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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. CSMP was developed as a curriculum for ordinary classroom use, but several school districts have begun to use the materials for elementary school students identified as well above average in ability. Three sites during the 1980-1981 school year carried out some kind of testing program to evaluate student outcomes, and these are the subject of this document. All the sites are located in large towns within 40 miles of relatively large cities in the Midwest. The Mathematics Applied to Novel Situations (MANS) test was used in administration. Results indicated a very strong CSMP advantage in probability, a strong advantage in estimation and other number systems, and a relatively weak advantage in computation, number patterns and relationships, and word problems. (MP)

Extended Pilot Trial of the Comprehensive School Mathematics Program

Evaluation Report 8-B-4

Three Evaluations of Gifted Student Use

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Math Research and Evaluation Studies
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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 (1975)	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-4
Three Evaluations of Gifted Student Use

Introduction

The Comprehensive School Mathematics Program (CSMP) has been developed as a K-6 curriculum in mathematics for ordinary classroom use. Nevertheless, during the last two or three years, school districts have begun to use CSMP for elementary school students identified as well above average in ability: gifted, upper track, etc. In the 1980-81 school year, three districts did this and also carried out some kind of testing program to evaluate student outcomes.[1]

Although each district had a somewhat different student identification procedure, a different type of utilization of CSMP and a different evaluation design, it is instructive to characterize the differences between the three and standardize the results so that comparisons can be made. With only three districts involved, one can only speculate as to what characteristics of the program account for various differences in achievement. As studies of this nature are accumulated over the years, it may be possible eventually to draw more definite conclusions about this use of CSMP.

In each site (district) the student achievement was measured using the MANS tests. The MANS Tests (Mathematics Applied to Novel Situations) are short test scales developed especially to assess what are throught to be some of the underlying thinking skills of CSMP. MANS scales of various kinds have been used in the evaluation of CSMP in second through fifth grade.

The scales are administered by trained testers, who follow 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

[1] An individual report on the results at each site was prepared in mimeographed form and made available to each school district.

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 unfamiliar to both CSMP and non-CSMP students.

The Setting in the Three Sites

All three sites are located in large towns (not suburbs) within 40 miles of relatively large cities in the Midwest.

Site 1

In the spring of 1980, this district was preparing to begin a gifted mathematics program for some its elementary school students. As part of this preparation, and partly for the purpose of helping to select students (though mainly for evaluation purposes) the MANS tests were administered to a small number of students in grades 2-4.

These students and many others added later, received instruction during the 1980-81 year in selected materials from the Comprehensive School Mathematics Program. Instruction was carried out by two teachers who were not math teachers during the other times of the day, but who had previous math teaching experience. The program was supplemental to the regular mathematics program of the district; 20-30 minutes were allocated to it every third day.

At the end of the year, the MANS tests were again administered to students in the program in grades 2-4. Thus it was possible to compare the performance of second graders in 1980 (who had not had CSMP) with the second graders in 1981 (who did have CSMP), and similarly for third and fourth graders.

Site 2

During the 1980-81 school year, approximately 40 students in the district, who had been identified as gifted, began special instruction. These students were in grades 1 through 6, with the majority in the upper grades. This was the

beginning of a three-year cycle of identification and instruction. Presumably, for the 1983-84 school year, another selection procedure will be carried out.

Students received this special instruction for an hour each school day, and this time was in addition to their regular program. Part of this instruction was in mathematics and this was done twice a week for about 30-40 minutes each time. The instruction in mathematics was a special schedule for gifted students from the Comprehensive School Mathematics Program; the schedule was different for each grade level, except that fifth and sixth graders studied the same schedule. Prior to this year, no set program in mathematics was used with gifted students, but rather an eclectic approach emphasizing problem solving.

Instruction was carried out by two special teachers, who reported that they were very pleased with the program and that it had many positive aspects. The program will be continued next year.

Site 3

At every grade level at each elementary school the students are grouped into 2, 3 or 4 classes (depending on enrollment) according to reading ability and are regrouped for math primarily on the basis of achievement test scores but also teacher recommendations. The "gifted" student program is for the students in the highest ability classes. The Comprehensive School Mathematics Program (CSMP) was used for the first time in 1980-81, by about half of the "gifted" classes. The classes were selected as the result of the teachers volunteering to be trained in CSMP. All grade levels were represented but most were concentrated in grades 3 through 5.

The regular CSMP program was taught essentially everyday during the math period. It was supplemented to some extent (usually between 5 and 15%) with more traditional material. Judging from the observation of about half of the CSMP teachers, the program was implemented faithfully. Most CSMP teachers covered 3/4 to 7/8 of the prescribed CSMP curriculum for their particular grade level.

In Table 1, the above information is summarized and the essential elements of the evaluation design is given for each site.

Table 1

Summary of Site Information

Characteristics		Site 1			Site 2			Site 3		
Type of Student		Gifted			Gifted			Upper Track		
Percent of Usual Math Time Actually Used for Math		120			130			100		
Percent of Actual Math Time Used for CSMP		about 15			about 25			about 90		
Comparison Group not studying CSMP		comparable groups tested Spring 1980			themselves tested in Fall 1980			comparable groups tested Spring 1981		
Grades Tested		2nd	3rd	4th	2nd-4th	5th	6th	2nd	3rd	4th
No. of Students	CSMP	12	17	11	9	7	10	33	81	81
	Non-CSMP	6	6	8	9	7	10	38	71	72
MANS Test Used*		old 3rd	old 4th	old 5th	old 4th	old 5th	old 5th	Blue	Green	old 4th

*The MANS Tests have been developed for each of 2nd through 5th grades. Currently the MANS Tests for each of these grade levels is being revised so as to be more readily administered by local school systems: the revised 2nd grade MANS Test is now called the Blue Level, the revised 3rd grade, the Green Level. The MANS Tests used in this study are described in some detail in Appendices D through H.

Comparison of the Results

In order to compare the evaluation results at the three sites, it was necessary to use a common statistic. For each grade level at each site a mean score on Total MANS was calculated for the CSMP students and the non-CSMP students.[1] Then it was determined what percentage increase (+) or decrease (-) the CSMP mean was in comparison to the non-CSMP mean. This latter figure was entered into the appropriate location in Table 2. Then, means were calculated across grades for each site (the last row of figures) and means were calculated across sites for each grade (the last column of figures). Finally in the lower right corner is the mean of the grade level means across sites.

