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ABSTRACT

This journal issue is devoted to review and analysis of 15 reports on the National Longitudinal Study of Mathematical Abilities (NLSMA). The reports reviewed concern achievement of students at various grade levels, nonintellective correlates of under- and overachievement, correlates of attitudes toward mathematics, teacher effectiveness, characteristics of successful insightful problem solvers, effects of different curricula, and a followup study. An annotated list of the 32 reports prepared for NLSMA is provided. Research related to mathematics education which was reported in RIE and CIJE between April and June 1975 is listed. (SD)

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INVESTIGATIONS IN MATHEMATICS EDUCATION

Special Issue:

Critical Analyses of the NLSMA Reports

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A note from the editor. . .

This is a single-topic issue of Investigations in Mathematics Education. It is devoted exclusively to abstracts and critical commentary of reports of the National Longitudinal Study of Mathematical Abilities (NLSMA). The Advisory Board for IME feels that a review and analysis of NLSMA reports is timely for three reasons. First, and foremost, we believe that the results are interesting and useful. Many mathematics educators have not acquired familiarity with the NLSMA reports simply because of the sheer mass of the study. Thirty-two volumes of NLSMA materials were published. This quantity of material about a historically interesting era in mathematical curriculum development has kept many individuals from a careful, critical perusal of the volumes. No document other than this issue of IME provides the reader a detailed, critical summary of the results of the NLSMA studies.

Second, assessment at both national and state levels is a major activity and interest of the educational community today. NLSMA was the first large-scale testing program in mathematics education in the United States. Although NLSMA was not concerned primarily with assessment, we suggest that the experience with NLSMA should offer valuable lessons for those concerned with assessment. NLSMA had to identify and specify variables and objectives. Testing instruments were selected or constructed. Sampling techniques were developed and statistical procedures were selected. Mountains of data were processed and reports prepared. We opine that much is to be learned from the NLSMA experience that is directly applicable for individuals designing and conducting large-scale assessments. Clearly, NLSMA was not designed exclusively as an evaluation project, but encompassed many other research goals. And you will discover as you read that the abstractors do question many aspects of NLSMA; some NLSMA processes and materials are identified as not suitable for immediate applicability. The point is that the mathematics education community should learn from this experience and apply this learning to current, related tasks. We remark that the abstractors have done an excellent job of identifying some of the perils and pitfalls in such studies.

Finally, NLSMA evolved in such a way that it served to raise questions and to identify problems for researchers in mathematics education. Many of the problems need to be followed up to the point of developing more precise research-based answers for curricular developers and mathematics teachers. We think this is one of the more powerful products of NLSMA. Researchers should accept the challenge of examining carefully the interesting instructional and curricular questions that are imbedded within the NLSMA studies.

We are pleased with the enthusiastic response we received from the abstractors for this volume. They shared the perception of the Advisory Board that a review of the NLSMA reports was both timely and appropriate. We followed the usual policy of IME in giving directions to the abstractors; namely, that we would not change the substance of their abstracts or commentary. We did deviate in one way from the usual procedures for selecting abstractors. The quantity of material for the X-, Y-, and Z-Populations was simply too much for us to feel comfortable in requesting a single person for a review. Consequently, we asked teams of individuals in each of three institutions to prepare the abstracts for these three population groups. Abstracts were invited from individuals who had no previous connections with NLSMA.

In an introduction, E. G. Begle, Director of NLSMA, gives a brief overview of the aims and goals of NLSMA. Then the abstracts of ten major studies are presented. The final section of this issue of IME Gives a brief annotation of the contents of each of the 32 published NLSMA reports and indicates its availability.

We do hope that you find this targeted issue of IME informative and useful.

Alan R. Osborne
Editor

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THE NATIONAL LONGITUDINAL STUDY OF MATHEMATICAL ABILITIES

The School Mathematics Study Group was organized in 1958 and, during the summer of that year, prepared detailed outlines of secondary school sample textbooks for grades 7-12. During the following summer preliminary versions of texts for grades 7, 9, 10, 11 and 12 were completed and were pilot tested during the following academic year. During the summer of 1960 feedback from the pilot testing was used in revising these texts (and completing the preliminary version of the eighth grade text). The revised texts were made available as of September 1, 1960 for any schools that wished to use them. Also during the summer of 1960, work began on the preparation of texts for grades 4, 5, and 6.

