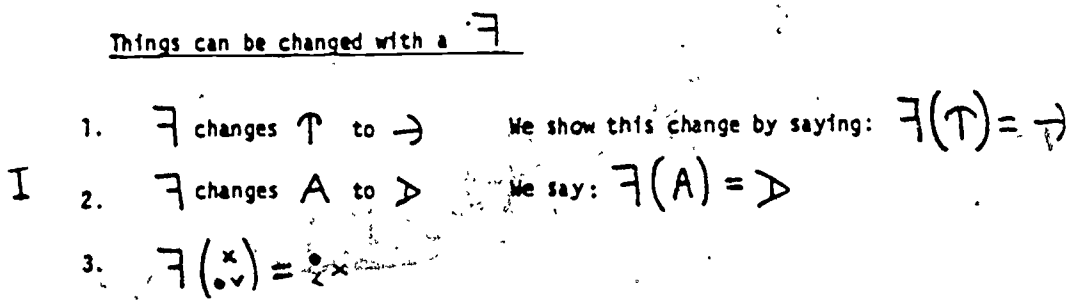
Discussion

Again, students were confused about the relations between the operator and the numbers. The first item, which most students were able to solve, involved the same "linear" solution strategy which students were able to use successfully in solving many items in (A3). However, when the items became more complex and called for more complex solution strategies the interviewees had difficulty keeping track of the operations.

(A5) Functions

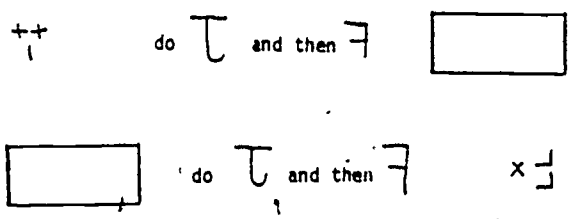
An operator symbol is shown to students and they are given samples of how the symbol changes sets of configurations. Students must then apply the same changes to other configurations. Producing those changes requires the coordination of several within-configuration variables.

Sample:



All students (3 CSMP and 2 Non-CSMP) correctly solved these items. Both groups of students expressed confusion about what was expected of them for one or more items but they did solve those items correctly. Both groups of students turned the paper sideways to check for the correctness of figure orientation.

> The 1 and the 2 up here on top of each other because up here it says change the 2 x's" and circle on the bottom to a circle on the side with 2 x's kind of on top of each other. And that was what that was and so I just changed it around. (long pause) Because, up here it says: Right there an x with 2 circles and to do it changes it to that. So, I moved it around--and then "" um (long pause) because up here it says and I just switched it around to what the directions said. (long pause) Because if you--okay, you move the backwards "L" right there, the other "L" will go there and then the x would go on the bottom right there.



• Well the "ㅋ" makes this turn so the line facing up would turn to the side --so it would go in east-west direction. And the "ㅋ" would turn the "M" to the side so it would be like lying down kind of and the "ㅋ" could change the 2 o's and the plus on its side--and the "H" which we're supposed to find out what happened. That would be like that (does it correctly).

ㅋ(ㅣ)-

• The xx's and the ooo's. There's 3 o's and 2 x's. I just make the x's have 3 and the o's have 2. The backward "ㅋ". And then the "ㅋ" would turn z and the 1 to 2 1s and 1 z. And then this one I had trouble on--I didn't know this one that much. Okay, the "ㅋ" would turn the 3 Vs--the upside down Vs--and 3 + s, I think it changes it to 2 vs and 2 + s. I'm not sure if that's right or not. And this--the last one. Um (long pause) Okay. This one, would be (long pause) 3 os and 1 y.

ㄷ(xx / ooo)-
ㄷ(22 / 1)-
ㄷ(^^^ / +++)-
ㄷ( )- °YYY

• "ㅋ" means that you just change the figure sideways so you do that (does it correctly) and then the same with all these. You turn the sideways and you turn the two circles sideways and the plus sign, and in this one the--its like an I turned on its side so I put it back like that.

ㅋ(ㅣ)-
ㅋ(M)-
ㅋ(oo / +)-
ㅋ( )- H

Discussion

Most students relied on visual cues, i.e., turning their papers sideways or re-copying the configuration and drawing a new configuration and rotating each variable within the configuration. Once students understood that only a rotation was required and no addition, subtraction, etc., they were able to complete the scale. When they produced errors it was due to confusion about how much of the configuration should be changed--all or only one portion, as well as confusion over the sequence in which the operators were used.

(P4) Dependent Outcomes

Students were given spinners (A and B) and a set of conditions (winning means a combined score of at least 15 on one set of items; winning means getting a larger result with spinner A for another set of items). Students had to combine all the possibilities exhaustively in order to achieve the correct answer.

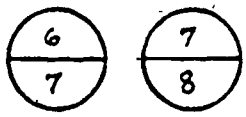
N = 7: 4 CSMP; 3 Non-CSMP

Samples:

I. **Rules**

Spin 2 spinners.
Add together the numbers the 2 spinners point to.
You win if they add to 15 or more.
Play the game 100 times.

If you played with these spinners:

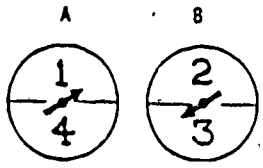


How many times do you think you would win out of 100? _____

II. **Rules**

Spin 2 spinners.
You win if Spinner A points to a larger number than Spinner B.
Play the game 100 times.

If you played with these 2 spinners:



How many times do you think you would win out of 100? _____

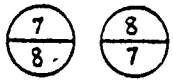
There were three levels of solution for this scale:

Level 1: Students used a combining strategy and used it exhaustively. (2 CSMP)

> You do how many times if you plussed all of these together would you get over 15 or more? And you get 100 changes. I put 75 because the only--would you--couldn't do it would be 7 x (sic) 7 and there's four ways of doing it, 1, 2 and 3 and the only way would be 7 x (sic) 7. That is 14 not 15--so you minus 1/4 that and that would be 75 out of 100.

If you played with these spinners:

How many times do you think you would win out of 100?

1. 

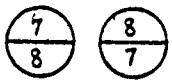
Level 2: Students had a combining strategy but they used in non-exhaustively.

(1 CSMP, 1 Non-CSMP)

> You would win, you would win--let's see. 50% of the time because 8, because, because (pause) 75% of the time on a scale of 1/4 (How come?) Because there's two sevens you'd win 50% of the time 'cause if I spun it I'd get 7 and if I spun it I'd get 8 and there's only 4 figures, 4 numbers so that would be 50% of the time.

