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ABSTRACT

Examined were the effects of varying the number of practice problems in a programed unit on negative bases designed for high school students. A sample of 421 students from grades 9 through 12 was divided into three groups on the basis of amount of mathematics coursework completed. Students were given four pretests (numeration, arithmetic reasoning, bases, and problems) followed by a pre-program designed to familiarize them with programed text materials. They were then assigned to treatment groups for instruction; materials were identical for the two groups except version F had only 1 or 2 examples for each explanation while version M had 4 or more. The posttest consisted of the Negative Number Base Achievement Test and Word Association Test. Means, standard deviations, and reliabilities were computed for all tests and subscales and data were submitted to regression analysis. Results indicated that increasing the number of practice problems improved student learning; there was an interaction between students' mathematical sophistication and the levels (e.g., comprehension) at which the improvement took place. (SD)

SMESG Working Paper No. 13

THE EFFECTS OF VARYING THE NUMBER OF PRACTICE PROBLEMS

By: E. G. Begle, Barbara Pence, Sau-Lim Tsang, Robert Enenstein

Introduction

This study examined the effects of varying the number of practice problems in a programmed unit on negative number bases designed for senior high math students.[1] The study was conducted during the 1974-75 school year by the Stanford Mathematics Education Study Group (SMESG) with the cooperation of teachers attending a National Science Foundation Mathematics Education Institute at Stanford University.[2]

The study was a follow up of a study carried out by SMESG in the spring of the 1973-74 school year. In the earlier study (SMESG Working Paper No. 7), seventh grade students were given a programmed unit on probability where the effects of varying the number of illustrative examples and the number of practice problems were experimentally examined. The results indicated that further study using different topics and other grade levels should be undertaken.

Population

The populations was diverse because it consisted of students of those teachers from the NSF Institute who had volunteered the previous summer. The sample of students who completed all of the materials totaled 421 students, grades 9-12, representing 14 states, two foreign countries, and private, public, and military schools. Although all students were grouped together for the computation of the general data description, treatment comparisons were made within groups formed on the basis of prerequisite mathematics knowledge.

1. The text, developed by SMESG, is available from the ERIC Science, Mathematics, and Environmental Clearinghouse, Columbus, Ohio.

2. We wish to thank the participating teachers, their principals, and students for their cooperation and assistance.

Group 1 - students who had completed elementary and advanced algebra and basic geometry. (N = 129)

Group 2 - students who had completed basic algebra and geometry. (N = 176)

Group 3 - students who had completed basic algebra and were taking geometry. (N = 116)

Procedures

A. Teacher Contact

Based upon an initial description of purpose, time committments, and materials, approximately 25 NSF participants volunteered to administer the study to their students. Each teacher selected the classes which would be appropriate. Early in the school year, the teachers received student materials and a teacher instructional booklet. The instructional booklet contained a step by step discussion of procedures for the administration of student materials.

B. Pretests

During the first day of the study, a battery of pretests was administered to the students.[3] The battery consisted of 1) Numeration, 2) Arithmetic Reasoning, 3) Bases, and 4) Problems.

The Numeration test is NLSMA (National Longitudinal Study of Mathematical Abilities) scale Z101. This 7 item scale is intended to measure computational facility and understanding of notation and properties of real numbers.

The Arithmetic Reasoning Test (also known as Necessary Arithmetic Operations) is NLSMA scale PZ222. This 15 item scale takes 5 minutes and correlates significantly with mathematics achievement tests.

The Bases Test was constructed specifically for this study. This 10 item, 8 minute test consisted of two parts. Part 1, items 1-5, tested the knowledge of positive bases while part 2, items 6-10, examined the entry knowledge of negative bases.

3. The Bases Pretest and Problems Pretest can be found in Appendix 2.

The Problems Test was composed of a subset of five different NLSMA scales. The test item number along with the NLSMA scale number and item number were:

1. Z324, #2	4. Z306, #1
2. Z310, #1	5. Z303, #8
3. Z306, #5	6. Z309, #2

This 6 item, 10 minute scale was designed to measure the ability to apply algebraic and geometric concepts to non-routine mathematical problems.[4]

C. Pre-Program

At the completion of the pretest battery, the students were given a five page programmed booklet entitled "Pre-Program for Negative Number Bases". This five page program was designed to familiarize the students with the format of the programmed text.

D. Programmed Instruction

After the Pre-Program, the students were given a programmed text, Negative Number Bases. The text developed the notational and computational algorithms for negative bases. Of the four sections of the text, only sections II and III contain treatment variations on the number of practice problems given immediately after the explanation. Version F (few) had one or two practice problems for each explanation, while version M (many) contained four or more practice problems for each explanation. Students were given four days to complete the first three sections.

Throughout the instructional phase, each student proceeeded at his/her own rate through the text. After section III, each student was given an achievement test. Then if time permitted, students worked through section IV. During the last 10 minutes of the experimental period, the Word Association Test was administered.

4. Because of the typographical error found in item 1, it was omitted from the analyses.

E. Posttests

The posttest consisted of the Negative Number Base Achievement Test and the Word Association Test.[5]

The Negative Number Base Achievement Test was designed to measure student achievement relative to the concepts and algorithms presented in the text. This test consisted of three scales. Scale 1, Computation, items 1-9, examined the ability to apply the algorithms in routine computations. Scale 2, Comprehension, items 10-23, measured the understanding of the algorithms. Scale 3, Transfer, items 24-31, measured the ability to transfer the algorithms to unique systems not discussed on the text. The comprehension scale was further divided into two subscales, Understanding, items 10-16, and Analysis, items 17-23.

The Word Association Test contained 8 key terms: "Positive", "Negative", "Base", "Addition", "Place Value", "Division", "Digit", and "Subtraction". Students were asked to write all of the words which each key word made them think of. Based upon previous work by Shavelson (1971)[6] and Geeslin (1974)[7], the Word Association data was used to assess the students' cognitive structure of negative number bases. Cognitive structure is "a hypothetical construct referring to the organization (interrelationships) of concepts in long-term memory [Shavelson, 1971, p. 9] ."

Analyses and Results

A. Item Analyses and Reliabilities of Tests.

Only students who completed all of the pretests and posttests were included. Item analyses were computed for each of the four pretests and for the three scales of the achievement posttest. The complete summary statistics are shown in Tables 1 and 2 in Appendix 1.

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5. The achievement test and Word Association Test can be found in Appendix 2.

6. Shavelson, R. J. Some Aspects of the Relationship Between Content Structure in Physics Instruction. (Doctoral dissertation, Stanford University) Ann Arbor, Michigan, University Microfilms, 1971. No 71-19,759.

7. Geeslin, W. E. An Exploratory Analysis of Content Structure and Cognitive Structure in the Content of a Mathematics Instructional Unit. (Doctoral dissertation, Stanford University) Ann Arbor, Michigan, University Microfilms, 1974. No. 74-6478.

Results for the Numeration and Arithmetic Reasoning tests were similar to the results obtained in a large scale national study called the National Longitudinal Study of Mathematical Abilities. The table below shows the similarities.