The SMSG Advisory Board felt that it was very important that a careful evaluation of the effectiveness of these texts be carried out. The Educational Testing Service was commissioned to conduct this evaluation and did so during the 1960-61 academic year. Students using traditional texts were compared with students using SMSG texts. At the end of the year two tests were administered at each grade level. One was a widely used standardized ETS test, which was of course slanted toward the traditional curriculum. The other was a test constructed by SMSG which emphasized the particular topics in these texts that were not included in traditional texts.

The results of this evaluation were not unexpected. Students using traditional texts did slightly better on the traditional tests while students using the SMSG texts did better on the SMSG tests.

This demonstrated that the SMSG texts were not inflicting any serious harm on the students using them and that these students were learning new ideas which might turn out to be useful to them. Unfortunately this evaluation provided no further useful information. In particular it provided no guidance as to how either traditional texts or the SMSG texts might be improved. In retrospect it became clear that the global kind of tests used in this evaluation, each providing a single score for each student, were of only marginal usefulness in curriculum development. What was needed instead was a battery of diagnostic tests, each devoted to a limited aspect of the mathematics curriculum so that the successes and failures of a particular text could be analyzed in detail.

Accordingly plans were immediately drawn up for a careful study of the effects of various kinds of mathematics texts on the learning of mathematics, a study which would utilize diagnostic rather than global measures of student achievement and which would be longitudinal, following students for five years, in order to detect long term as well as short term effects.

This study was called the National Longitudinal Study of Mathematical Abilities (NLSMA). During the 1961-62 academic year, a panel of distinguished mathematicians, mathematics educators, mathematics teachers, and psychologists outlined plans for the study and developed the initial battery of tests. At the same time a large number of elementary and junior and senior high schools were recruited to participate in the study. These schools, while not forming a cross section of the U.S. school system, did have a wide geographical distribution and planned to use in the 1962-63 academic year a wide variety, both modern and conventional, of mathematical texts. Specifically, fourth grade (X-Population), seventh grade (Y-Population), and tenth grade (Z-Population) classes were recruited. Well over 100,000 students completed the initial battery of tests in September of 1962.

All of the participating schools were informed that this was a naturalistic rather than a laboratory study. SMSG exerted no influence on the choice of textbooks by any of the participating schools, provided no consultant services to any of these schools and provided no free materials to those schools using SMSG texts.

The overall plan for NLSMA called for the gathering of a great deal of information about each of the students involved in the study. It was generally believed that success in mathematics depended not only on the students' cognitive abilities but also on various affective variables such as attitudes toward mathematics, self-concept, etc. It was also believed that success in mathematics depended to some extent on characteristics of the students' teachers and on the socio-economic status of the school and community. Consequently, extensive information on all of these variables was gathered during the course of the study.

Data were collected in two ways. An extensive battery of tests was administered to each student at the beginning and at the end of each of the five school years (three in the case of the Z-Population students). A lengthy questionnaire was filled out by most of the teachers involved in the first three years of the study. Other questionnaires were filled out by the administrators of the schools involved in the study.

The battery of tests administered to the students covered a substantial number of mathematical topics and in addition measured a wide variety of cognitive abilities and also measured a number of affective variables.

Guidance in the selection of the cognitive and affective psychological variables to be included in the study was provided bv a number of distinguished psychologists, some of them members of the steering panel and others serving as consultants. Guidance on the selection of mathematical topics to be studied was provided by a conference held in September 1963 which brought together a total of 38 mathematicians, mathematics teachers, mathematics educators and users of mathematics.

Although a few standardized mathematics tests were used during the course of the five years of the study, most of the tests were constructed specifically for this study. The standard paradigm used in the construction of these tests was the following:

	Number System	Geometry	Algebra
Computation			
Comprehension			
Application			
Analysis			

The rows in the diagram above indicate different cognitive levels at which the students could be expected to perform. The farther down one moves in this matrix, the more complex are the cognitive behaviors required to function satisfactorily. A more detailed specification of each of these cognitive levels is the following:

1. Computation - Items designed to require straightforward manipulation of problem elements according to rules the subjects presumably have learned. Emphasis is upon performing operations, not upon deciding which operations are appropriate.

2. Comprehension - Items designed to require higher recall of concepts and generalizations or transformation of problem elements from one mode to another. Emphasis is upon demonstrating understanding of concepts and their relationships, not upon using concepts to produce a solution.