Table 2

Percent Differences in Means on Total MANS Score*

by Site and Grade Level

(+ = CSMP advantage; - = non-CSMP advantage)

	Site 1			Site 2			Site 3			Means across sites
	Gr 2	Gr 3	Gr 4	Gr 2-4	Gr 5	Gr 6	Gr 2	Gr 3	Gr 4	
Gr 2	+.10						+.07			+.08
Gr 3		+.07						+.24		+.15
Gr 4			-.08						+.18	+.05
Gr 2-4				+.64						+.64
Gr 5					+.22					+.22
Gr 6						+.09				+.09
Mean across grades		+.03			+.32			+.16		+.20

*The actual means for CSMP and non-CSMP for each site and grade level can be found in Appendices A through C.

[1] At the third and fourth grades in Site 3 (where many more students were involved), these means were taken across classes instead of across students.

From Table 2, it is clear that, except in fourth grade at Site 1, CSMP outscored non-CSMP at every grade level at every site. Looking at the grade level means across sites (the last column), the CSMP advantage is fairly consistent except for the Grades 2-4 group coming from Site 2, where it is much larger. Looking at the site means across grades (the last row), the CSMP advantage depends a great deal on the site. This latter is not too surprising given the great variation in the math program and evaluation method at each site. Site 2 showed the largest advantage in favor of CSMP, but that CSMP group received the most math instruction and the scores were compared Fall to Spring. Site 1 showed the smalle advantage in favor of CSMP, but that CSMP group received the least exposure to CSMP and was compared Spring to Spring (the more conservative approach).

The MANS tests consist of various individual scales each of which involves an aspect of mathematics. The scales have been grouped into some ten categories[1], according to the content of the scales. Six of the categories contain enough scales to make it worthwhile to look at them separately. Therefore in Table 3, for each of these six categories, there is a section which was constructed for the total score on the scales in that category exactly as Table 2 was constructed for the total MANS score.

[1]The reader can consult Appendices D through H where the scales are listed and described by category.

Table 3

Percent Differences in Means Across Scales in a Category

by Site and Grade Level

(+ = CSMP advantage, - = Non-CSMP advantage)

	Site 1			Site 2			Site 3			Mean across sites
	Gr 2	Gr 3	Gr 4	Gr 2-4	Gr 5	Gr 6	Gr 2	Gr 3	Gr 4	
Computation										
Gr 2	02						09			05
Gr 3		07						18		12
Gr 4			-22						15	-04
Gr 2-4				142						142
Gr 5					26					26
Gr 6						09				09
Means across grades		-04			59 (17)*			14		32 (10)*
Estimation										
Gr 2	17						22			19
Gr 3		00						38		19
Gr 4			-06						.12	03
Gr 2-4				38						38
Gr 5					26					26
Gr 6						19				19
Means across grades		04			28			24		21
Other Number Systems										
Gr 2	-09						09			00
Gr 3		-09						33		12
Gr 4			-09						38	14
Gr 2-4				75						75
Gr 5					39					39
Gr 6						14				14
Means across grades		-09			43			27		26
Probability										
Gr 2	—						—			—
Gr 3		85						—		85
Gr 4			-08						19	05
Gr 2-4				189						189
Gr 5					21					21
Gr 6						05				05
Means across grades		38			72			19		61
Number Patterns & Relationships										
Gr 2	09						06			07
Gr 3		24						26		25
Gr 4			04						29	16
Gr 2-4				54						54
Gr 5					16			—		16
Gr 6						05				05
Means across grades		01			09			08		07
Word Problems										
Gr 2	-10						-09			-10
Gr 3		18						28		23
Gr 4			-04						05	00
Gr 2-4				25						25
Gr 5					-08					-08
Gr 6						10				10
Means across grades		01			09			08		07

*( ) = average with grades 2-4 Computation entry removed.

Looking at the lower right figure for each category, and using the more appropriate "10" (in parentheses) for computation, it is clear that there is considerable variation in the results depending on the category of scale. Whereas the CSMP advantage is relatively weak (7 to 10 percent) in Computation, Number Patterns & Relationships, and Word Problems, it is rather strong in Estimation and Other Number Systems (fractions and decimals), and very strong in Probability.

It is instructive to compare these results to the results obtained from data collected previously, on much larger numbers of students, the majority of which were not gifted. This comparison is made in Table 4.

Table 4

Mean[1] Percent Differences in Category Means

Gifted Data[2] vs Previous Data[3]

Category	Gifted Data	Previous Data
Computation	+.32 (+.10)	+.09
Estimation	+.21	+.10
Other Number Systems	+.26	+.21
Probability	+.61	+.14
Number Patterns & Relationships	+.20	+.20
Word Problems	+.07	+.15

[1]Mean Across sites and then across grades.

[2]Grades 2 through 6.

[3]Grades 2 through 5.

The present results on gifted students is quite similar to the previous data in three of the six categories: Computation, Other Number Systems and Number Patterns & Relationships. In Estimation and Probability the CSMP advantage is much greater with gifted students than with all students, but in Word Problems it is not as great.

Appendix A

Site One Results by Scale Category

Table 5

Site One

Second Grade Results by Scale Category

Scale Category (specific scales)[1]	Number of Items	Mean Scores Across Students		Percent Gain
		1980	1981	
Computation (A5)	12	6.2	6.3	02
Estimation (A2, B1, B4, B5)	56	25.8	30.3	17
Fluency (B3)	12	6.8	8.3	22
Other Number Systems (B7)	8	3.5	3.2	-09
Number Relations (A1, A3, A6, A7, B2)	26	19.8	21.5	09
Word Problems (A4, B6)	10	6.0	5.4	-10
Total	124	68.1	75.0	10

[1]See Appendix F for the description of the scales, listed by category.

Table 6

Site One

Third Grade Results by Scale Category

Scale Category (specific scales)[1]	Number of Items	Mean Scores Across Students		Percent Gain
		May '80 (n=6)	May '81 (n=17)	
Computation (C1, C2, C3, C6)	39	22.3	23.8	07
Estimation (E1, E2, E3, E4, E5)	43	24.6	24.7	00
Geometry (G1)	8	5.8	6.5	12
Other Number Systems (N1, N2, N3)	19	9.5	8.6	-09
Probability (P1)	19	3.3	6.1	85
Number Relations (R1, R2, R3, R4, R5)	49	22.7	28.1	24
Place Value (V1, V2)	19	14.0	12.0	-14
Word Problems (W2)	7	4.0	4.7	18
Total	176	106.6	113.9	07

[1]See Appendix G for the description of the scales, listed by category.