		Items	Mean	S. D.	Reliability	Sample Size
Numeration	NNB	7	5.09	1.40	.44	421
	NLSMA	7	3.44	1.56	.48	963
A. R.	NNB	15	8.67	2.25	.62	421
	NLSMA	15	8.85	2.23	.62	827

The Bases Test was analyzed as one scale and then part 1 was re-examined. The results were:

Bases Test	Items	Mean	S. D.	Reliability	Sample Size
Total	10	2.41	1.98	.67	421

Part 1 had the same reliability as the whole test (.67). The total test results reflected a lack of knowledge of negative number bases. Four of the five items on the negative base scale, part II, were below chance. Since for all of the items in part I as well as one item in part II students scored above the chance level, a scale composed of items 1-5 and 7 was used in all subsequent analyses.

The Problems Test contained one reproduction error; item 1 had two choices both labeled D. Since this misprint produced an extremely low biseral (.06), problem 1 was omitted from future calculations.

	Mean	S. D.	Reliability	Sample Size
6 item test	2.15	1.28	0.28	421
5 item test	1.84	1.17	0.31	421

The achievement scales results are shown below. Question 17 of the Achievement Test was poorly worded and resulted in a low biseral (0.09). This item was deleted in subsequent analysis of the Comprehension scale and Analysis scale (a subset of the Comprehension scale).

Scale	Items	Mean	S. D.	Reliability	Sample Size
Computation	9	5.12	2.33	0.72	421
Comprehension	14	7.69	2.65	0.676	421
Comprehension (rev.)	13	7.26	2.57	0.693	421
Transfer	8	2.71	1.85	0.65	421
Understanding Algorithms	7	5.25	1.58	0.58	421
Analysis	7	2.44	1.54	0.48	421
Analysis (rev.)	6	2.01	1.42	0.52	421

Since subdivision of the Comprehension scale contributed no unique results, only the three scales Computation, Comprehension (rev.), and Transfer will be included in further discussion.

The Word Association test is analyzed separately in Appendix 3 of the report.

B. Regression Analyses

Since the amount of mathematics taken could be a significant variable, separate stepwise regressions were calculated for each of the three groups described in the population section. In each regression analysis, the independent variables were the Numeration Pretest, the Arithmetic Reasoning Pretest, the six item Bases Pretest, and the five item Problems Pretest. Within each population group, the regression analysis was repeated for each of the three achievement posttest scales. Summary statistics are shown in tables 3 to 5 in Appendix 1.

The four pretests accounted for between 14% and 32% of the variance in achievement scale scores. Even though performances on the three achievement posttests were highly correlated, each posttest scale correlated differently with the pretests (see table 8 to 11). The order in which the pretests were entered varied across the dependent scales. The most powerful predictor of computation achievement was Numeration. For comprehension, the leading pretests were Numeration and Bases. For the transfer scale, there was no pretest that was consistantly powerful. The power of the pretests also varied across population groups. For group 1 subjects Numeration, Arithmetic Reasoning, and Bases were useful predictors. For group 2 subjects, Numeration, Arithmetic Reasoning, and Problems were useful predictors. For group 3 subjects, only Numeration and Bases were useful predictors.

C. Treatment Effects

Comparison of the pretest and achievement scores showed that the students from all three groups learned from both text versions. They scored at or below chance level on the Negative Number Base scale of the Bases Pretest, but had means of 5.12, 7.69, and 2.71 on the computation, comprehension, and transfer tests respectively which are all significantly above the chance level.

The effects of varying the number of practice problems was examined through Analysis of Covariance (ANCOVA) computed separately for each group. Appendix 1, tables 6 to 11 give means, standard deviations, and correlations and tables 12 to 14 give ANCOVA results. ANCOVA assumes parallel regression lines. When this assumption is rejected (heterogeneity of regression p value < .05) the ANCOVA is not valid and analysis of variance (ANOVA) results must be consulted. The parallel regression line assumption was rejected for group 2 scales of computation and comprehension and for the comprehension scale for the "high" subgroup of group 3. With only one exception the adjusted means favored the treatment containing many practice problems. The table below gives the adjusted means.

	Computation		Comprehension		Transfer	
	Many	Few	Many	Few	Many	Few
Group 1	6.26	5.95	8.71	7.95	3.18	3.30
Group 2	5.34	4.70	7.46	7.07	3.05	2.56
Group 3	4.51	3.81	6.50	5.53	2.36	1.74

Significant contrasts varied across groups. A summary of the p values is shown below

	Computation	Comprehension	Transfer
Group 1	.37	.04	.70
Group 2	.04*	.22*	.04
Group 3	.07	.02	.06

*p values from ANOVA

The effect of increasing the number of practice problems became more generalized as the mathematics knowledge decreased. For the advanced math students, many practice problems significantly increased their understanding of the algorithms, while, for geometry students, many practice problems increased their achievement at all three levels.

One additional question was investigated - does the treatment effect for compuation and transfer differ for those who did or did not understand the algorithms? To answer this question, the data was analyzed by splitting each mathematics level group into two subgroups, the "low" subgroup included all students with scores below the group comprehension scale mean while students with scores above the group mean were assigned to the "high" subgroup (mean scores were assigned to the smaller of the two subgroups). Within each subgroup, ANCOVA was computed for each dependent variable. Unfortunately, the sample sizes were small. Also, the mean scores of the high subgroup of group 1 were very high and the mean scores of the low subgroup of group 3 were very low. Consequently the power of the analyses was reduced and the results were not conclusive. The table below (p values for treatment comparisons) show that when split on comprehension, the treatment effect approached significance for the high subgroups only. Also, for the high subgroups, the effect of the increased number of practice problems tended to become more generalized as the level of mathematical knowledge decreased.

P Values for Treatment Comparisons

		Computation	Comprehension	Transfer
Group 1	High	.39	.51	.70
	Low	.12	.39	.66
Group 2	High	.11	.95	.19
	Low	.39	.32	.59
Group 3	High	.14	.09	.07
	Low	.91	.88	.49

Discussion

Several interesting results were found in this study:

A. Regression

The correlation between the pretests and posttest scales was very low. It was also interesting that the single best predictor was the

Numeration test while the Arithmetic Reasoning pretest, which correlates highly with I. Q., was not a consistently good predictor.

B. Treatment Effect

Increasing the number of practice problems positively affected student learning of the Negative Base algorithms. However, the level of performance affected varied with mathematical sophistication. Less sophisticated students benefited at all levels while more sophisticated students showed significant improvement on achievement in comprehension.

Although the topic of Negative Number Bases concentrated on the development of algorithms and the population of high school students was split on the amount of previous math taken, these differential results (relative to population differences) are similar to the findings of the earlier study (SMESG No. 7) which developed probability concepts for junior high students. The results of this previous study were that increasing the number of practice problems helped the less able student deal with relevant dimensions and helped the above average student deal with irrelevant dimensions.

Conclusions

The differential effect for both the grouping based on prerequisite mathematics knowledge and that based on comprehension justify further investigation. Also, since all practice problems in this study were presented immediately after the algorithm, the effect of distributing the practice problems for a specific algorithm over the entire unit should be examined. Additional investigations should include other mathematical topics and a variety of grade levels.