3. Application - Items designed to require (1) recall of relevant knowledge, (2) selection of appropriate operations, and (3) performance of the use concepts in a specific context and in a way he has presumably practiced.

4. Analysis - Items designed to require a non-routine application of concepts.

For each test session and for each population separately the column headings were sub-divided and more closely specified so as to be appropriate to the normal content of the curriculum for the relevant year. Then certain cells in the matrix were selected (because of time constraints not all cells could be dealt with each year) and a small number of test items specific to that cognitive level and to that mathematical topic, but varying in difficulty, were constructed and, after pilot testing, were incorporated in the battery for that testing period. These "scales" provided very specific information about student achievement with respect to specific mathematical topics at specific cognitive levels.

It soon became apparent that the information being collected by NLSMA would be useful not only in investigating the differential effects of various kinds of textbooks on student achievement in mathematics but also in answering a large number of other questions about various aspects of mathematics education. In the spring of 1965 a second conference, whose representatives again formed a broad cross section of the entire mathematics education community, convened to review these questions and to recommend priorities for the analyses of the data. Two major analyses were carried out after the last testing session in the spring of 1967.

The first of these produced profiles of student achievement, after IQ, previous achievement, etc., had been factored out, on four sets of students. These sets were defined by textbook used, either the SMSG texts or a traditional text, and by the sex of the student. Both main effects and interactions were calculated.

In order to inform the mathematical community of the nature and of the findings of this study a total of 32 reports was prepared. A complete list of these reports is provided on page . The first nine of these reports provide background information. The first three include the actual test items used for each of the three populations. The next three describe and provide the standard statistics on the various scales included in the various test batteries. Report No. 7 provides a detailed discussion of the development of the test batteries. No. 8 describes the various statistical procedures used in the analyzing of NLSMA data. Report No. 9 includes the various questionnaires used to collect NLSMA information.

Reports 10 through 18 contain the achievement profiles ascribable to textbooks at the various grade levels from 4 through 12. Reports 21 through 25 are devoted to the second main analysis of the NLSMA data, the effects of individual variables on student achievement. The results of these analyses are summarized in Report No. 26. The remaining NLSMA Reports are devoted to smaller analyses which utilized NLSMA data.

All of the NLSMA data has been preserved. Inquiries concerning utilization of these data should be addressed to E. G. Begle, School of Education, Stanford University, Stanford, CA 94305.

ED 044 283, ED 045 447
PATTERNS OF MATHEMATICS ACHIEVEMENT IN GRADES 4, 5, AND 6: X-POPULATION.
Carry, L. Ray; Weaver, J. Fred. NLSMA Report No. 10.

PATTERNS OF MATHEMATICS ACHIEVEMENT IN GRADES 7 AND 8: X-POPULATION.
Carry, L. Ray. NLSMA Report No. 11.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Joe Dan Austin and George W. Bright, Emory University.

1. Purpose

The purpose of Reports No. 10 and No. 11 was to identify differential patterns in mathematical achievement that may be ascribed to different textbook series used continuously either in grades 4 through 6 or in grades 7 through 8.

2. Rationale

This is part of a study of the effects on students of various kinds of mathematics programs.

3. Research Design and Procedure

Student achievement was characterized by the 3x4 matrix presented earlier (see Begle's article in this volume of I.M.E.). Non-achievement variables were verbal and non-verbal ability (as covariates) and stratification (textbook and sex). Textbook groups were classified as conventional or modern. The data unit was the mean score for all pupils in a school. On each scale, sum and difference scores for boys' and girls' means for each school were analyzed to test for sex x textbook interaction. Scales that did not show an interaction were analyzed through the sum scores; those that did show an interaction were analyzed separately for boys and for girls.

In the analysis for grades 4 through 7 (fall), 317 schools were classified into six textbook groups---three conventional and three modern. Four covariates were used in analyzing student achievement: Lorge-Thorndike verbal, Lorge-Thorndike non-verbal, computation, and structure. In the analysis for grades 7 (spring) through 8, 198 schools were classified into eight textbook groups---three conventional and five modern. Six covariates were used: Lorge-Thorndike verbal, Lorge-Thorndike non-verbal, whole number structure, multiplication of fractions, algorithms, and the Stanford Achievement Test. Not all covariates were measured simultaneously.