If you played with these spinners:

How many times do you think you would win out of 100?

1. 

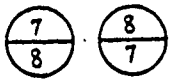
Level 3: Students used no strategy, were confused and relied on guessing.

(1 CSMP, 2 Non-CSMP)

> I really don't know why but I think it's 25.

If you played with these spinners:

How many times do you think you would win out of 100?

1. 

Discussion

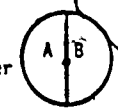
When students were aware of a strategy, i.e., combining both numbers on both spinners and they used the strategy exhaustively, they could solve the items. Errors were made when they failed to use the correct strategy (i.e. guessed) or when they were not exhaustive in their use of all four numbers.

(P5) Conditional Probability

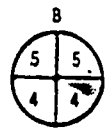
Using spinners shown students were required to predict the frequency with which given numbers would appear. To complete the task successfully students had to know that the results of the first spin (getting A or B) then affected all subsequent results. Students also had to calculate exhaustively the possible outcomes.

Samples:

Rules to play Game 1.

1. First spin this spinner 

2. Then: if you get A, spin Spinner A OR if you get B, spin Spinner B



Pretend you played the game 100 times

How many times do you think you would get 4? _____

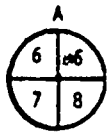
How many times do you think you would get 5? _____

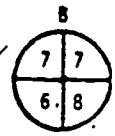
How many times do you think you would get 6? _____

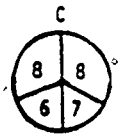
Rules to play Game 2

1. First spin this spinner 

2. If you get A, spin Spinner A OR if you get B, spin Spinner B OR if you get C, spin Spinner C







N = 4: 2 CSMP; 2 Non-CSMP

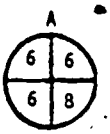
There were two levels of student solution for this scale:

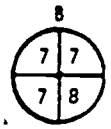
Level 1: Students successfully used a comprehensive strategy. (2 CSMP)

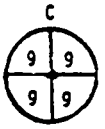
Well, since there are 3 chances, you have more chances to get A than B but there aren't any 6s on B so I figured that the 3 6s, there are only 3 6s out of these 8 quarter shapes so I figured it would be 37.

1. First spin this spinner 

2. If you get A, spin Spinner A OR if you get B, spin Spinner B OR if you get C, spin Spinner C







Pretend you played the game 100 times

How many times do you think you would get 6? _____

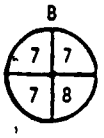
Level 2: Students were not successful and they used a confused strategy.

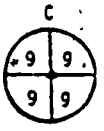
(2 Non-CSMP)

I don't know how you'd figure the percents on this. Um. If it were pointing to 4 and if it were pointing to 3 it would work. 6 and 7, it wouldn't so that's 2/3. It wouldn't work. If it were 5 only, 3 would work again so that's 3 (long pause) 30%. I don't know what the percents would be.

1. First spin this spinner 

2. If you get A, spin Spinner A OR if you get B, spin Spinner B OR if you get C, spin Spinner C





Pretend you played the game 100 times

How many times do you think you would get 6? _____

Discussion

As with (P4), some students understood the task, had the correct strategy, and used it exhaustively, while other students did not understand how to calculate the probabilities, were confused by the multiple combinations, and guessed.

(L4) Identification

This scale required students to use negative information (Tom doesn't play hockey), to eliminate players by using the clues correctly and to coordinate two sets of clues (i.e., indoor/outdoor and sport or days of the week and sport) in order to assign players to activities.

N = 8: 5 CSMP; 3 Non-CSMP

There were three levels of solution for this scale:

Level 1: Students did the scale correctly (and did it by "reading off" the text and making correct assignments without recourse to paper and pencil record keeping.) (2 CSMP, 1 Non-CSMP)

> Ed doesn't play outdoor (pause) doesn't play soccer. He plays hockey. Ed plays indoor hockey. Tom, let's see, Bill plays indoors. Bill plays indoor soccer. Tom plays outdoor soccer so Pete must play outdoor hockey.

These are the 4 boys: Bill Tom Ed Pete

These are the 4 leagues: indoor soccer outdoor soccer indoor hockey outdoor hockey

These are the facts:
- Each boy plays in a different league.
- Bill plays indoors.
- Tom doesn't play hockey.
- Ed doesn't play outdoors and he doesn't play soccer.

What league does each boy play in? (Circle your answers)

Bill:	indoor soccer	outdoor soccer	indoor hockey	outdoor hockey
Tom:	indoor soccer	outdoor soccer	indoor hockey	outdoor hockey
Ed:	indoor soccer	outdoor soccer	indoor hockey	outdoor hockey
Pete:	indoor soccer	outdoor soccer	indoor hockey	outdoor hockey

Level 2: Students incorrectly assigned one or more players (and also did it by "reading off"); the incorrect assignments were a) non-specific for one or two players (i.e., Pete played hockey) or b) a double assignment for one or more

players (i.e., Tom plays indoor soccer--Pete plays indoor soccer)

(3 CSMP, 1 Non-CSMP)

> Bill doesn't play, Bill plays indoors so he can't play outdoor soccer and he can't play outdoor hockey, um, Tom doesn't play hockey. Bill plays, he can either play indoor soccer or indoor hockey. Tom doesn't play hockey. Ed doesn't play outdoors and he doesn't play soccer. Okay, so Tom plays, um, hockey, so Bill has to play indoor soccer and Tom doesn't play hockey. Tom has--well, Ed plays indoor soccer. Okay, Tom plays outdoor soccer and Pete plays outdoor soc, I mean hockey.

Level 3: Student made incorrect assignments and seemed to guess (i.e., "Well, it doesn't say anything about Pete, so he must play them all.") This student used paper and pencil to keep records.

(1 Non-CSMP)

> Directions. Okay, Bill would play (long pause; writes down sports; long pause) and um, Tom would play (long pause) writes down more sports (long pause) um--
> (Reads) It says Bill. Oh, I got it backwards. Bill plays indoors. It'd be the other way round. Bill plays outdoor soccer and outdoor hockey. Bill does. (Reads) Bill plays indoors. That is right. Bill plays indoor soccer. Indoor hockey. Yea, that'd be right if on this scale Bill plays indoors--and Tom--Tom doesn't play hockey--indoor and outdoor--soccer and Ed doesn't play outdoors and doesn't play soccer so he would--play indoor hockey--um--and Pete--it doesn't say anything about Pete so he'd play all of them I guess.