APPENDIX 1 - STATISTICAL TABLES

TABLE 1

NUMERATION PRETEST

SCALE STATISTICS:

NUMBER OF CASES	=	420
NUMBER OF ITEMS	=	7
MEAN TOTAL SCORE	=	5.090
STANDARD DEVIATION	=	1.405
CRONBACH'S ALPHA	=	0.444
ERROR OF MEASUREMENT	=	1.047

ARITHMETIC REASONING PRETEST

SCALE STATISTICS:

NUMBER OF CASES	=	420
NUMBER OF ITEMS	=	15
MEAN TOTAL SCORE	=	8.671
STANDARD DEVIATION	=	2.252
CRONBACH'S ALPHA	=	0.625
ERROR OF MEASUREMENT	=	1.379

BASES PRETEST

SCALE STATISTICS:

NUMBER OF CASES	=	420
NUMBER OF ITEMS	=	10
MEAN TOTAL SCORE	=	2.412
STANDARD DEVIATION	=	1.975
CRONBACH'S ALPHA	=	0.673
ERROR OF MEASUREMENT	=	1.130

ITEM STATISTICS:

ITEM	P'S	ADJ. P'S	N.S. BIS	PERCENT NT
23	0.338	0.504	0.414	32.857
24	0.555	0.623	0.424	10.952
25	0.426	0.465	0.668	8.333
26	0.329	0.351	0.726	6.429
27	0.264	0.345	0.555	23.333
28	0.160	0.245	0.321	34.762
29	0.252	0.408	0.501	38.095
30	0.021	0.028	0.440	23.333
31	0.029	0.043	0.459	32.857
32	0.038	0.055	0.463	30.238

BASES PRETEST - 5 ITEMS

SCALE STATISTICS:

NUMBER OF CASES	=	420
NUMBER OF ITEMS	=	5
MEAN TOTAL SCORE	=	1.912
STANDARD DEVIATION	=	1.563
CRONBACH'S ALPHA	=	0.671
ERROR OF MEASUREMENT	=	0.896

PROBLEMS PRETEST

SCALE STATISTICS:

NUMBER OF CASES	=	420
NUMBER OF ITEMS	=	6
MEAN TOTAL SCORE	=	2.148
STANDARD DEVIATION	=	1.277
CRONBACH'S ALPHA	=	0.283
ERROR OF MEASUREMENT	=	1.081

ITEM STATISTICS:

ITEM	P'S	ADJ. P'S	N.S. BIS	PERCENT NT
33	0.312	0.316	0.055	1.190
34	0.550	0.589	0.275	6.667
35	0.205	0.319	0.135	35.714
36	0.383	0.451	0.197	15.000
37	0.162	0.231	0.130	29.762
38	0.536	0.598	0.181	10.476

PROBLEMS PRETEST - 5 ITEMS

SCALE STATISTICS:

NUMBER OF CASES	=	420
NUMBER OF ITEMS	=	5
MEAN TOTAL SCORE	=	1.836
STANDARD DEVIATION	=	1.171
CRONBACH'S ALPHA	=	0.310
ERROR OF MEASUREMENT	=	0.973

ITEM STATISTICS:

ITEM	P'S	ADJ. P'S	N.S. BIS	PERCENT NT
34	0.550	0.589	0.249	6.667
35	0.205	0.319	0.190	35.714
36	0.383	0.451	0.216	15.000
37	0.162	0.231	0.155	29.762
38	0.536	0.598	0.166	10.476

COMPUTATION POSTTEST - SCALE 1

SCALE STATISTICS:

NUMBER OF CASES	=	420
NUMBER OF ITEMS	=	9
MEAN TOTAL SCORE	=	5.117
STANDARD DEVIATION	=	2.332
CRONBACH'S ALPHA	=	0.718
ERROR OF MEASUREMENT	=	1.238

COMPREHENSION POSTTEST - SCALE 2

SCALE STATISTICS:

NUMBER OF CASES	=	420
NUMBER OF ITEMS	=	14
MEAN TOTAL SCORE	=	7.686
STANDARD DEVIATION	=	2.653
CRONBACH'S ALPHA	=	0.676
ERROR OF MEASUREMENT	=	1.511

ITEM STATISTICS:

ITEM	P'S	ADJ. P'S	N.S. BIS	PERCENT NT
48	0.776	0.825	0.433	5.952
49	0.683	0.774	0.488	11.667
50	0.598	0.621	0.567	3.810
51	0.681	0.751	0.378	9.286
52	0.755	0.785	0.429	3.810
53	0.831	0.847	0.379	1.905
54	0.926	0.931	0.439	0.476
55	0.421	0.448	0.093	5.952
56	0.183	0.209	0.426	12.143
57	0.467	0.547	0.440	14.762
58	0.155	0.221	0.311	30.000
59	0.205	0.227	0.372	9.762
60	0.669	0.726	0.523	7.857
61	0.336	0.413	0.393	18.810

COMPREHENSION SCALES 2 - 13 ITEMS

SCALE STATISTICS:

NUMBER OF CASES	=	420
NUMBER OF ITEMS	=	13
MEAN TOTAL SCORE	=	7.264
STANDARD DEVIATION	=	2.571
CRONBACH'S ALPHA	=	0.693
ERROR OF MEASUREMENT	=	1.423

TRANSFER POSTTEST - SCALE 3

SCALE STATISTICS:

NUMBER OF CASES =	420
NUMBER OF ITEMS =	8
MEAN TOTAL SCORE =	2.714
STANDARD DEVIATION =	1.848
CRONBACH'S ALPHA =	0.646
ERROR OF MEASUREMENT =	1.099

UNDERSTANDING ALGORITHM - SCALE 4

SCALE STATISTICS:

NUMBER OF CASES =	420
NUMBER OF ITEMS =	7
MEAN TOTAL SCORE =	5.250
STANDARD DEVIATION =	1.579
CRONBACH'S ALPHA =	0.585
ERROR OF MEASUREMENT =	1.017

ANALYSIS POSTTEST - SCALE 5

SCALE STATISTICS:

NUMBER OF CASES =	420
NUMBER OF ITEMS =	7
MEAN TOTAL SCORE =	2.436
STANDARD DEVIATION =	1.536
CRONBACH'S ALPHA =	0.484
ERROR OF MEASUREMENT =	1.103

ANALYSES POSTTEST SCALES 5 - 6 ITEMS

SCALE STATISTICS:

NUMBER OF CASES =	420
NUMBER OF ITEMS =	6
MEAN TOTAL SCORE =	2.014
STANDARD DEVIATION =	1.419
CRONBACH'S ALPHA =	0.523
ERROR OF MEASUREMENT =	0.930

STEPWISE REGRESSION USING GROUP 1

SUMMARY TABLE   DEPENDENT VARIABLE 5   COMPUTE POST I

VARIABLE NAME	VAR NO. REMOVED	VAR NO. ENTERED	STEP NO.	MULTIPLE R	RSQ	INCREASE IN RSQ	F VALUE TO ENTER/REMOVE	P	NO. OF INDEP VAR INCLUDED
NUMERATION PRE		1	1	0.3356	0.1126	0.1126	16.1210	0.0001	1
BASES PRE		3	2	0.3885	0.1509	0.0383	5.6793	0.0186	2
ARITH. REAS. PRE		2	3	0.4230	0.1789	0.0280	4.2678	0.0409	3
PROBLEMS PRE		4	4	0.4307	0.1855	0.0065	0.9970	0.3200	4