4. Findings

For each grade the following statistics appear in the reports:

- raw score means, variances, and standard deviations by textbook groups on the sum and difference variables (including covariates)

- correlation matrix for sum and difference variables

- results of tests for sex x textbook interaction

- homogeneity of regression tests

After tests for sex x textbook interaction, the following statistics (with analyses conducted separately by sex when appropriate) are presented:

- regression coefficients, standard errors, and t-statistics for coefficients

- statistics for regression analysis

- correlations, variances, and standard deviations (covariates eliminated)

- analysis of covariance for contrasts between groups

- adjusted means, standardized adjusted means, and conditional standard errors of standardized adjusted means by textbook group

- contrasts of the form Tk-T1 (k≠1), conditional standard errors, and t-statistics for the contrasts (Group T1 was the SMSG textbook group)

- first and second discriminant functions and test criteria for significance

- canonical form of textbook group contrasts

For each scale there is a plot of a 90 percent confidence interval for the standardized adjusted mean for each textbook group. Profiles of each textbook group are presented for those scales having significant variation across textbook groups.

Grade 4: See Table 1. Groups T2, T5, T6 had higher adjusted means than groups T1, T3, T4 on X102 (boys and girls) and X101 (less pronounced) but not on X103. X107 (boys and girls) separated T1, T3, T4 (high) from T2, T4, T6; and X105 separated T1, T4 (high) from the others. X109 (boys) separated T1, T2, T3 (high) from T4, T5. No discriminant analysis was performed.

Grade 5: See Table 2. Groups T3, T5, T6 were slightly higher than T1, T4 on computation scales. X306 separated T1, T3, T4 (high) from T2, T5, T6; and X308 separated T1, T6 (high) from T2, T3, T5. On the discriminant analysis, T2, T3, T5, T6 clustered together, with T1 separated on the first dimension and T4 separated on the second.

Table 1

STATISTICAL SUMMARY FOR GRADE 4

LEVELS of BEHAVIOR	SCALE	SEX X TEXT INTERACTION	HOMOGENEITY of REGRESSION	DIFFERENCES ACROSS TEXT GROUPS	SIGNIFICANT CONTRASTS Tk-T1, K≠1
COMPUTATION	X101: Subtraction of Whole Numbers			**	T1 T2,T5,T6
	X102: Division of Whole Numbers 1	*	B*	B**	B: T3 T1 T2,T5,T6
				G**	G: T3 T1 T2,T5,T6
	X103: Subtraction of Fractions 1	*		B*	B: T3 T1
				G**	G: T1 T2,T5,T6
COMPREHENSION	X104: Whole Number Numeration		B* G*	**	T2,T3,T4,T5,T6 T1
	X105: Whole Number Structure 1			**	T2,T3,T5,T6 T1
	X106: Fractional Representation 1			**	T3,T4 T1
	X107: Open Sentences - Operations 1	*		B**	B: T2,T4,T5,T6 T1
				G**	G: T2,T3,T4,T6 T1
	X108: Open Sentences - Translation				
APPLICATION	X109: STEP (Form 4B)	*		B**	B: T4.T5 T1

*p .05
**p .01

B: boys
G: girls

Modern: T1(SMSG),T3,T4
Conventional: T2,T5,T6

Table 2.

STATISTICAL SUMMARY FOR GRADE 5

LEVELS of BEHAVIOR	SCALE	SEX X TEXT INTERACTION	HOMOGENEITY of REGRESSION	DIFFERENCES ACROSS TEXT GROUPS	SIGNIFICANT CONTRASTS Tk-T1, k≠1
COMPUTATION	X301: Fractions 3			**	T1 T3,T4,T6
	X302: Decimals 2		B*		T4 T1
	X303: Division of Whole Numbers 2			**	T1 T2,T3,T5,T6
COMPREHENSION	X304: Decimal Notation			**	T2,T3,T4,T4,T6 T1
	X305: Translation		G*		T2,T3,T4,T5,T6 T1
	X306: Geometric Figures[a]			**	T2,T5,T6 T1 T4
APPLICATION	X307: Working with Numbers			**	T2,T3,T4,T5,T6 T1
ANALYSIS	X308: Five Dots[a]			**	T2,T3,T4,T5 T1

*p .05 B: boys Modern: T1(SMSG),T3,T4
**p .01 G: girls Conventional: T2,T5,T6

[a]geometry scale

Grade 6: See Table 3. Group T6 (high) separated from all other groups on X510 and from T1, T2, T3, T5 (middle) and T4 (low) on X509, X511, and X522. X523 separated T1, T4 (high) from T2, T6 (middle) and T3, T5 (low); and X524 separated T1, T3, T4 (high) from T2, T4. X527 separated T6 (high) from T1, T2 (middle) and T3), T4, T5 (low). Two clusters appeared in the discriminant analysis: (1) T2, T3, T5, T6 and (2) T1, T4.