Table 7

Site One

Fourth Grade Results by Scale Category

Scale Category (specific scales)[1]	Number of Items	Mean Scores Across Students		Percent Gain
		May '80 (n=8)	May '81 (n=11)	
Computation (C1, C2)	40	32.9	25.8	-22
Estimation (E2, E3, E4, E7, E8, M1)	29	27.9	26.2	-06
Other Number Systems (N2, N5, N8 N10, N1)	41	26.7	24.4	-09
Number Patterns and Relationships (O1, R1, R2)	28	20.4	21.3	04
Probability (P1, P2)	31	20.4	18.7	-08
Elucidation (U1)	25	14.1	15.1	07
Word Problems (W3)	5	2.8	2.7	-04
Total	199	145.8	134.2	-08

[1]See Appendix H for the description of the scales, listed by category.

Appendix B

Site Two Results by Scale Category

Table 8

Site Two

Second Through Fourth Grade Results by Scale Category

Scale Category (specific scales)[1]	Number of Items	Mean Scores Across Students		Percent Gain
		Fall '80 (n=9)	May '81 (n=9)	
Computation (C1, C2, C3, C6)	39	13.4	32.4	142
Estimation (E1, E2, E3, E4, E5)	43	24.7	34.0	38
Geometry (G1)	8	6.2	7.8	26
Other Number Systems (N1, N2, N3)	19	9.5	16.6	75
Probability (P1)	19	4.4	12.7	189
Number Relations (R1, R2, R3, R4, R5)	49	27.2	41.9	54
Place Value (V1, V2)	19	11.1	15.0	35
Word Problems (W2)	7	5.1	6.4	25
Total	176	101.6	166.6	64

[1]See Appendix G for the description of the scales, listed by category.

Table 9

Site Two

Fifth Grade Results by Scale Category

Scale Category (specific scales)[1]	Number of Items	Mean Scores Across Students		Percent Gain
		Fall'80 (n=7)	May'81 (n=7)	
Computation (C1, C2)	40	26.9	33.8	26
Estimation (E2, E3, E4, E6, E9, M1)	29	26.1	32.8	26
Other Number Systems (N2, N3, N6 N9, N1, N2)	51	31.4	43.7	39
Number Patterns and Relationships (O1, R1, R2)	28	18.8	21.9	16
Probability (P1, P2)	31	18.7	22.7	21
Elucidation (U1)	25	18.2	17.1	-06
Word Problems (W3)	5	3.8	3.5	-08
Total	209	143.9	175.5	22

[1]See Appendix H for the description of the scales, listed by category.

Table 10

Site Two

Sixth Grade Results by Scale Category

Scale Category (specific scales)[1]	Number of Items	Mean Scores Across Students		Percent Gain
		Fall'80 (n=10)	May'81 (n=10)	
Computation (C1, C2)	40	34.4	37.5	09
Estimation (E2, E3, E4, E6, E9, M1)	29	30.1	35.9	19
Other Number Systems (N2, N3, N6 N9, N1, N2)	51	42.0	47.7	14
Number Patterns and Relationships (O1, R1, R2)	28	22.8	23.9	05
Probability (P1, P2)	31	27.4	28.8	05
Elucidation (U1)	25	21.5	20.8	-03
Word Problems (W3)	5	4.1	4.5	10
Total	209	182.3	199.3	09

[1]See Appendix H for the description of the scales, listed by category.

Appendix C

Site Three Results by Scale Category

Table 11

Site Three

Second Grade Results by Scale Categories

Scale Category (specific scales)[1]	Number of Items	Adjusted[2] Mean Scores, May 1981		Percent Gain
		non-CSMP Students (n=38)	CSMP Students (n=33)	
Computation (C1, C2)	21	14.0	15.2	09
Estimation (E2, E3, E4)	18	9.2	11.6	22
Fluency (F1)	16	11.4	10.8	-05
Other Number Systems (N1) (Negative Numbers)	4	2.2	2.4	09
Number Patterns and Relationships (R1,R3,R4,R5)	23	13.4	14.2	06
Place Value (V3)	11	8.7	9.3	07
Word Problems (W1)	9	6.7	6.1	-09
Total	102	65.9	70.3	07

[1] See Appendix D for the description of the scales, listed by category.

[2] These mean scores were adjusted to take into account differences in reading ability, based on scores from the Gates-McGinitie Vocabulary Test, Level B, Form 1. The mean scores on this vocabulary test were 38.7 for CSMP students and 41.3 for non-CSMP students. The adjustment of MANS scores was relatively small - less than 2% (adjusted upward for CSMP and downward for non-CSMP).

Table 12

Site Three

Third Grade Results by Scale Category

Scale Category (specific scales)[1]	Number of Items[2]	Adjusted[2] Mean Scores, May 1981		Percent Gain
		Non-CSMP Classes (n=4)	CSMP Classes (n=5)	
Computation (C1, C2)	54	35.8	42.2	18
Estimation (E1, E2, E3, E4)	34	19.1	26.3	38
Geometry (G1)	6	3.2	3.7	16
Other Number Systems (N1) (Negative Numbers)	8	4.8	6.4	33
Number Patterns and Relationships (R1,R2,R4,R5)	48	29.7	37.3	26
Place Value (V4)	16	9.0	10.3	14
Word Problems (W2, W4)	12	7.1	9.1	28
Total	178	109.0	135.5	24

[1]See Appendix E for the description of the scales, listed by category.

[2]These mean scores were adjusted based on scores from the Gates-McGinitie Vocabulary Test, Level C, Form 1. The mean scores on this vocabulary test were nearly identical, 41.2 for CSMP classes and 41.0 for non-CSMP classes, so that adjustments in MANS scores were miniscule.

Table 13

Site Three

Fourth Grade Results by Scale Category

Scale Category (specific scales)[1]	Number of Items[2]	Adjusted[2] Mean Scores, May 1981		Percent Gain
		non-CSMP Classes (n=4)	CSMP Classes (n=4)	
Computation (C4, C5, C6, C7)	26	17.2	19.7	15
Estimation (E1, E2, E3, E4)	35	23.4	26.1	12
Geometry (G1)	8	5.1	5.1	00
Other Number Systems (N1, N2, N3)	19	6.4	8.8	38
Probability (P1)	19	7.3	8.7	19
Number Patterns and Relationships (R1,R2,R3,R4,R5)	49	32.6	42.2	29
Place Value (V1)	8	4.6	44.6	00
Word Problems (W1, W2)	14	10.2	10.7	05
Total	178	104.5	123.7	18

[1]See Appendix G for the description of the scales, listed by category.