STEPWISE REGRESSION USING GROUP 1 SS

SUMMARY TABLE   DEPENDENT VARIABLE 6   COMPREH. POST II

VARIABLE NAME	VAR NO. REMOVED	VAR NO. ENTERED	STEP NO.	MULTIPLE R	RSQ	INCREASE IN RSQ	F VALUE TO ENTER/REMOVE	P	NO. OF INDEP VAR INCLUDED
BASES PRE		3	1	0.4003	0.1602	0.1602	24.2351	0.0000	1
ARITH. REAS. PRE		2	2	0.4697	0.2206	0.0604	9.7607	0.0022	2
NUMERATION PRE		1	3	0.5048	0.2548	0.0342	5.7361	0.0181	3
PROBLEMS PRE		4	4	0.5265	0.2772	0.0224	3.8429	0.0521	4

STEPWISE REGRESSION USING GROUP 1 SS

SUMMARY TABLE   DEPENDENT VARIABLE 7   TRANSFER POST III

VARIABLE NAME	VAR NO. REMOVED	VAR NO. ENTERED	STEP NO.	MULTIPLE R	RSQ	INCREASE IN RSQ	F VALUE TO ENTER/REMOVE	P	NO. OF INDEP VAR INCLUDED
ARITH. REAS. PRE		2	1	0.2984	0.0890	0.0890	12.4125	0.0006	1
BASES PRE		3	2	0.3803	0.1446	0.0556	8.1856	0.0049	2
PROBLEMS PRE		4	3	0.4202	0.1766	0.0319	4.8496	0.0295	3
[illegible]TION PRE		1	4	0.4363	0.1904	0.0138	2.1154	0.1480	4

TABLE 4

STEPWISE REGRESSION USING GROUP 2 SS

SUMMARY TABLE DEPENDENT VARIABLE 5 COMPUTE POST I

VARIABLE NAME	VAR NO. REMOVED	VAR NO. ENTERED	STEP NO.	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ	F VALUE TO ENTER/REMOVE	P	NO. OF INDEP VAR INCLUDED
NUMERATION PRE		1	1	0.2947	0.0869	0.0869	16.5528	0.0001	1
ARITH. REAS. PRE		2	2	0.3427	0.1175	0.0306	5.9973	0.0153	2
PROBLEMS PRE		4	3	0.3653	0.1335	0.0160	3.1764	0.0763	3
BASES PRE		3	4	0.3723	0.1386	0.0052	1.0258	0.3102	4

STEPWISE REGRESSION USING GROUP 2 SS

SUMMARY TABLE DEPENDENT VARIABLE 6 COMPREH. POST II

VARIABLE NAME	VAR NO. REMOVED	VAR NO. ENTERED	STEP NO.	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ	F VALUE TO ENTER/REMOVE	P	NO. OF INDEP VAR INCLUDED
PROBLEMS PRE		4	1	0.3525	0.1243	0.1243	24.6926	0.0000	1
NUMERATION PRE		1	2	0.4299	0.1848	0.0606	12.8531	0.0004	2
BASES PRE		3	3	0.4704	0.2213	0.0365	8.0590	0.0051	3
ARITH. REAS. PRE		2	4	0.4715	0.2223	0.0010	0.2164	0.6424	4

STEPWISE REGRESSION USING GROUP 2 SS

SUMMARY TABLE DEPENDENT VARIABLE 7 TRANSFER POST III

VARIABLE NAME	VAR NO. REMOVED	VAR NO. ENTERED	STEP NO.	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ	F VALUE TO ENTER/REMOVE	P	NO. OF INDEP VAR INCLUDED
PROBLEMS PRE		4	1	0.3488	0.1217	0.1217	24.1058	0.0000	1
ARITH. REAS. PRE		2	2	0.4184	0.1751	0.0534	11.1938	0.0010	2
NUMERATION PRE		1	3	0.4496	0.2022	0.0271	5.8434	0.0167	3
BASES PRE		3	4	0.4608	0.2123	0.0102	2.2089	0.1386	4

TABLE 5

STEPWISE REGRESSION USING GROUP 3 SS

BLE DEPENDENT VARIABLE 5 COMPUTE POST I

NAME	VAR NO. REMOVED	VAR NO. ENTERED	STEP NO.	MULTIPLE R	RSQ	INCREASE IN RSQ	F VALUE TO ENTER/REMOVE	P	NO. OF INDEP VAR INCLUDED
		3	1	0.4195	0.1760	0.1760	24.3431	0.0000	1
N PRE		1	2	0.5179	0.2682	0.0922	14.2425	0.0003	2
PRE		4	3	0.5323	0.2834	0.0152	2.3701	0.1262	3
AS. PRE		2	4	0.5324	0.2834	0.0001	0.0115	0.9148	4

STEPWISE REGRESSION USING GROUP 3 SS

BLE DEPENDENT VARIABLE 6 COMPREH. POST II

NAME	VAR NO. REMOVED	VAR NO. ENTERED	STEP NO.	MULTIPLE R	RSQ	INCREASE IN RSQ	F VALUE TO ENTER/REMOVE	P	NO. OF INDEP VAR INCLUDED
N PRE		1	1	0.4822	0.2325	0.2325	34.5306	0.0000	1
		3	2	0.5476	0.2999	0.0674	10.8827	0.0013	2
AS. PRE		2	3	0.5583	0.3117	0.0118	1.9269	0.1674	3
PRE		4	4	0.5617	0.3155	0.0037	0.6019	0.4395	4

STEPWISE REGRESSION USING GROUP 3 SS

BLE DEPENDENT VARIABLE 7 TRANSFER POST III

NAME	VAR NO. REMOVED	VAR NO. ENTERED	STEP NO.	MULTIPLE R	RSQ	INCREASE IN RSQ	F VALUE TO ENTER/REMOVE	P	NO. OF INDEP VAR INCLUDED
N PRE		1	1	0.3946	0.1557	0.1557	21.0196	0.0000	1
		3	2	0.4660	0.2171	0.0614	8.8690	0.0035	2
PRE		4	3	0.4934	0.2434	0.0263	3.8923	0.0509	3
AS. PRE		2	4	0.4934	0.2435	0.0000	0.0066	0.9353	4

TABLE 6

RAW SCORE MEANS BY TREATMENT GROUPS

GROUP 1

VARIABLE NAME	NO.	Treatment* GROUP 1	Treatment* GROUP 2	TOTAL
NUMERATION PRE	2	5.43	5.46	5.44
ARITH REASON. PRE	3	9.57	9.50	9.54
BASES PRE	4	2.39	2.77	2.54
PROBLEMS PRE	5	2.38	2.23	2.32
COMPUTE POST I	6	6.23	5.98	6.13
COMPREH - POST II	7	8.66	8.02	8.40
TRANSFER - POSTIII	8	3.17	3.31	3.22
ALG. POST IV	9	5.92	5.65	5.81
ANALYSIS POST V	10	2.74	2.37	2.59