Discussion

Student errors resulted from an inability to assign one and only one player to a sport. The confusion was compounded by the fact that few of the students interviewed attempted any systematic record keeping but instead "read off" the questions and then began "reading off" answers.

(L9-L10) Venn Diagrams

Students were required to solve a two-way classification (L9) or a three-way classification (L10) problem where a simple addition strategy would yield the wrong answer but assignment of data via Venn Diagrams would be helpful for a correct solution.

Samples:

In Mrs. Jones' class.

11 students wear tennis shoes.

17 students wear glasses.

8 students wear tennis shoes and glasses.

2 students don't wear tennis shoes or glasses.

Write your answers in the blanks.

How many students are there in Mrs. Jones' class? _____

How many students wear either tennis shoes or glasses but not both? _____

How many students wear glasses but not tennis shoes? _____

In Mr. Smith's class:

18 students play baseball.

13 students play basketball.

21 students play football.

No students play all three sports.

No students play both baseball and basketball.

7 students play both football and baseball.

17 students play football but not basketball

How many students play baseball only?

How many students play football only?

How many students play basketball only?

There were four levels of strategies:

Level 1: Students correctly solved the scale. In this category were students who appeared to be using a good strategy and correctly solved the items. (2 CSMP) and also a student who correctly solved the items but who appeared to be confused while solving the scale. (1 CSMP)

> 22 students? (Tell me how you figured it out.) If 11 students wear tennis shoes and 17 wear glasses and 8 students are gonna be--that's 28 there who are wearing tennis shoes and glasses or glasses and 8 of those are wearing both that would be 20 who were just wearing tennis shoes or glasses--28 that's gonna be 30--though--I just--okay 28 students wear tennis shoes or glasses 8 wear both so at least 28-20 wear either tennis shoes or glasses. 8 wear both tennis shoes and glasses and 2 students don't wear tennis shoes or glasses. That's 30-20 wear either tennis shoes or glasses but not both, hm--but not tennis shoes--oh 9-9- (How?) I took 8 out of 17 because 8 would be wearing tennis shoes and glasses and 9 would be wearing 9.

See items on p. B22

Level 2: A student who tried an assignment strategy but who was confused and got the wrong answer. (1 CSMP)

> Um-2-tennis shoes (long puase) Okay, this would be 3. Could I use a pencil? (writes down) .3. 8, 17, 11 -- (Tell me what you're doing.) Okay, I'm minusing 8 from 17 and 11 because it says the, 8 students wear tennis shoes and glasses so you can mark 8 from here and 8 from here 'cause there's going to be 8 from the tennis shoes and 8 from the glasses because you're gonna have a guy in each cl, in each (pause) a student that's wearing tennis shoes and glasses. So just take 8 from each and that'll leave you 3 with tennis shoes not glasses and 17 or 11 with just glasses and 2 with tennis shoes. So you'll have 6, 16 students in Mrs. Jones' class.

See items on p. B22

Level 3: Students who added all the students.

(2 CSMP)

> 18, 2 is 30. 28 and 2 is 30. There's 38 students in Mrs. Jones--. I added these together.

See items on p. B22

Level 4: Students who appeared to be confused and tried no specific strategy, or guessed.

(2 Non-CSMP)

> 17 and 8 wear tennis shoes. Okay, 7, 6, 15, 17, 38. How many students wear either tennis shoes or glasses but not both? Wait. Tennis--how many students wear either tennis shoes or glasses, that makes sense, but not both. How many students wear either tennis shoes or glasses but not both? 2. That doesn't make any sense, that question. How many students wear glasses but not tennis shoes? Glasses. This one doesn't make nay sense though. How many students wear either tennis shoes or glasses but not both? They can wear one or the other but not both? The reason I put down 2 is because--but not both--. I could put 2, 11, 17 down, because 2--. How many students wear either tennis shoes or glasses. Well, they can switch. That'd be 2. Let that be 2-8. That'd be 2-8. That's not a very good question. (2, 8?) It'd be 2 or 8.

See items on p. B22

Discussion

Students' confusion over the correct solution strategy was widespread as the results of testing show. Students were unable to assign the given information correctly and did not make use of Venn diagrams or other aids to organize the data. After the interview, one student (CSMP) was asked if Venn diagrams could be used to solve the problem. She said yes, drew the Venn diagrams, put in the numbers and then added all the numbers--just as she had originally solved the problem.

NON-MANS TASKS

Geometry

The geometry task, unlike the tasks reported previously, was administered only in the interview situation. In all, 30 students were interviewed. All interviews followed the same standard format (which will be described below).

The task was a simple one. Each student was shown five pairs of figures and asked to tell in what ways the figures were "the same."

The purpose of the task was to see whether or not sixth grade students, some of whom were CSMP students and some of whom were not, would be able to note similarities between parts of figures (angle size, line orientation, etc.) even when the figures as a whole might not be similar.

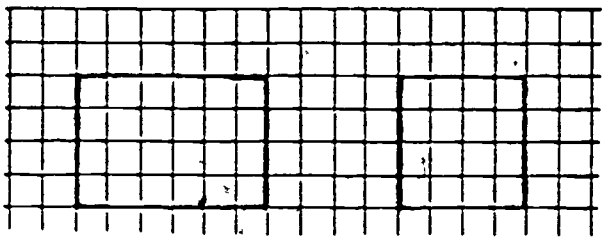
By interviewing students and asking them to tell in what ways the figures were similar, we hoped to be able to analyze the data and design a geometry scale which would a) be understood as a paper and pencil task, and b) be of an appropriate difficulty level for sixth graders.

In the pages that follow, a preliminary data analysis will be discussed. The data analysis is conservative. That is, some students did mention ways in which the figures were similar--but they did so after persistent questioning/structuring on the part of the interviewer. Since that questioning and structuring was not done consistently for all figures and for all students, and since it represents a considerable amount of "coaching", the resulting data are not included here. Instead, students' comparisons prior to substantive interviewer intervention are reported.