[2]The mean scores were adjusted to take into account differences in Total Ability scores from the Scholastic Testing Service (S.T.S.) Educational Development Series, Elementary Level, Form R. The mean total ability scores were 69.9 for CSMP classes and 67.7 for non-CSMP classes. The adjustment of MANS scores, to take into account these differences, was as high as 5% (adjusted downwards for CSMP and upwards for non-CSMP).

APPENDIX D

Description of the Blue Level (Second Grade) MANS Scales

Given to 2nd Graders at Site 3

(C) COMPUTATION

(C1) Computation

Abstract: Items patterned after those in arithmetic computation sections of standard achievement tests for 2nd Grade.
(9 items (using +,−,x), 2 forms)

Examples:

$$\begin{array}{r} 19 \\ +\,6 \end{array} \qquad \begin{array}{r} 49 \\ -\,7 \end{array} \qquad 5 \times 8 =$$

(C2) Mental Arithmetic

Abstract: Put the number in the box which makes the number sentence true, where the box may be in any of the "3 positions" and where the numbers are large and easy to work with.
(12 items (using +,−,x), 2 forms)

Examples:

$$\square + 70 = 90$$

$$600 - 100 = \square$$

$$3 \times \square = 300$$

(E) ESTIMATION

(E2-E4) Estimating Intervals

Abstract: Given a computation problem, and 5 fixed intervals (0-10, 10-50, 50-100, 100-500, 500-1000), determine which interval contains the answer to the problem and put an x in the interval. By instruction, format and time limits, students are discouraged from computing exact answers.

Examples:

(E2) Estimating Intervals - Addition

51 + 53 | 0 | 10 | 50 | 100 | 500 | 1000

(7 items, on form, time limit: 1½ minutes)

(E3) Estimating Intervals - Subtraction

900 − 601 | 0 | 10 | 50 | 100 | 500 | 1000

(6 items, one form, time limit: 1½ minutes)

(E4) Estimating Intervals - Multiplication

5 x 11 | 0 | 10 | 50 | 100 | 500 | 1000

(5 items, one form, time limit: 1½ minutes)

(F) FLUENCY

(F1) Number Fluency

Abstract: Given sample number sentences about 9 (9 = 10 - 1, 9 = 1 + 5 + 3, 9 = 3 x 3, 9 = 18 ÷ 2) make up as many number sentences as you can about 8. (Open ended, but a maximum of 16 were counted, 1 form, time limit = 4 minutes)

Example:

My number sentences about 8.

8 = _____ 8 = _____

8 = _____ 8 = _____

8 = _____ 8 = _____

(N) OTHER NUMBER SYSTEMS

(N1) Negative Numbers

Abstract: Given the starting score (which could be above or below zero), and how much the score went up or down, determine the final score. (4 items, two forms).

Example:

Dave: Score at the start: 5 below zero
Then: Won 2

Score at the end? 7 below zero 3 below zero 3 above zero 7 above zero

(R1) Solving Number Machines

Abstract: From 3 pairs of numbers (clues), determine what the person's game is (i.e. how the second number is derived from the first). Then use this knowledge to find the missing number from the 4th pair.
(4 items, two forms)

Example:

David's Game

	Class said:	David's answer:
First clue:	5	10
Second clue	1	2
Third clue:	3	6
Question:	4	☐

(R3) Sequences

Abstract: Determine the missing number in a given sequence of numbers.
(5 items, two forms)

Example:

28, 25, ___, 19, 16, 13

(R4) Which is Larger?

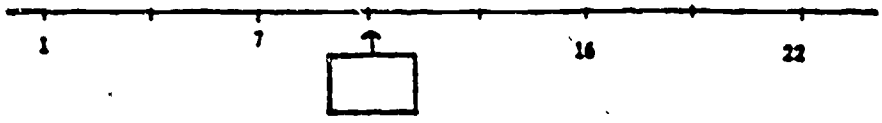
Abstract: Given two similar computation problems choose the one which gives the larger answer. By instruction, format and time limits, students are discouraged from computing exact answers. The larger answer could always be determined more easily by inspection than by doing the computation.
(9 items (using +,−,x), 2 forms, time limit = 3 minutes)

Example: 585 + 250 ☐
580 + 290 ☐ (Check the larger one)

(R5) Labelling Number Lines

Abstract: Given a number line with some of the marks labelled, use the pattern shown to fill in the indicated blank with a label. A sample was worked collectively.
(5 items, 2 forms)

Example:



(V) PLACE VALUE

(V3) Writing Numbers

Abstract: a) Write a number that is read aloud. (6 items, one form)
b) Given a number, determine what number is 1, 10 or 100 larger or smaller than the given number. A sample item was worked collectively. (5 items, 2 forms)

Example:

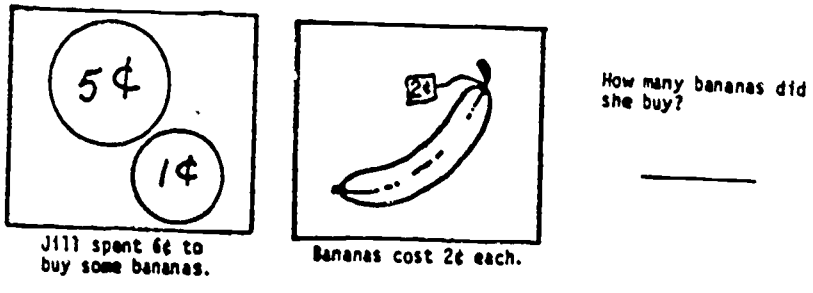
What number is 10 more than 402? _____

(W) WORD PROBLEMS

(W1) One-step Word Problems

Abstract: As the student looks at a series of cartoons and and/or follows the story in the captions below, the story is read by the tester. (9 items, 1 form)

Example:



_____

APPENDIX E

Description of the Green Level (Third Grade) MANS Scales

Given to 3rd Graders at Site 3

(C1) Computation

Abstract: Items patterned after those in arithmetic computation sections of standard achievement tests for 3rd grade.
(17 items (+,−,x,÷), 2 forms)

Example:

$$\begin{array}{r} 124 \\ +305 \\ \hline \end{array} \qquad \begin{array}{r} 679 \\ -338 \\ \hline \end{array} \qquad \begin{array}{r} 53 \\ \times\ 3 \\ \hline \end{array} \qquad 84 \div 2 =$$

(C2) Large Number Computation

Abstract: Put the number in the box which makes the number sentence true, where the box may be in any of the "3 positions" and where the numbers are large and easy to work with.
(10 items (+,−,x), 2 forms)

Examples:

$500 + \square = 800$

$\square - 150 = 50$

$2 \times 200 = \square$

(E) ESTIMATION

(E1) Two, Five or Ten

Abstract: Quickly estimate whether a given number is about 2 or 5 or 10 times as large as another given number. A sample item was worked collectively. (12 items, one form, time limit: 3 minutes)

Examples:

65 is about _____ times as large as 12

602 is about _____ times as large as 298

(E2-E4) Estimating Intervals

Abstract: Given a computation problem, and 5 fixed intervals (0-10, 10-50, 50-100, 100-500, 500-1000), determine which interval contains the answer to the problem, and put an x in the interval. By instructions, format and time limits, students are discouraged from computing exact answers.