Group 2

VARIABLE NAME	NO.	Treatment GROUP 1	Treatment GROUP 2	TOTAL
NUMERATION PRE	2	5.28	5.04	5.16
ARITH REASON. PRE	3	8.71	8.54	8.62
BASES PRE	4	1.92	1.96	1.94
PROBLEMS PRE	5	1.81	1.87	1.84
COMPUTE POST I	6	5.37	4.67	5.01
COMPREH - POST II	7	7.49	7.04	7.26
TRANSFER - POSTIII	8	3.07	2.53	2.80
UNDERSTANDING -POS	9	5.35	5.23	5.29
ANALYSIS - POST V	10	2.14	1.61	1.97

GROUP 3

VARIABLE NAME	NO.	Treatment GROUP 1	Treatment GROUP 2	TOTAL
NUMERATION PRE	2	4.42	4.83	4.61
ARITH REASON. PRE	3	7.60	8.09	7.83
BASES PRE	4	2.23	2.31	2.27
PROBLEMS PRE	5	1.16	1.50	1.32
COMPUTE POST I	6	4.32	4.02	4.18
COMPREH - POST II	7	6.26	5.81	6.05
TRANSFER - POSTIII	8	2.19	1.93	2.07
UNDERST.ALGOR.-POS	9	4.71	4.43	4.58
ANALYSIS - POST V	10	1.55	1.39	1.47

* Treatment Group 1 received Version M
Treatment Group 2 received Version F

TABLE 7

STANDARD DEVIATIONS BY TREATMENT GROUPS

GROUP 1

VARIABLE NAME	NO.	GROUP 1	GROUP 2	TOTAL
NUMERATION PRE	2	1.26	1.57	1.39
ARITH REASON. PRE	3	2.24	2.51	2.35
BASES PRE	4	1.73	1.89	1.80
PROBLEMS PRE	5	1.27	1.18	1.23
COMPUTE POST I	6	2.03	2.16	2.07
COMPREH - POST II	7	2.40	2.00	2.27
TRANSFER - POSTIII	8	1.82	1.86	1.83
ALG. POST IV	9	1.21	1.23	1.22
ANALYSIS POST V	10	1.46	1.36	1.43

GROUP 2

VARIABLE NAME	NO.	GROUP 1	GROUP 2	TOTAL
NUMERATION PRE	2	1.41	1.39	1.40
ARITH REASON. PRE	3	2.36	2.05	2.20
BASES PRE	4	1.62	1.80	1.71
PROBLEMS PRE	5	1.07	1.15	1.11
COMPUTE POST I	6	2.27	2.17	2.24
COMPREH - POST II	7	2.35	2.44	2.40
TRANSFER - POSTIII	8	1.73	1.64	1.70
UNDERSTANDING -POS	9	1.49	1.60	1.54
ANALYSIS - POST V	10	1.31	1.31	1.32

GROUP 3

VARIABLE NAME	NO.	GROUP 1	GROUP 2	TOTAL
NUMERATION PRE	2	1.40	1.19	1.32
ARITH REASON. PRE	3	2.04	1.84	1.95
BASES PRE	4	1.78	2.10	1.93
PROBLEMS PRE	5	0.87	1.11	1.00
COMPUTE POST I	6	2.56	2.10	2.35
COMPREH - POST II	7	2.73	2.55	2.65
TRANSFER - POSTIII	8	2.13	1.75	1.96
UNDERST.ALGOR.-POS	9	1.75	1.73	1.74
ANALYSIS - POST V	10	1.47	1.28	1.38

TABLE 8

CORRELATION MATRIX
(SAMPLE SIZES IN PARENTHESES)

		1	2	3	4	5	6	7	8	9
NUMERATION PRE	1*	1.000 (421)	0.288 (421)	0.214 (421)	0.318 (421)	0.382 (421)	0.399 (421)	0.342 (421)	0.363 (421)	0.317 (421)
ARITH. OPERATION P	2*	0.288 (421)	1.000 (421)	0.253 (421)	0.266 (421)	0.303 (421)	0.348 (421)	0.330 (421)	0.302 (421)	0.290 (421)
BASES PRE	3*	0.214 (421)	0.253 (421)	1.000 (421)	0.288 (421)	0.274 (421)	0.342 (421)	0.281 (421)	0.262 (421)	0.322 (421)
PROBLEMS PRE	4*	0.318 (421)	0.266 (421)	0.288 (421)	1.000 (421)	0.334 (421)	0.391 (421)	0.352 (421)	0.269 (421)	0.399 (421)
COMPUTE POSTTEST S	5*	0.382 (421)	0.303 (421)	0.274 (421)	0.334 (421)	1.000 (421)	0.665 (421)	0.535 (421)	0.579 (421)	0.554 (421)
COMPREHENSION POST	6*	0.399 (421)	0.348 (421)	0.342 (421)	0.391 (421)	0.665 (421)	1.000 (421)	0.530 (421)	0.855 (421)	0.849 (421)
TRANSFER POSTTEST	7*	0.342 (421)	0.330 (421)	0.281 (421)	0.352 (421)	0.535 (421)	0.530 (421)	1.000 (421)	0.448 (421)	0.456 (421)
UNDERSTANDING ALGO	8*	0.363 (421)	0.302 (421)	0.262 (421)	0.269 (421)	0.579 (421)	0.855 (421)	0.448 (421)	1.000 (421)	0.453 (421)
ANALYSIS POSTTEST	9*	0.317 (421)	0.290 (421)	0.322 (421)	0.399 (421)	0.554 (421)	0.849 (421)	0.456 (421)	0.453 (421)	1.000 (421)

TABLE 9

GROUP 1, CORRELATION MATRICES

CORRELATION MATRIX FOR GROUP 1

		2	3	4	5	6	7	8	9	10
NUMERATION PRE	2	1.00	0.06	0.32	0.29	0.33	0.30	0.28	0.29	0.25
ARITH REASON. PRE	3		1.00	0.06	0.32	0.16	0.22	0.29	0.27	0.14
BASES PRE	4			1.00	0.25	0.34	0.38	0.27	0.36	0.33
PROBLEMS PRE	5				1.00	0.30	0.32	0.30	0.26	0.32
COMPLTE POST I	6					1.00	0.73	0.41	0.70	0.62
COMPREH - POST II	7						1.00	0.37	0.88	0.92
TRANSFER - POSTIII	8							1.00	0.32	0.34
ALG. POST IV	9								1.00	0.61
ANALYSIS POST V	10									1.00

SAMPLE SIZE = 77

CORRELATION MATRIX FOR GROUP 2

		2	3	4	5	6	7	8	9	10
NUMERATION PRE	2	1.00	0.02	-0.00	0.00	0.35	0.22	0.08	0.16	0.18
ARITH REASON. PRE	3		1.00	0.24	0.01	0.26	0.43	0.31	0.27	0.39
BASES PRE	4			1.00	0.31	0.14	0.49	0.28	0.22	0.53
PROBLEMS PRE	5				1.00	0.06	0.26	0.27	0.10	0.20
COMPLTE POST I	6					1.00	0.50	0.36	0.31	0.46
COMPREH - POST II	7						1.00	0.33	0.75	0.80
TRANSFER - POSTIII	8							1.00	0.14	0.37
ALG. POST IV	9								1.00	0.19
ANALYSIS POST V	10									1.00