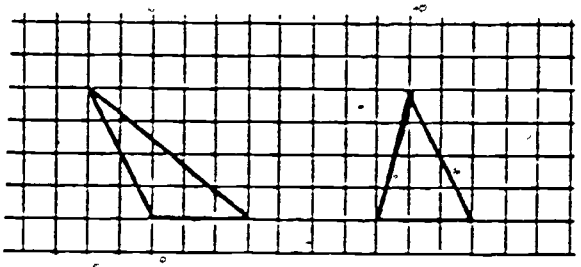
Geometry

Each student was shown five pairs of figures, one pair at a time in the same order for all interviews. The five pairs of figures are shown below.

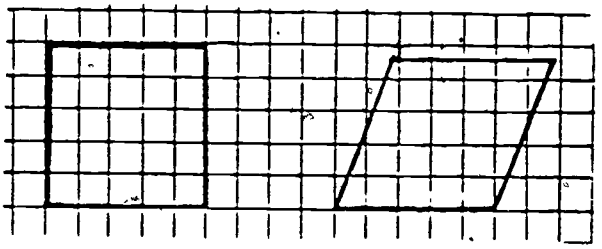
Pair 1



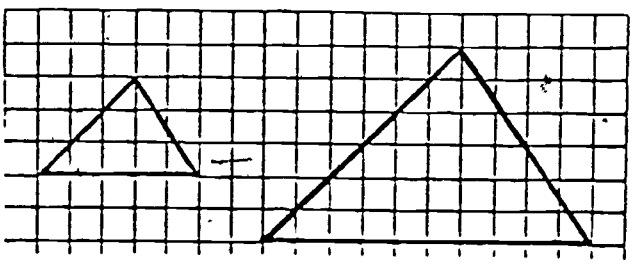
Pair 2



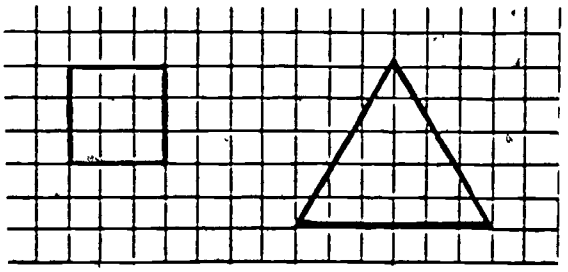
Pair 3



Pair 4



Pair 5



Representative verbatim records of students' responses for each of the pairs are presented below. Following the transcripts, a summary of students' responses for each pair will also be presented. The summary will briefly discuss

1) Nomenclature used by students

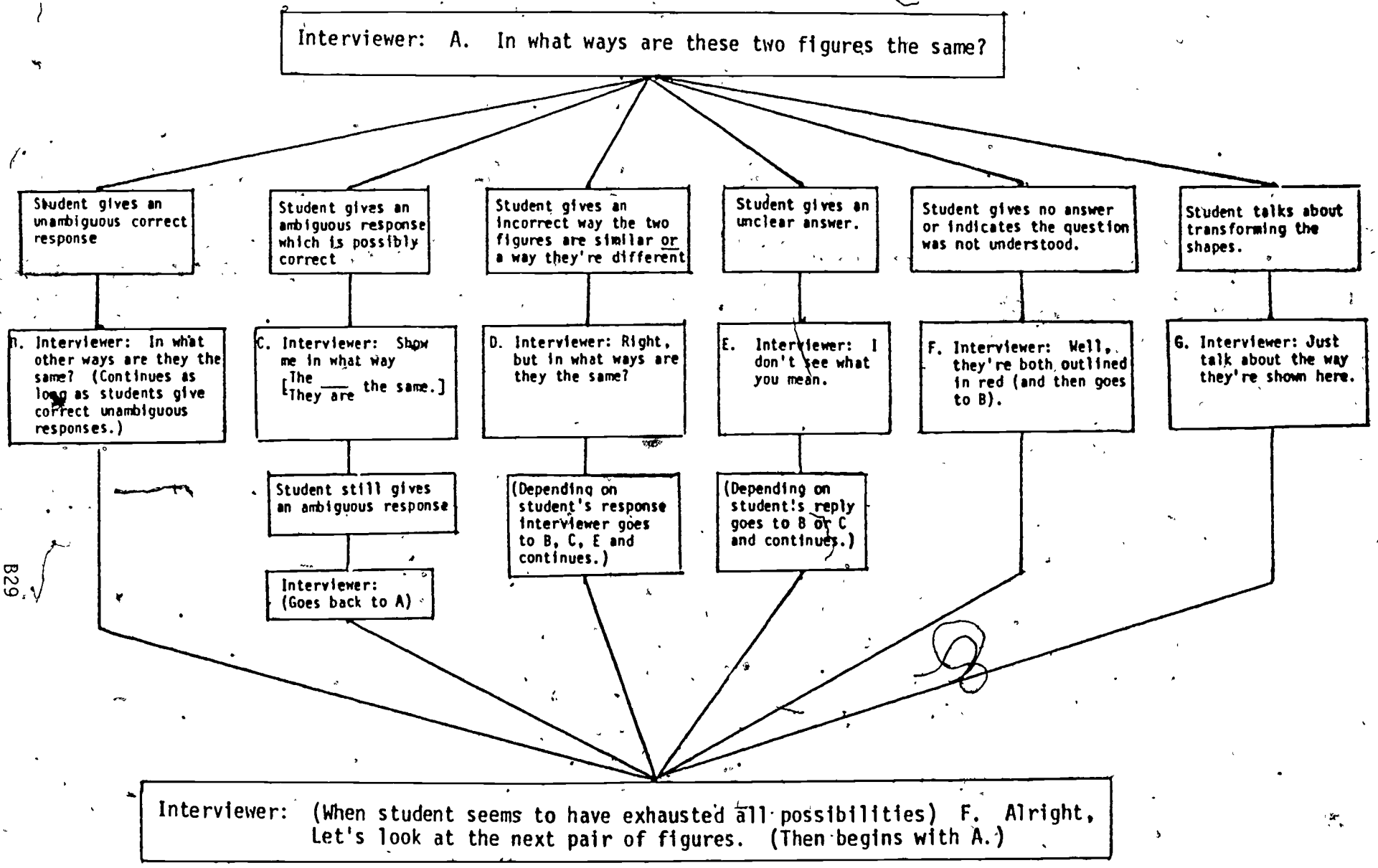
2) Students' comparisons of figure sides

3) Students' comparisons of figure angles

4) Interesting other comments made by students.

In all interviews, questioning of students followed the format shown on the facing page flowchart.