Examples:

(E2) Estimating Intervals - Addition

19 + 29	0	10	50	100	500	1000
279 + 165	0	10	50	100	500	1000

(8 items, one form, time limit: 1½ minutes)

(E3) Estimating Intervals - Subtraction

105 − 8	0	10	50	100	500	1000
827 − 231	0	10	50	100	500	1000

(8 items, one form, time limit: 1½ minutes)

(E4) Estimating Intervals - Multiplication

2 x 209	0	10	50	100	500	1000
5 x 11	0	10	50	100	500	1000

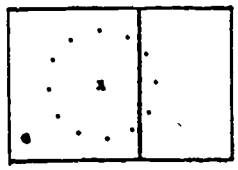
(6 items, one form, time limit: 1½ minutes)

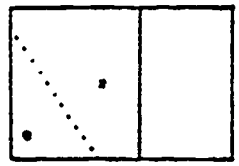
(G) GEOMETRY

(G1) Loci

Abstract: Presented with six pictures which have an identically placed line, "x" and "o" and a different series of dots, the student must determine which picture a given statement describes. No samples. First statement read by tester.
(6 items, 1 form)

Examples:

A 

E 

2. All the dots are the same distance from the x in picture ____.

5. Each dot is just as close to x as to o in picture ____.

(N) OTHER NUMBER SYSTEMS

(N1) Negative Numbers

Abstract: Given the starting score (which could be above or below zero), and how much the score went up or down, determine the final score. 2 sample items.
(4 items, 2 forms)

Examples:

Ann: Score at the start: 3 below zero
Then: Lost 4
Score at the end? 7 below zero 1 below zero 1 above zero 7 above zero

Billy: Score at the start: 2 above zero
Then: Lost 4
Score at the end? 6 below zero 2 below zero Zero 2 above zero

(R) NUMBER RELATIONS

(R1) Solving Number Machines

Abstract: From 3 pairs of numbers (clues), determine what the person's game is (i.e. how the second number is derived from the first). Then use this knowledge to find the missing number from the 4th pair.
(4 items, 2 forms)

Examples:

MARIA'S GAME

	Class said:	Maria's answer:
First clue:	5	10
Second clue:	7	12
Third clue:	8	13
Question:	2	☐

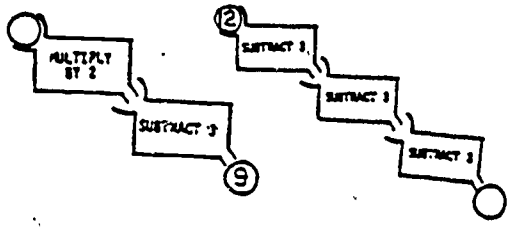
JIM'S GAME

	Class said:	Jim's answer:
First clue:	?	6
Second clue:	5	9
Third clue:	10	14
Question:	☐	12

(R2) Using Number Machines

Abstract: Given a number of labelled machines in sequence, find the initial or the terminating number, given the other. 3 samples.
(5 items, 2 forms)

Examples:



(R4) Check the Larger?

Abstract: Given two similar computation problems, choose the one which gives the larger answer. By instruction, format and time limits, students are discouraged from computing exact answers. The larger answer could always be determined more easily by inspection than by doing the computation.
(10 items, 2 forms)

Examples:

Sample Problem 1

200 ☐		173 + 174 ☐
2 X 127 ☑		172 + 175 ☐

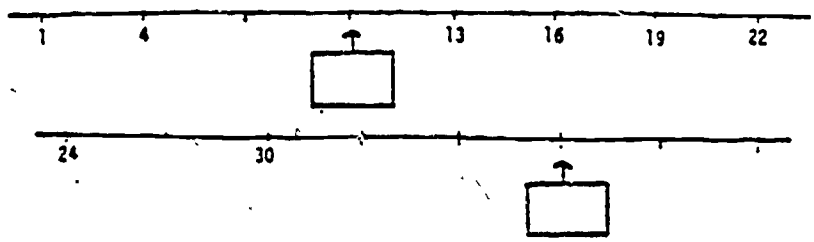
Sample Problem 2

31 + 90 ☑		69 ÷ 57 ☐
27 30 + 91 ☑		69 X 57 ☐

(R5) Number Line Labelling

Abstract: Given a number line with some of the marks labelled use the pattern shown to fill in the indicated blank with a label. A sample was worked collectively.
(5 items, 2 forms)

Examples:



(V) PLACE VALUE

(V4) 1, 10, 100, 1000

Abstract: Given two numbers decide whether the first number is about 1, 10, 100, or 1000 more than the second. Two sample items.
(8 items, 2 forms, time limit: 2 minutes)

Examples:

4,265 is about 1 / 10 / 100 / 1000 more than 4,254

2,050 is about 1 / 10 / 100 / 1000 more than 2,039

(W) WORD PROBLEMS

(W2) Two Stage Word Problems

Abstract: Word problems read to the students in which two different operations must be performed and where the numbers in the given data are relatively small.
(6 items, 1 form)

Examples:

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? _____

There are 40 apples in our barrel now.
We will eat 2 apples every day.
How many apples will be left in our barrel after 5 days? _____

(W4) Special (Word Problems)

Abstract: A collection of six word problems which are computationally easy but unusual for third graders in different ways: (a) 3-stage solution required, (b and c) beginning state unknown (1 and 2 stage), (d) integral answer required, (e) ratio, (f) extraneous data. Read to the students.
(6 items, 1 form)

Examples:

(b) At first, Sally had some marbles.
Then, she lost 3 of them.
Then, she found 2 marbles.
After that, she still had 8 marbles left.
How many did she have at first? _____

(d) Sam has to move 10 boxes.
He can carry 3 boxes each trip.
How many trips will he need to make? _____

APPENDIX F

Description of Old Third Grade MANS Scales

Given to Second Graders at Site 1

(C) COMPUTATION

(A5) Large Number Computations

Abstract: Solve computation problems given in an open sentence format, with the boxes sometimes in non-standard positions, and with numbers in the hundreds but relatively easy to work with (addition, subtraction and multiplication). (12 items)

Sample:

500 + ☐ = 800

(E) Estimation

(A2) Estimation

Abstract: Quickly estimate which of 5 standard intervals contains the answer to each of a series of computation problems. Three separate pages containing 8 addition, 8 subtraction and 7 multiplication problems respectively. (25 items)

Sample:

100 - 93 | 0 | 10 | 50 | 100 | 500 | 1000

(B1) 2 or 5 or 10

Abstract: Quickly estimate whether a given number is about 2 or 5 or 10 times as large as another given number. (10 items)

Sample:

60 is about ____ times as large as 31

(B4) Circle the Larger

Abstract: Given pairs of computation problems, quickly determine which one has the larger answer. (13 items)

Sample: 371 + 248 370 + 258

(E) Estimation, continued

(B5) Missing Digits

Abstract: Given a computation problem with one or two digits of the problem crossed out, determine whether or not the given answer could have been right (before the digits were crossed out).
(8 items)

Sample:

$$\begin{array}{r} 54 \\ +3\blacksquare\blacksquare \\ \hline 500 \end{array}$$

Could 500 be the answer?

No, 500 is too small. ☐
Yes, 500 could be right. ☐
No, 500 is too big. ☐

(F) FLUENCY

(B3) Equation Fluency

Abstract: Given the symbols: = + - x 1 2 3 (), construct as many different equations as possible.

Sample Answer: 3 - 1 = 2

(N) OTHER NUMBER SYSTEMS

(B7) Fractions

Abstract: Solve problems of the form x of y = ☐ or x of ☐ = y where x is 1/2 or 1/3.
(8 items)

Sample:

$\frac{1}{2}$ of 12 = ☐

(R) NUMBER RELATIONS

(A1) Height and Weight Table

Abstract: Read and interpret data from a table of students' weights and heights for two different years.
(6 items)

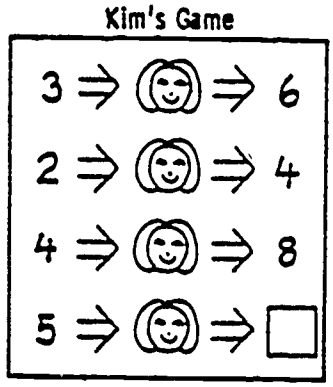
Sample:

Who stayed the same height?

(A3) Functions

Abstract: For each of several problems, determine from 3 pairs of numbers what the "secret rule" is which produces the second number from the first, and use it to find the missing number from the 4th pair.
(8 items)

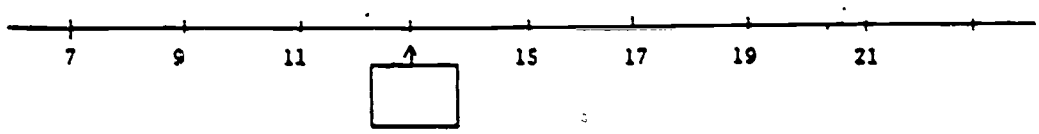
Sample:



(A6) Number Line Labelling

Abstract: Label the indicated "mark" on several number lines, where marked intervals vary from item to item and where other marks are irregularly labelled.
(8 items)

Sample:



(A7) Hints and Problems

Abstract: Quickly complete a given addition problem by using the answer to another problem where one addend is the same as,.and one is only slightly different from the given problem. (5 items)

Sample:

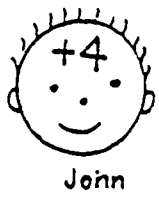
Hint: 537 + 293 = 830

537 + 283 = ☐

(B2) Composite Functions

Abstract: Starting with a given number, apply one or more operations in sequence and determine final result. Also, same process except final result is known and starting number is to be determined.
(9 items)

Sample:



4 ⇒ Bill ⇒ Mary ⇒ ☐

(W) WORD PROBLEMS

(A4) Two Stage Word Problems

Abstract: Word problems (printed in booklet and read by tester) in which two different operations must be performed and where the numbers in the given data are relatively small. (5 items)

Sample:

Our hens lay 9 eggs every day.

Each day we eat 6 of them and give the others away.

During the next 5 days how many eggs will we give away? _____

(B6) Word Problems with "Rounding"

Abstract: Solve word problems (printed in booklet and read by the tester) involving division in which the given numbers do not divide evenly - i.e., the answer, which must be an integer, can be obtained by rounding the obtained quotient up or down. The numbers of the given data are relatively small.
(5 items)

Sample:

An elevator can't hold more than 5 people.

23 people want to ride to the top floor.

How many times will the elevator have to go up? _____

APPENDIX G

Description of the Old Fourth Grade MANS Scales

Given to:

third graders at Site 1

second, third and fourth graders at Site 2

fourth graders at Site 3

SCALE CATEGORY: COMPUTATION

(C1) Stanford Achievement Test: Computation

(Students took one of two 20-item forms)

Abstract: 40 multiple choice questions of two different types: (a) standard computation, 22 items; (b) paired comparison of two computations, 18 items. With each type, items involved each of the four operations and at least 90% involved only whole numbers.

Sample: a) $\begin{array}{r} 532 \\ \times\ 32 \end{array}$

f 16,924
g 2660
h 17,024
j 17,004
k NH

b) $54 + 9 \bigcirc 48 + 6$ > = <

(C2) Fractions

(Students took one of two 6 item forms.)

Abstract: 12 items, with 6 of each type, identical to those in C1 except that 8 involved fractions and 4 involved large number multiplication and division.

Sample:

a) $6{,}000 \div 78 \bigcirc 6{,}000 \div 79$ > = <

b) $\frac{3}{5} - \frac{1}{5} =$

a $\frac{2}{5}$
b $\frac{4}{5}$
c $\frac{2}{10}$
d $\frac{2}{0}$
e NH

(C3) Mental Arithmetic: Addition

Abstract: An open number sentence involving addition must be completed without aid of pencil and paper, 5 items.