Grade 7 (fall): See Table 4. For X604 - X609, T1, T2, T6 (high) separated from T3, T4, T5. T1, T6 (high) separated from T3, T4, T5 on X601; T2 joined the high cluster on X611 and X603, with T6 dropping to the low cluster on X603. On the discriminant analysis T2, T3, T4, T5 seemed to cluster together, with T1 separated on the first dimension and T6 separated on the second.

Grade 7 (spring): See Table 5. All five computation scales showed differences across groups and satisfying homogeneity of regression were division scales. It was postulated that division was not mastered by grade 7, so these scales were most sensitive to differences across textbooks. On these five scales there was a trend for T3, T6, T8 to be high and T4 to be low. X707 separated T5 (high) from T4, T8; and T8 was low on X721. Discriminant analysis yielded three clusters: (1) T1, T2, T4, T5; (2) T3, T6, T7; and (3) T8.

Grade 8 (fall): See Table 6. Group T8 was high on X803, the only variable free of heterogeneity of regression problems and with significant differences across groups. No discriminant analysis was performed since only three variables showed significant differences across groups.

Grade 8 (spring): See Table 7. Groups T3, T8 (high) separated from T1, T5, T7 on X901, X903, X906, and X908, all computation scales. For comprehension scales no clear pattern emerged. X909 separated T1, T2, T4 (high) from T3, T5, T6, T7; X913 separated T1, T4, T5 (high) from T3, T6, T7; and X916 separated T3 (low). Discriminant analysis yielded three clusters: (1) T2, T4; (2) T3, T5, T6, T7, T8; and (3) T1.

5. Interpretations

The results lend support to the conclusion that different patterns of mathematical achievement were associated with the use of different textbooks, and "unless the textbook is the causal agent, other factors which do produce the differences also influence textbook choices (No. 10, p. 167)." There is also support for a distinction between the behavioral levels of computation and comprehension. In general there was a tendency for scales which were similar in content and behavioral dimensions (e.g., number systems comprehension) to yield similar achievement patterns. The conjecture that achievement patterns would be similar within the textbook groups of conventional and modern proved to be too simplistic. The discriminant analyses did, however, provide limited evidence for delineating textbook clusters.

Table 3.

STATISTICAL SUMMARY FOR GRADE 6

LEVELS of BEHAVIOR	SCALE	SEX X TEXT INTERACTION	HOMOGENEITY of REGRESSION	DIFFERENCES ACROSS TEXT GROUPS	SIGNIFICANT CONTRASTS Tk-T1, k≠1
COMPUTATION	X508: Rational Numbers			**	T2,T3,T4,T5,T6 T1
	X509: Multiplication of Fractions		G*	**	T4 T1 T2,T5,T6
	X510: Multiplication of Decimals			**	T1 T6
	X511: Division of Fractions 2			**	T4 T1 T2,T5,T6
	X522: Stanford Achievement Test			**	T4 T1 T6
COMPREHENSION	X523: Whole Number Structure 2		G*	**	T2,T3,T4,T5,T6 T1
	X524: Open Sentences - Operations 2			**	T2,T4 T1 T3
	X525: Algorithms			**	T2,T3,T5,T6 T1
	X526: Geometry - Informal Ideas[a]			**	T2,T3,T4,T5,T6 T1
APPLICATION	X527: Estimating (?)			**	T3,T4,T5 T1 T6

*p .05
**p .01

B: boys
G: girls

Modern: T1(SMSG),T3,T4
Conventional: T2,T5,T6

[a]geometry scale

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Table 4.