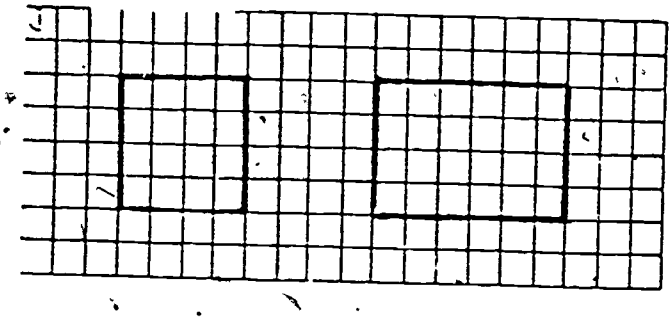
As each pair was shown to the students, the following protocol was used:



Geometry

PAIR 1

N = 30; 16 CSMP; 14 Non-CSMP



Samples of Students' Responses

Student X, whose comments are typical of non-specific responses:

Both have an area (traces) both have squares in them. They're sort of square -- well, this one's a square and that one's sort of a square.

Student Y, whose responses are typical of the specific but limited comments given by some students:

Each have 4 sides and 4 corners. An even number of squares - (gives a complicated metric based on interior squares) 4 & 4 + by 16 24 24 's +

Color-wise-red and black squares around the edges and white square. 4 high. Divisible by 4.

Student Z, whose responses are typical of the diffuse comments given by students:

4 sides - both of them are 4 sides. They - um - each two of the parallel lines are even (Pairs of parallel lines are even) (What do you mean by even?) Well, these two lines... I mean the lines are even with each other. (How do you mean even?) Well, the same length, (Same length, okay.) and the same breadth. (What other way?) They're both drawn centered in the graph. (Centered in the graph, how do you mean by that?) Centered, well here's the graph. One's not - um, graphed. They're each a group of blocks in the same in one plane. One's not here and one's down here. (In what other ways?) They each have four right angles. (Okay.) They're -- each of them can be broken up into smaller squares -- at the bottom -- the - um - if you make a cross in the middle with the four squares here. If you did the same here you'd get 4 rectangles. (Okay)

1) Nomenclature

Sides

Seventeen students (50% of the CSMP students and 64% of the Non-CSMP students) mentioned "sides"; "lines" were mentioned by 6% of the CSMP students and 29% of the Non-CSMP students.

Angles

Three students (13% of the CSMP students and 7% of the Non-CSMP students) mentioned "angles"; 19% of the CSMP students and 50% of the Non-CSMP students called them "corners" and 7% of the Non-CSMP students called them "points". *

Naming the Figures

Fifty-six percent of the CSMP students and 50% of the Non-CSMP students referred to the shape of the figures. However, students showed confusion in naming the figures. Both groups of students said they were "sort of squares" or were "square shaped rectangles". When probed for what defines a square and/or a rectangle, students offered either no response or a confused mix of technical and non-technical terms.

2) Students' Comparisons of Figure Sides

Twenty-five percent of the CSMP and 86% of the Non-CSMP students mentioned a similarity between one or more lines in the figures. For the CSMP students the comparisons were based on similarity between one or more lines in the figures; for the CSMP students the comparisons were based on similarity of line length, while for Non-CSMP students, the similarity was just as often the statement that the lines were alike because they were straight.

3) Students' Comparisons of Angle Similarity

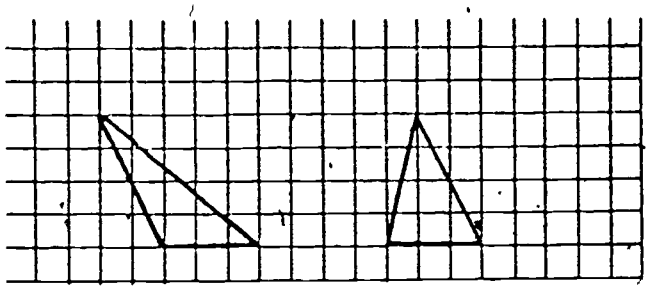
Only one CSMP student and one Non-CSMP student mentioned angle similarity - the CSMP student saying "They have right angles on the corners." and the Non-CSMP student saying "They have right angles."

4) Other Student Comments

An equal number of students (25% CSMP and 29% Non-CSMP) referred to the figures as not being "perfect" or as being "distorted" or as being "sort of squares".

*In all cases percentages, or counts of students (CSMP and Non-CSMP) are reported only when students mentioned an aspect (nomenclature, angles, etc.). Thus a statement "7% of the Non-CSMP students called them points" means no CSMP student called them points.

PAIR 2



Student M's comments are typical of the non-specific comments made:

Like in a triangle shape. 3 points. I'm not sure. On the same line.

Student N's comments are typical of comments made about the "distortions" in the figures:

Both sort of triangles. Both have an area. (traces) (Show me what you mean by that) That's sort of a triangle shape and that's sort of a triangle. It's a little off but...

Student O's comments are typical of the comparative statements made:

Both triangles and they each have 3 sides. Well, they're not perfectly shaped triangles. They have different sides but they're -- you know same shape - Um, they're not -- the sides are the same length - between the same length. They're both different lengths. All three of them.

1) Nomenclature

Sides.

Thirty eight percent of the CSMP students and 57% of the Non-CSMP students referred to "sides"; 6% of the CSMP students called them "lines" as did 43% of the Non-CSMP students.

Angles.

Thirteen percent of the CSMP students and none of the Non-CSMP students called them "angles"; 31% of the CSMP students called them "corners" as did 50% of the Non-CSMP students; 13% of the CSMP and 21% of the Non-CSMP students called them "points".

Shape.

Sixty-nine percent of the CSMP students and 64% of the Non-CSMP students mentioned that both were triangles.

2) Students' Comparisons of Figure Sides

Forty-four percent of the CSMP students and 50% of the Non-CSMP students compared one or more of the sides of the figures. CSMP students made comparisons based on the similarity of base lengths or the slant of one of the sides; Non-CSMP comparisons mentioned that the lines were straight.

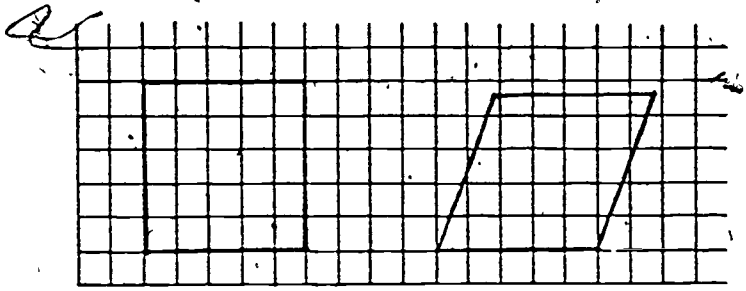
3) Students' Comparisons of Figure Angles

Only one student, Non-CSMP, mentioned angle similarity and that reference was "no right angles".