Sample: $53 + 8 = \square$

(C6) Mental Arithmetic: Division

Abstract: Same as C3, but with division, 8 items

Sample: 150 DIVIDED BY 25 = ☐

SCALE CATEGORY; ESTIMATION

(E1) 2, 5 or 10

Abstract: Quickly estimate whether a given number is about 2 or 5 or 10 times as large as another given number, 13 items.

Sample: 100 is about _____ times as large as 19

(E2) Estimating Intervals: Addition

Abstract: Quickly estimate which of 5 intervals contains the answer to a series of computation problems, 8 items.

Sample: 479 + 86 0 10 80 100 500 1000

(E3) Estimating Intervals: Multiplication

Abstract: Same as E2, except multiplication, 8 items.

Sample: 40 x 10 0 10 80 100 500 1000

(E4) Estimating Intervals: Division

Abstract: Same as E2, except division, and only 4 intervals, 8 items.

Sample: 101 DIVIDED BY 9 0 1 10 20 100

(E5) Word Problem Approximations

Abstract: Quickly choose one of 4 round-number answers as closest to the exact answer to a word problem with relatively easy calculations, 6 items

Sample: Susan has $131.
Chairs cost $32.
About how many chairs can Susan buy?

2 chairs 4 chairs 6 chairs 10 chairs

SCALE CATEGORY: GEOMETRY

(G1) Geometric Congruencies

Abstract: After examining 3 correct and 3 incorrect solutions to a sample problem, given a regular geometric shape and a number of parts, the shape must be divided into that many congruent parts, 8 items. The word "congruent" was not used.

Sample:

SCALE CATEGORY: OTHER NUMBER SYSTEMS

(N1) Decimal Gas

Abstract: With word problems about gasoline, one step solutions are required in which the numbers involve decimals, 7 items.

Sample: Tom has 6.5 gallons.
He buys 3.5 more gallons.
How much gas will he have then? _____

(N2) Negative Hits and Misses

Abstract: Given two rules [(a) each hit means a gain of 5 points (b) each miss means a loss of 1 point] and given a vertical number line running from 12 below zero to 15 above, players turns are described in part with the required task being to to complete the description, 6 items.

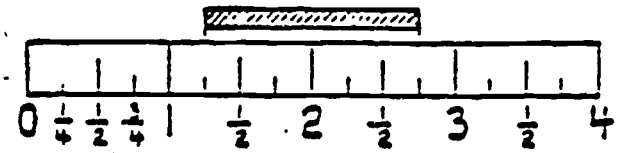
Sample:

Pete:	Started with a score of	Number of Hits	Number of Misses	Ended with a score of
	10 below zero	1		12 below zero

(N3) Measuring Fractional Inches

Abstract: Calculate the length of a given bar laid along a ruler marked in 1/2, 1/4 or 1/10 inches, 6 items.

Sample:



_____

V4 Place Value 1, 10, 100, 1000 (Form 1)

4,265 is about 1 / 10 / 100 / 1000 more than 4,254

65%	52%
.54	.48

4,960 is about 1 / 10 / 100 / 1000 more than 4,851

43%	40%
.32	.39

7,329 is about 1 / 10 / 100 / 1000 more than 7,227

46%	37%
.3[illegible]	.54

2,050 is about 1 / 10 / 100 / 1000 more than 2,039

57%	54%
.76	.41

60,482 is about 1 / 10 / 100 / 1000 more than 59,481

53%	36%
.25	.42

2,987 is about 1 / 10 / 100 / 1000 more than 2,001

36%	30%
-.02	.04

1,001 is about 1 / 10 / 100 / 1000 more than 998

21%	13%
.31	.07

$423\frac{1}{2}$ is about 1 / 10 / 100 / 1000 more than $422\frac{1}{3}$

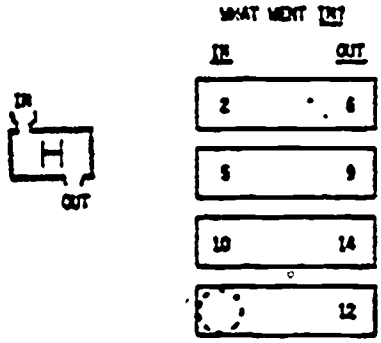
42%	23%
.36	.22

	Correlations		Frequency Distribution by Percentages												
	With Vocabulary	Adjusted KR20	0	1	2	3	4	5	6	7	8	9	10	11	12
CSMP	.52	.66	2	14	17	17	13	17	15	4	2				
Non-CSMP	.56	.64	5	24	20	18	16	5	10	2	0				

(R1) Solving Number Machines

Abstract: From 3 pairs of numbers, determine what the machine is doing to produce the second number from the first and use this knowledge to find the missing number from the 4th pair, 8 items.

Sample:



(R2) Using Number Machines (only done by students previously doing R1)

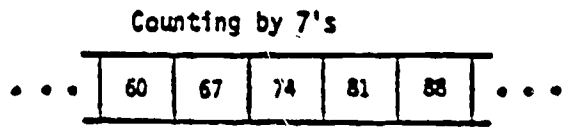
Abstract: Given a number of labelled machines in sequence, find the initial or the terminating number, given the other, 10 items.

Sample:

(R3) Boxes: Counting by

Abstract: Presented with an infinite series of boxes each of which contains a member of an additive series of numbers, questions are asked about the series' membership of other numbers, 4 different series, 12 questions (3 on each one series).

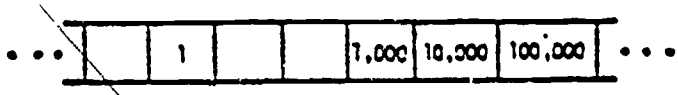
Sample:



(R4) Boxes: Multiplying By

Abstract: Same idea and format as in R3 except that the series is multiplicative and specific empty boxes are to be filled in, 5 series, 13 items (empty boxes).

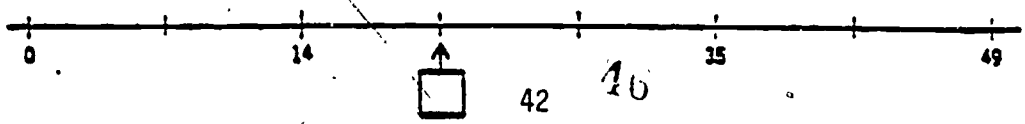
Sample:



(R5) Labelling Number Lines

Abstract: Same basic idea as R4 only with an additive series in number line context, 6 number lines, 6 items.