SAMPLE SIZE = 52

CORRELATION MATRIX FOR TOTAL

		2	3	4	5	6	7	8	9	10
NUMERATION PRE	2	1.00	0.04	0.17	0.16	0.34	0.25	0.19	0.22	0.21
ARITH REASON. PRE	3		1.00	0.14	0.19	0.21	0.30	0.30	0.27	0.24
BASES PRE	4			1.00	0.26	0.25	0.40	0.28	0.28	0.29
PROBLEMS PRE	5				1.00	0.20	0.31	0.29	0.20	0.31
COMPLTE POST I	6					1.00	0.64	0.38	0.54	0.56
COMPREH - POST II	7						1.00	0.34	0.83	0.88
TRANSFER - POSTIII	8							1.00	0.24	0.34
ALG. POST IV	9								1.00	0.46
ANALYSIS POST V	10									1.00

SAMPLE SIZE = 129

TABLE 10

GROUP 2, CORRELATION MATRICES

CORRELATION MATRIX FOR GROUP 1

		2	3	4	5	6	7	8	9	10
NUMERATION PRE	2	1.00	0.38	0.20	0.37	0.41	0.41	0.32	0.35	0.34
ARITH REASON. PRE	3		1.00	0.22	0.29	0.51	0.44	0.37	0.41	0.32
BASES PRE	4			1.00	0.35	0.25	0.40	0.22	0.29	0.39
PROBLEMS PRE	5				1.00	0.44	0.48	0.43	0.42	0.38
COMPUTE POST I	6					1.00	0.64	0.50	0.56	0.51
COMPREH - POST II	7						1.00	0.43	0.86	0.82
TRANSFER - POSTIII	8							1.00	0.40	0.32
UNDERSTANDING -POS	9								1.00	0.41
ANALYSIS - POST V	10									1.00

SAMPLE SIZE = 86

CORRELATION MATRIX FOR GROUP 2

		2	3	4	5	6	7	8	9	10
NUMERATION PRE	2	1.00	0.38	0.27	0.32	0.17	0.29	0.33	0.20	0.29
ARITH REASON. PRE	3		1.00	0.30	0.38	-0.00	0.02	0.29	-0.04	0.10
BASES PRE	4			1.00	0.34	0.16	0.27	0.31	0.08	0.41
PROBLEMS PRE	5				1.00	0.09	0.25	0.29	0.08	0.38
COMPUTE POST I	6					1.00	0.52	0.47	0.46	0.40
COMPREH - POST II	7						1.00	0.45	0.87	0.80
TRANSFER - POSTIII	8							1.00	0.32	0.45
UNDERSTANDING -POS	9								1.00	0.39
ANALYSIS - POST V	10									1.00

SAMPLE SIZE = 90

CORRELATION MATRIX FOR TOTAL

		2	3	4	5	6	7	8	9	10
NUMERATION PRE	2	1.00	0.38	0.23	0.34	0.29	0.35	0.33	0.27	0.32
ARITH REASON. PRE	3		1.00	0.26	0.33	0.27	0.24	0.33	0.18	0.22
BASES PRE	4			1.00	0.34	0.20	0.33	0.26	0.17	0.40
PROBLEMS PRE	5				1.00	0.25	0.35	0.35	0.23	0.37
COMPUTE POST I	6					1.00	0.58	0.50	0.51	0.46
COMPREH - POST II	7						1.00	0.45	0.86	0.81
TRANSFER - POSTIII	8							1.00	0.36	0.40
UNDERSTANDING -POS	9								1.00	0.40
ANALYSIS - POST V	10									1.00

SAMPLE SIZE = 176

TABLE 11
GROUP 3, CORRELATION MATRICES

CORRELATION MATRIX FOR GROUP 1

		2	3	4	5	6	7	8	9	10
NUMERATION PRE	2	1.00	0.16	0.21	0.21	0.44	0.45	0.41	0.45	0.29
ARITH REASON. PRE	3		1.00	0.37	0.21	0.07	0.26	0.20	0.28	0.15
BASES PRE	4			1.00	0.13	0.39	0.31	0.28	0.33	0.18
PROBLEMS PRE	5				1.00	0.31	0.42	0.47	0.33	0.39
COMPUTE POST I	6					1.00	0.72	0.69	0.65	0.56
COMPREH - POST II	7						1.00	0.77	0.88	0.82
TRANSFER - POSTIII	8							1.00	0.62	0.70
UNDERST.ALGOR.-POS	9								1.00	0.44
ANALYSIS - POST V	10									1.00

SAMPLE SIZE = 62

CORRELATION MATRIX FOR GROUP 2

		2	3	4	5	6	7	8	9	10
NUMERATION PRE	2	1.00	0.37	0.38	0.16	0.41	0.59	0.41	0.55	0.41
ARITH REASON. PRE	3		1.00	0.33	0.20	0.44	0.39	0.21	0.37	0.27
BASES PRE	4			1.00	0.48	0.47	0.48	0.45	0.44	0.35
PROBLEMS PRE	5				1.00	0.31	0.11	0.17	0.00	0.21
COMPUTE POST I	6					1.00	0.63	0.48	0.49	0.59
COMPREH - POST II	7						1.00	0.59	0.89	0.79
TRANSFER - POSTIII	8							1.00	0.56	0.42
UNDERST.ALGOR.-POS	9								1.00	0.42
ANALYSIS - POST V	10									1.00

SAMPLE SIZE = 54

CORRELATION MATRIX FOR TOTAL

		2	3	4	5	6	7	8	9	10
NUMERATION PRE	2	1.00	0.26	0.28	0.21	0.41	0.48	0.39	0.47	0.33
ARITH REASON. PRE	3		1.00	0.35	0.22	0.20	0.30	0.19	0.31	0.19
BASES PRE	4			1.00	0.33	0.42	0.39	0.35	0.38	0.26
PROBLEMS PRE	5				1.00	0.29	0.24	0.30	0.14	0.28
COMPUTE POST I	6					1.00	0.68	0.61	0.58	0.57
COMPREH - POST II	7						1.00	0.70	0.88	0.81
TRANSFER - POSTIII	8							1.00	0.60	0.59
UNDERST.ALGOR.-POS	9								1.00	0.43
ANALYSIS - POST V	10									1.00

SAMPLE SIZE = 116

TABLE 12

GROUP 1, ANCOVA

DEPENDENT VARIABLE -- COMPUTE POST I

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	P
REGRESSION	102.164	4.	25.541	6.936	0.000
TREATMENT MEANS	2.936	1.	2.936	0.797	0.374
HETEROGENEITY OF REGRESSION	7.487	4.	1.872	0.508	0.730
ERROR	438.174	119.	3.682		
TOTAL	550.762	128.			

DEPENDENT VARIABLE -- COMPREH - POST II

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	P
REGRESSION	182.141	4.	45.535	11.898	0.000
TREATMENT MEANS	17.216	1.	17.216	4.499	0.036
HETEROGENEITY OF REGRESSION	2.264	4.	0.566	0.148	0.964
ERROR	455.418	119.	3.827		
TOTAL	657.039	128.			