4) Other Student Comments

Two CSMP students mentioned the area of the triangles, i.e., "both have an area" and "...trying to see if the area is the same", while two other CSMP students said the figures were "sort of triangles".

PAIR-3



Student E whose responses were typical of the specific but limited comments of some students:

They have 4 corners and 4 sides. They're both have parallel lines. This also - well ...

Student F whose responses show students' mix of technical and non-technical terms as well as the type of side/side comparisons made:

Both have four corners and four points, same colors around the sides
This is parallogram (shows) a pushed over square.
And I think they have the same area-they have the same area (demonstrates by pointing to squares across and down) and each side is, I think, the same (points to each and traces)

Student G whose responses show more comparisons, but also the non-specificity of those comparisons:

Both got 4 sides. Both got 4 corners. Each of them - each of the parallel lines in each of ther are the same length. (In other words you mean the opposite sides). These two are the same length. These two. (Any other ways) Well...I was going to say you might classify them as squares. (In what way?) That they have. Oh no you couldn't. (What were you thinking of?) Well, I was thinking a square has 4 equal sides and um, angles. Angles (In what way does this qualify). This, well no. I was wrong because these - they don't have, there's just pairs of angles. This has the same angle as this. The corners, the opposite corners are the same angles. (How 'bout the sides?) The sides - (You said before the opposite sides were equal) Were equal - well all sides are equal - (Both of them?) Yes. (Okay that's another thing the same then) I guess so.

1) Nomenclature

Sides

Thirty one percent of the CSMP and 79% of the Non-CSMP students referred to "sides"; one CSMP student called them "lines".

Angles

Only one student, a CSMP student, referred to "angles"; 31% of the CSMP students called them "corners" as did 57% of the Non-CSMP students; 25% of the CSMP students called them "points" and so did 13% of the Non-CSMP students; one Non-CSMP student called them "tips".

Shape

Forty-four percent of the CSMP students made some reference to shape but those references ranged from "this is a parallelogram" to "both boxes, kinda square up on the bottom". In contrast, 86% of the Non-CSMP students referred to shape and most frequently referred to the figures as "squares" or "squarish".

2) Students' Comparisons of Figure Sides

Fifty-six percent of the CSMP students mentioned side/side similarities -- either in terms of side length or in terms of sides being parallel but only one student mentioned both; 71% of the Non-CSMP students mentioned side similarity, the most frequent reference was that the sides were straight but one student also mentioned that the lines parallel and were the same length.

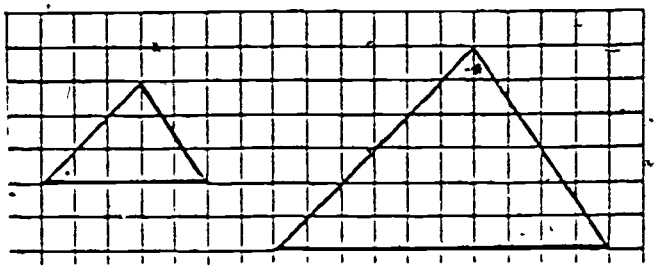
3) Students' Comparisons of Figure Angles

Only one student, Non-CSMP, made an angle/angle comparison, saying "The corners, the opposite corners are the same angles".

4) Other Student Comments

Both CSMP students and Non-CSMP students showed confusion over what to call the shapes ("both boxes") and also discussed straightening one of the figures ("If you'd slant this a little, you'd get that shape. This way you'd get whatever that's called") to make it more like a prototypical figure - a square.

PAIR 4



. . Student A, whose response typifies the specific mention of sides and angles:

They both have 3 sides. They both have 3 corners.

Student B, whose response shows confusion about nomenclature as well as acceptance of the figures as "real" triangles:

(In what ways are these two figures the same?) They're both trinagles. Ah, they have verticles and edges. That's a big triangle, that's a small triangle. And there's distortion right there and distortion right here. This is the same as this only it's smaller. (How do you mean "it's the same as this only smaller"?) Okay. This line is longer than that on both sides. On both of the triangles and... (Okay let's say the left, the left crooked line is longer than that left one and this one on that one, right. Okay. How else can you show me that they're the same?) I don't know. I don't see any other way. (That's it. Okay.)

Student C, whose response shows the attempt at comparisons:

(In what ways are these two figures the same?) Well, they're both triangles, both 3 angles, they both have 3 sides and they're...this one, I think. Hold on, It is the exact same angle but smaller. (A, ha) The exact same thing but reduced to, I'd say, 1/4. (What's smaller?) Well, there's less boxes on the inside. (Okay, it's smaller that way but the angles are the same?) Angles are the same. (Can you show me which angles are the same?) Well, that one is (the same as what?) Okay, that one, that one and that one, that one. (It's just that this triangle's bigger. Okay. Any other ways in which those two figures are the same?) Not that I know of. (Okay)

Nomenclature

Sides

Nineteen percent of the CSMP students referred to "sides" and 64% of the Non-CSMP students; 6% of the CSMP students called them "lines" and so did 14% of the Non-CSMP students.

Angles

One CSMP student referred to "angles"; 19% of the CSMP students called them "lines" and so did 57% of the Non-CSMP students; 13% of the CSMP students called them "points" and so did 3% of the Non-CSMP students, while one Non-CSMP student referred to "tips".

Shape

Seventy-five percent of the CSMP students referred to the shape and all but one of those students were unequivocal in calling the figures triangles; all the Non-CSMP students referred to shape but only 71% called them triangles.

2) Students' Comparisons of Figures' Side

Thirty-eight percent of the CSMP students referred to a comparison of figure sides, two of these students comparing the length of all 3 lines, i.e., the side length of one triangle is 1/2 the side length of the other; only one CSMP student referred to the slope of the lines. Sixty-four percent of the Non-CSMP students referred to the sides and 29% of those discussed the similarity in terms of the same "slant" or "distortion" of the lines.