Sample:



SCALE CATEGORY: WORD PROBLEMS (also see E5 and N1)

(W2) Two-Stage

Abstract: Student must read a 2 to 4 sentence word problem and complete a solution involving two different operations, 7 items.

Sample: Pam gets 50¢ each week.
She always spends 30¢ and saves the rest.
How much will she save in 4 weeks? _____

17

APPENDIX H

Description of the Old Fifth Grade MANS Scales

Given to:

fourth graders at Site 1

Fifth and sixth graders at Site 2

ESTIMATION SCALES

E2-E4 Estimation Intervals

Determine which of several given intervals contains the answer to a computation problem.
There was a time limit of 1½ minutes for each of E2, E3, E4.

E2 Addition (8 items)

Sample:

279 + 165 | 0 | 10 | 50 | 100 | 500 | 1000

E3 Multiplication (7 items)

Sample:

11 x 50 | 0 | 10 | 50 | 100 | 500 | 1000

E4 Division (7 items)

Sample:

133 divided by 50 | 0 | 1 | 10 | 20 | 100

E7,8 Most Reasonable Answer

For a given computation problem, determine which of 3 answers (all of which are wrong) is most reasonable.

There was a time limit of $1\frac{1}{2}$ minutes for each of E6, E9.

Example: 5,079 + 5,076 + 5,075 = 15,030 / 15,230 / 17,230

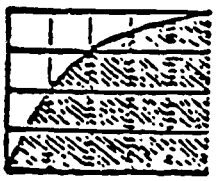
E7 Subtraction (6 items)
E8 Multiplication (6 items)

MEASUREMENT ESTIMATION SCALE

M1 Measurement Estimation (6 items)

Estimate the answer to a visually presented problem in area, volume, height, etc.
A range of answers was accepted.

Sample:



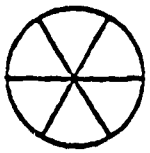
This playground is divided into 20 sections.
It takes one gallon of paint to cover one section.

About how many gallons of paint would it take to cover the shaded part of the playground? _____

FRACTIONS Scales[1]

N5 Fractional Areas (8 items)

Sample: Shade $\frac{2}{3}$ of the figure



N7 Fractional Open Sentences (6 items)

Sample:

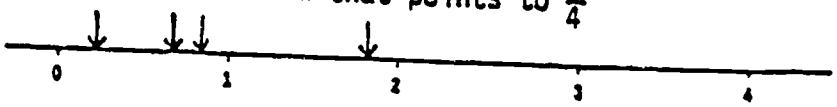
$$\frac{1}{2} + \square = 1$$

N8 Which Fraction is Larger (5 items)

Sample: $\frac{3}{4}$ or $\frac{5}{10}$

N10 Other Representations of Fractions (6 items)

Sample: Circle the arrow that points to $\frac{1}{4}$



[1] Fractions, Negative Numbers, and Decimals were all labelled "N" for Other Number Systems.

NEGATIVE NUMBERS Scale

N2 Negative Hits and Misses (10 items)

Given two rules: each hit means a gain of 5 points
each miss means a loss of 1 point

Determine the missing piece of information.
Half the students took one set of 5 items, the others took 5 other items of a similar format.

Sample:

Peter	Started with a score of	Number of Hits	Number of Misses	Ended with a score of
	10 below zero	1		12 below zero

DECIMAL Scale

N1 Decimal Gas (7 items)

A series of simply worded word-problems about gasoline involving decimal numbers.

Sample:

Tom has 6.5 gallons.

He buys 3.5 more gallons.

How much gas will he have then? _____

O1 Weight Graph (10 items)

Given a graph in which weight (axis labelled at 10 pound increments for each 5 units) is plotted against age (axis labelled at 2 year increments for each 2 units), determine age per given weights and vice versa.

PROBABILITY Scales

P1 100 Outcomes (24 items)

Various random devices are given.
In 100 trials give the best estimate for how often each outcome will occur?

Sample:

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? _____

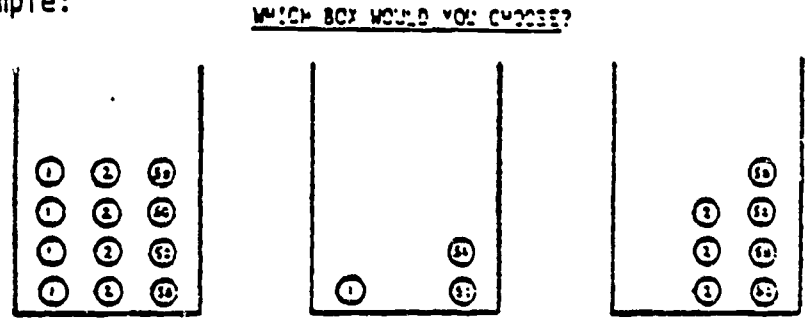
About how many times would he get a shaded marble? _____

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

P2. Which Box? (6 items)

Given three boxes containing various 1, 2 and 50-cent "balls", determine from which box it would be best to make a blind draw.

Sample:

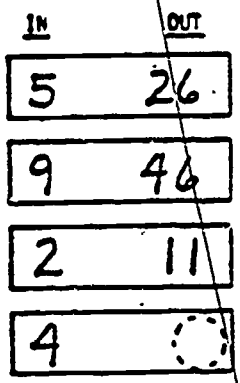


52

R1 Solving Functions (8 items)

Given 3 pairs of numbers produced by a "number machine", deduce the missing number from the 4th pair.

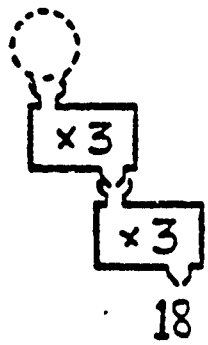
Sample:



R2 Using Number Machines (10 items)

Given a set of labelled number machines in sequence, find the original input or the final output.

Sample:



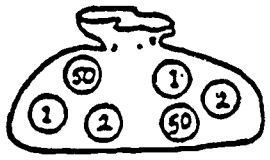
ELUCIDATION Scale

U1 Elucidation (4 problems, 25 possible correct answers)

Find as many solutions as possible to a given problem.

Sample:

Close your eyes.
Pick out three balls.
Add to get a total score.



What are the possible total scores? 52, _____

WORD PROBLEMS Scales

W3 Three-Stage Word Problems (5 items)

Sample:

Joe puts boxes into piles.
Each box is $\frac{1}{2}$ foot high.
Each pile is 5 feet high.
How many boxes does he need to make 3 piles? _____