DEPENDENT VARIABLE -- TRANSFER - POSTIII

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	P
REGRESSION	81.947	4.	20.487	7.055	0.000
TREATMENT MEANS	0.424	1.	0.424	0.146	0.703
HETEROGENEITY OF REGRESSION	2.567	4.	0.642	0.221	0.926
ERROR	345.543	119.	2.904		
TOTAL	430.481	128.			

TABLE 13

GROUP 2, ANCOVA

DEPENDENT VARIABLE -- COMPUTE POST I

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	P
REGRESSION	121.437	4.	30.359	7.552	0.000
TREATMENT MEANS	17.620	1.	17.620	4.383	0.038
HETEROGENEITY OF REGRESSION	69.560	4.	17.390	4.326	0.002
ERROR	667.363	166.	4.020		
TOTAL	875.980	175.			

DEPENDENT VARIABLE -- COMPREH - POST II

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	P
REGRESSION	224.078	4.	56.019	12.834	0.000
TREATMENT MEANS	6.416	1.	6.416	1.470	0.226
HETEROGENEITY OF REGRESSION	52.928	4.	13.232	3.032	0.019
ERROR	724.558	166.	4.365		
TOTAL	1007.980	175.			

DEPENDENT VARIABLE -- TRANSFER - POSTIII

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	P
REGRESSION	107.576	4.	26.894	11.684	0.000
TREATMENT MEANS	10.431	1.	10.431	4.532	0.035
HETEROGENEITY OF REGRESSION	6.541	4.	1.635	0.710	0.586
ERROR	382.088	166.	2.302		
TOTAL	506.636	175.			

TABLE 13 (cont)

GROUP 2, ANOVA

UNIVARIATE ANOVA ON -- COMPUTE - POST I

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	21.89	1	21.89	4.46
WITHIN	854.09	174	4.91	
TOTAL	875.98	175		

PROBABILITY OF ERROR IN REJECTING THE HYPOTHESIS = 0.0361

UNIVARIATE ANOVA ON -- COMPREH - POST II

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	8.66	1	8.66	1.51
WITHIN	999.32	174	5.74	
TOTAL	1007.98	175		

PROBABILITY OF ERROR IN REJECTING THE HYPOTHESIS = 0.2198

TABLE 14

GROUP 3, ANCOVA

DEPENDENT VARIABLE -- COMPUTE POST I

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	P
REGRESSION	180.036	4.	45.009	11.592	0.000
TREATMENT MEANS	13.270	1.	13.270	3.418	0.067
HETEROGENEITY OF REGRESSION	30.323	4.	7.581	1.952	0.107
ERROR	411.569	106.	3.883		
TOTAL	635.198	115.			

DEPENDENT VARIABLE -- COMPREH - POST II

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	P
REGRESSION	254.159	4.	63.540	13.959	0.000
TREATMENT MEANS	25.756	1.	25.756	5.658	0.019
HETEROGENEITY OF REGRESSION	43.264	4.	10.816	2.376	0.057
ERROR	482.513	106.	4.552		
TOTAL	805.691	115.			

DEPENDENT VARIABLE -- TRANSFER - POSTIII

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F	P
REGRESSION	107.475	4.	26.869	9.527	0.000
TREATMENT MEANS	10.573	1.	10.573	3.749	0.055
HETEROGENEITY OF REGRESSION	24.462	4.	6.116	2.169	0.077
ERROR	298.938	106.	2.820		
TOTAL	441.448	115.			

TABLE 14 (cont)

GROUP 3, ANOVA

UNIVARIATE ANOVA ON -- COMPUTE POST I

****

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	2.67	1	2.67	0.48
WITHIN	632.53	114	5.55	
TOTAL	635.20	115		

PROBABILITY OF ERROR IN REJECTING THE HYPOTHESIS = 0.4894

****

UNIVARIATE ANOVA ON -- COMPREH - POST II

****

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	5.67	1	5.67	0.81
WITHIN	800.02	114	7.02	
TOTAL	805.69	115		

PROBABILITY OF ERROR IN REJECTING THE HYPOTHESIS = 0.3705

****

UNIVARIATE ANOVA ON -- TRANSFER - POSTIII

****

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	2.07	1	2.07	0.54
WITHIN	439.38	114	3.85	
TOTAL	441.45	115		

PROBABILITY OF ERROR IN REJECTING THE HYPOTHESIS = 0.4654

****

APPENDIX 2 - TESTS

APPENDIX 3 - WORD ASSOCIATIONS

Appendix

The students were divided into three ability groups for the analysis as discribed in the preceeding pages. The word association result obtained from each student was converted to a corresponding Relatedness Coefficient (RC) Matrix. The conversion procedure is discussed in Geeslin's dissertation.[1] Within each ability group, a mean RC Matrix was generated for the students who took Form M of the programmed text and a second one for those who took Form F of the programmed text. The mean RC Matrix was generated by averaging each of the elements in the RC Matrices over all the students who took either Form M or Form F of the programmed text.

These mean Rc Matrices were subjected to the Non-Metric Multidimensional Scaling Procedure developed by Shepherd and Kruskal.[2] The two dimensional graphical representations of these mean RC Matrices are shown in the following pages.