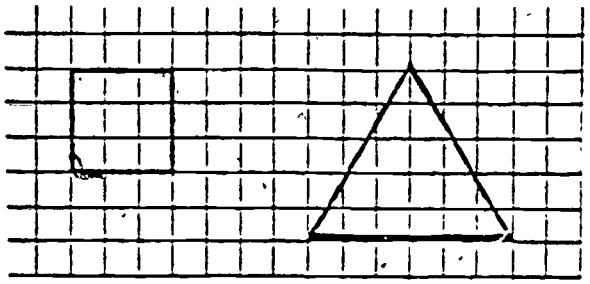
3) Students' Comparison of Figure Angle

Thirty-one percent of the CSMP students said "It was the same angle", two of those saying "It's smaller" one saying the "degrees" were the same, another saying "they both have acute angles on all three corners"; 14% of the Non-GSMP students referred to angle/angle comparisons.

4) Other Student Comments

One student (Non-CSMP) discussed "vertices and edges"; another used a figure/ground orientation and said "one's farther back, and one's closer in, or one's enlarged and one's small." Three of the students, 1 CSMP and 2 Non-CSMP described the figures as "not perfectly shaped, slanted" or "distorted" or not mathematically perfect".

PAIR 5



Student P, whose comparison is limited to "straight lines" and the figure/ground details:

(And in what ways are those two figures the same?) They both have straight lines surrounding them, they've both got square units in them. Both have lines in color. Nothing else. (No other ways?) Um-hum - are there? (Depends on how you look at it.)

Student R, whose comparison is at the more general level of shapes:

(In what ways are those two figures the same?) They're both geometric shapes. (How do you mean by that?) Well, they're red (Yeah, but that doesn't make them geometric shapes, right? What do you mean by geometric shapes.) I guess is what squares and circles and triangles. (Okay they kinda like... Any other ways in which they're the same?) No.

Student S, whose comments show how students tried to articulate within-figure comparisons:

(In what ways are these two figures both the same?) Okay, um, ... they both have a black and red line. Um, they're both shapes. (What do you mean by that?) Well, like, well not both shapes but, well, like square, yea square could be a shape and a triangle could be a shape and so they're both shapes. Uh-huh and eh. Well the points are different, like okay, okay. What I can say about this one that it has four points and they're directly on the lines and this one doesn't have 4 well, it's directly - well, the bottom part is directly on the line but these two lines are not and these have 3 points which, this, the square has 4 points (So that's ways that they're different but what ways are they the same) Okay, like I said they have black and red lines, they're both shapes - um- hum. I really can't find anything else.

1) Nomenclature

Sides

Six percent of the CSMP students mentioned "sides" and 7% of the Non-CSMP students; 21% of the Non-CSMP students referred to them as "lines".

Angles

Thirteen percent of the CSMP students referred to "points" and 14% of the Non-CSMP students referred to "corners".

Shape

Six percent of the CSMP students referred to both as "shapes" as did 21% of the Non-CSMP students. Another Non-CSMP student referred to them as "geometric figures".

2) Students' Comparisons of Figure Sides

One CSMP student said "the lines in both shapes are all the same length", while another said "both have areas and distances (perimeters)." Of the 21% Non-CSMP students discussing similarities, one said, "The number of sides is equal to the number of corners" while another's similarity was that all had straight lines, and another's was that "they're both enclosed".

Overall, neither group, CSMP or Non-CSMP, showed a high level of knowledge of nomenclature, of side/side similarity or angle/angle similarity. However, CSMP students used correct nomenclature slightly more than Non-CSMP, and were more sophisticated in their comparisons of sides. Specifically:

a) Nomenclature:

The nomenclature used by students, both CSMP and non-CSMP, was varied. While some students referred to "sides" and "angles", others referred to "lines" or "edges" and "corners", "tips", and "points". Both groups of students also used terms like "square", "parallel lines" and even "triangle" but, given the context in which those terms were used, it seems clear most students have only a hazy idea of what they mean.

b) Side/Side and Angle/Angle Comparisons:

When asked to compare the figures, a relatively low percentage of CSMP and non-CSMP students mentioned ways in which one, two, or more of the sides of the pairs were similar; and even fewer students mentioned ways in which the angles were similar. More frequently students made global comparisons, i.e., said the two figures in the pair were triangles, or squares.

However, under the socratic-type questioning strategies which the interview situation allowed for, students were able to generate comparisons of line to line or angle to angle which they had not generated under the initial round of questioning.

c) Other Comments:

Several students commented that the figures, especially the triangles, were not "mathematically perfect" or "were distorted" which suggests to us that children this age carry a mental template of a figure, like an isosceles triangle, against which they judge the "correctness" of other triangles.

Several children, when comparing the two figures, commented on what could be done to one figure to make it more like another figure, i.e., adding on more length, slanting it upright, suggesting that students were unable to see the relevant comparisons, but instead had to induce their own less elegant solutions.

Overall, students, both CSMP and Non-CSMP, were more likely to talk about the global aspects of the figures, shape or size, than they were to make within-shape comparisons (e.g., comparing all the angles in one figure to all the angles in the other). Both groups of students appeared to have no strategy for making the comparisons. For example, no student systematically began with a whole figure/whole figure comparison and then did part/part side and then part/part angle comparisons. It follows that all students were non-exhaustive in their solutions. Students also varied in what they discussed from figure to figure. For example, a student might mention area for one set of figures and then not mention it again for any other set. Finally, all students seemed not to have a working knowledge of a) of the necessary and sufficient conditions for naming the figures and b) of the technical meaning of terms like "parallel lines" of "angles", etc.

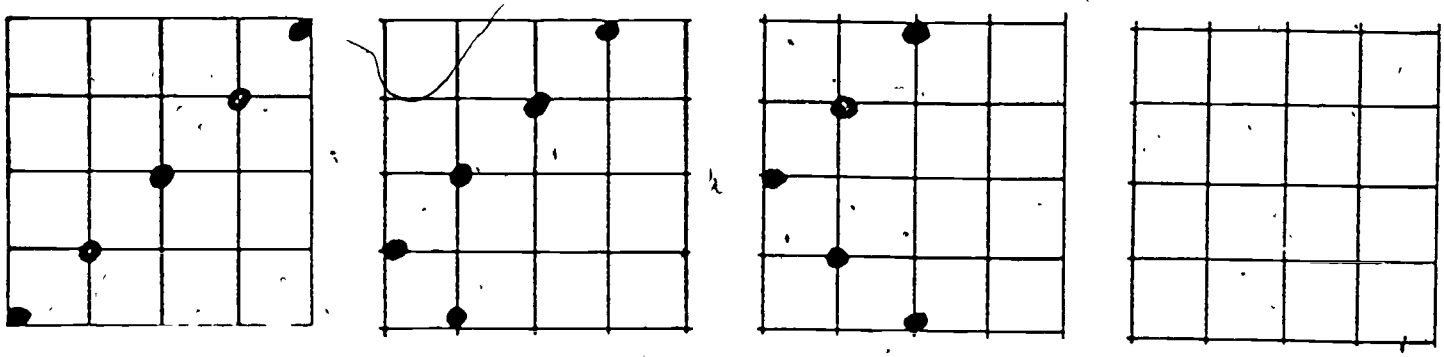
PATTERN RECOGNITION

Pattern Recognition/Generation

Like the geometry task, this task was conducted only in the interview setting and no paper and pencil scale paralled this task. Like the geometry task, it was administered to find out whether or not a pattern recognition/generation task would be understood by students and whether or not their responses would yield meaningful data on pattern recognition/generation in general and CSMP/Non-CSMP differences in particular.

Each student was interviewed individually and was presented with a sheet of paper on which three grids were filled in and the fourth plus a page of blank boxes was available. (See below for a sample of the student page.) Students were asked, "What would the fourth look like? and the fifth? and the sixth? are there any other sixths? and any others?" until students seemed to have exhausted all the patterns they could generate.

Patterns

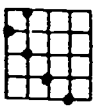


1st 2nd 3rd 4th

Student Generated Patterns

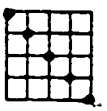
Students' Responses:

4ths



6 CSMP
4 Non-CSMP

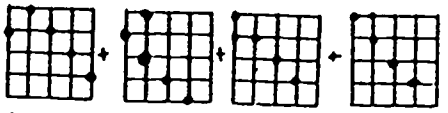
5ths



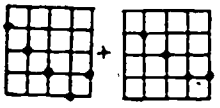
6 CSMP
4 Non-CSMP

Non-CSMP

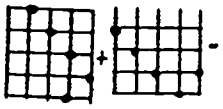
6ths



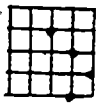
1 Non-CSMP



1 Non-CSMP

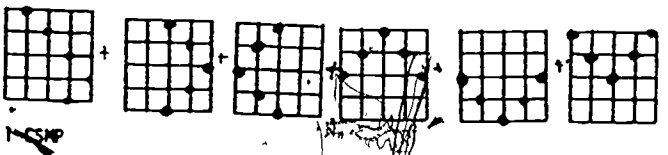


1 Non-CSMP

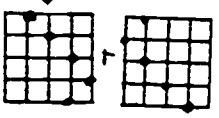


1 Non-CSMP

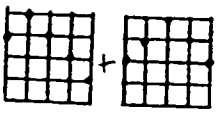
CSMP



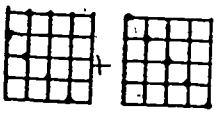
1 CSMP



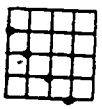
1 CSMP



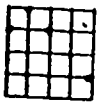
1 CSMP



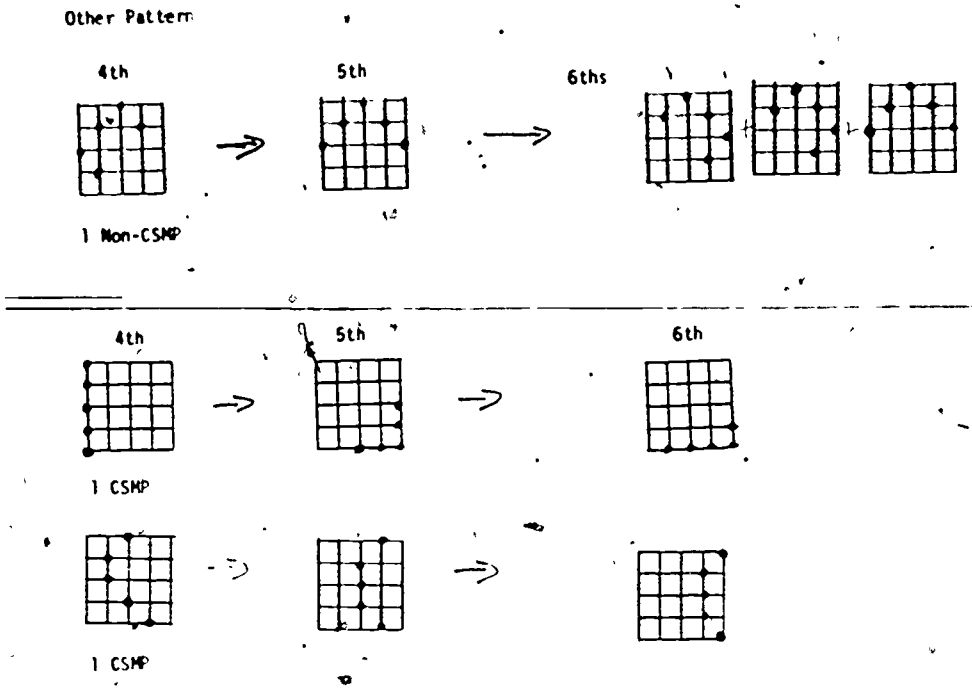
1 CSMP



1 CSMP



1 CSMP



Discussion

Overall, the patterns generated by both groups were similar. Four of the five Non-CSMP and six of the eight CSMP students had identical fourth patterns; three of the five Non-CSMP and seven of the eight CSMP students had identical fifth patterns. But many different patterns were generated for the sixth pattern. In spite of these difference among students, most of these patterns were logical extensions of the students' previous patterns. CSMP students and Non-CSMP students were similar in their ability to generate additional sixth patterns; i.e., a few students in both groups generated only one sixth, a few in both groups generated two, and a few in both groups generated three patterns.

All students understood the task and acted as though "the pattern really is there".

Summary of Interview Results

The interviews showed that the majority of students understood the task demands of the new scales, and, in most cases, had the mathematical knowledge to complete the tasks. While there were few marked CSMP/Non-CSMP differences, CSMP students showed a higher level of sophistication in use of nomenclature and/or ease of solution.

For both CSMP and Non-CSMP individual students were fairly consistent in their level of success on the MANS tasks and on the pattern recognition task. On the geometry task, however, there was considerable within-student variation in the way the various figures were analyzed.