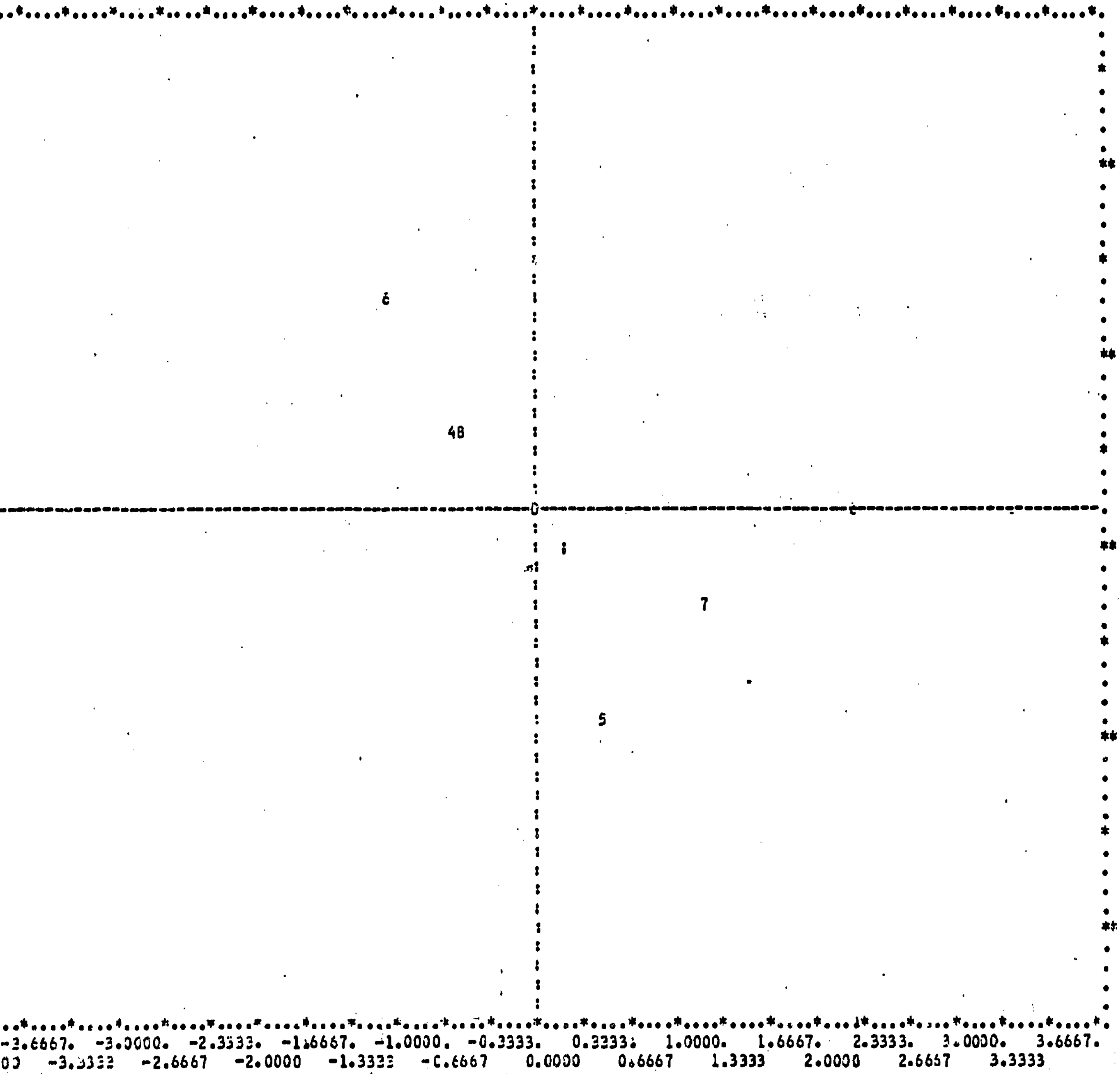
---

[1]Geeslin, W. E. An exploratory analysis of content structure and cognitive structure in the context of a mathematics instructional unit. (Doctoral dissertation, Stanford University) Ann Arbor, Mich.: University Microfilms, 1974.

[2]Kruskal, J. B. Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. Psychometrika, 1964, 29, 1-27.
Kruskal, J. B. Nonmetric multidimensional scaling: A numerical method. Psychometrika, 1964, 29, 115-129.
Shepherd, R. N. The analysis of proximities: Multidimensional scaling with an unknown distance function, I. Psychometrika, 1962, 27, 125-140.
Shepherd, R. N. The analysis of proximities: Multidimensional scaling with an unknown distance function, II. Psychometrika, 1962, 27, 219-246.

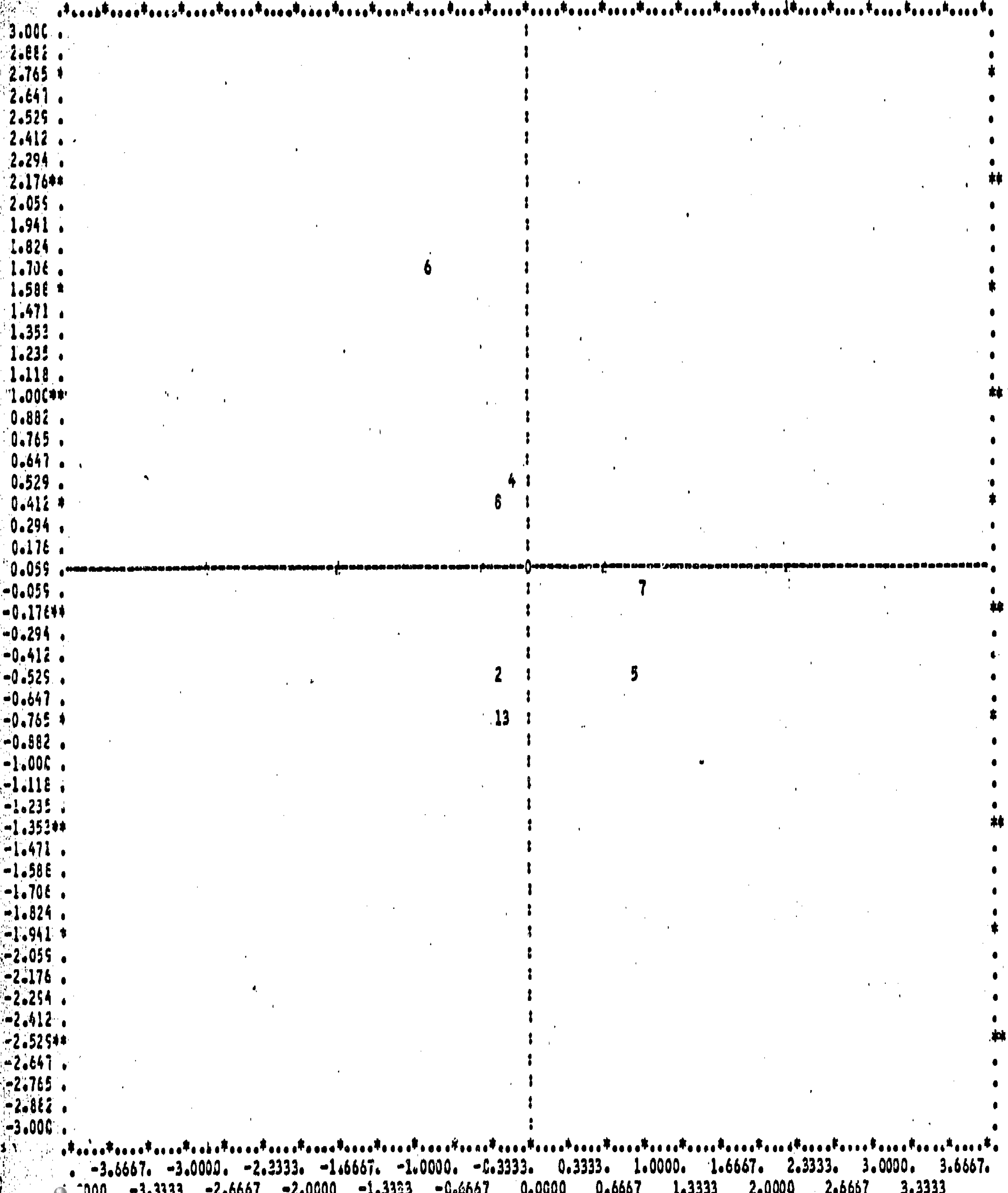
ICN FOR M-D-SCALING OF GROUP 1 TREATMENT 1 MEAN RC-MATRIX STRESS = 0.0094; 2 DIMENSIONS

(HORIZONTAL AXIS) VS. DIMENSION 2 (VERTICAL AXIS)



CONFIGURATION FOR M-D-SCALING OF GROUP 2 TREATMENT 1 MEAN RC-MATRIX STRESS = 0.1378; 2 DIMENSIONS

DIMENSION 1 (HORIZONTAL AXIS) VS. DIMENSION 2 (VERTICAL AXIS)



TION FOR M-D-SCALING OF GROUP 3 TREATMENT 1 MEAN RC-MATRIX STRESS = 0.1048: 2 DIMENSIONS

1 (HORIZONTAL AXIS) VS. DIMENSION 2 (VERTICAL AXIS)