STATISTICAL SUMMARY FOR GRADE 7 (FALL)

LEVELS of BEHAVIOR	SCALE	SEX X TEXT INTERACTION	HOMOGENEITY of REGRESSION	DIFFERENCES ACROSS TEXT GROUPS	SIGNIFICANT CONTRASTS Tk-T1, k≠1
COMPREHENSION	X604: Squares of Numbers			**	T2,T3,T4,T5 T1
	X605: Fractions for Regions			**	T2,T3,T4,T5 T1
	X606: Regions for Fractions	**		**	T3,T4,T5 T1
	X607: Equivalent Fractional Representations		G*	**	T3,T4 T1
	X608: Fractions and Number-Line Points		B*	**	T2,T3,T4,T5,T6 T1
	X609: Numbers - Rational		G*	**	T2,T3,T4,T5 T1
	X610: Numbers - Whole 1			**	T2,T3,T4,T5,T6 T1
	X602: Algebra - Number Properties 1[b]		G**	**	T2,T3,T4,T5,T6 T1
ANALYSIS	X601: Letter Puzzles 1			**	T2,T3,T4,T5 T1
	X611: Analysis 1			**	T2,T3,T4,T5 T1
	X603: Geometry - Spatial Relations[a]			**	T3,T4,T5,T6 T1

*p .05
**p .01

B: boys
G: girls

Modern: T1(SMSG),T3,T4
Conventional: T2,T5,T6

[a]geometry scale

[b]algebra scale

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Table 5.

STATISTICAL SUMMARY FOR GRADE 7 (SPRING)

LEVELS of BEHAVIOR	SCALE	SEX X TEXT INTERACTION	HOMOGENEITY of REGRESSION	DIFFERENCES ACROSS TEXT GROUPS	SIGNIFICANT CONTRASTS Tk-T1, k≠1
COMPUTATION	X701: Subtraction of Decimals		G**		
	X702: Division of Decimals			*	T4 T1
	X703: Subtraction of Fractions 2				
	X704: Division of Fractions 1	*		*	c
	X705: Conversion to Percent			**	T4 T1 T3,T6,T7,T8
	X706: Conversion to Decimals			*	T4 T1
	X709: Reduction to Lowest Terms		B*	*	T6,T7 T1
	X711: Subtraction of Whole Numbers		G**	*	
	X712: Division of Whole Numbers 1			*	T1 T6
	X717: Addition				
	X718: Subtraction		B** G**	*	T1 T2
	X719: Multiplication and Division		B** G**		
	X722: Division of Whole Numbers 2			*	T1 T7
COMPREHENSION	X707: Structure of Rationals			**	T1 T5
	X708: Rational Numeration		G*		
	X710: Problem Formulation		B*		
	X713: Whole Number Numeration				
	X714: Decimal Notation				
	X721: Structure		B** G**	**	T8 T1
ANALYSIS	X715: Directions[a]	*	G**	**	T1 T5

*p .05
**p .01

B: boys
G: girls

Modern: T1(SMSG),T2,T3, T4,T5
Conventional: T6,T7,T8

[a]geometry scale
[c]no significant contrasts with T1

Table 6.

STATISTICAL SUMMARY FOR GRADE 8 (FALL)

LEVELS of BEHAVIOR	SCALE	SEX X TEXT INTERACTION	HOMOGENEITY of REGRESSION	DIFFERENCES ACROSS TEXT GROUPS	SIGNIFICANT CONTRASTS Tk-T1, k≠1
COMPUTATION	X803: Fractions 3 + X804: Decimals 2			*	T1 T8
COMPREHENSION	X801: Open Sentences - Operations 2	**	B**	*	T1 T4,T6,T7
	X802: Whole Number Structure 2		B** G**	**	T4,T8 T1

*p .05
**p .01

B: boys
G: girls

Modern: T1(SMSG),T2,T3, T4,T5
Conventional: T6,T7,T8

Table 7.

STATISTICAL SUMMARY FOR GRADE 8 (SPRING)

LEVELS of BEHAVIOR	SCALE	SEX X TEXT INTERACTION	HOMOGENEITY of REGRESSION	DIFFERENCES ACROSS TEXT GROUPS	SIGNIFICANT CONTRASTS Tk-T1, k≠1
COMPUTATION	X901: Multiplication of Fractions			**	T1 T3,T6,T8
	X902: Multiplication of Decimals	*	B*	**	Not interpreted
	X903: Division of Fractions 2			*	T1 T3,T8
	X904: Division of Whole Numbers 2				
	X906: Conversion to Percents			**	T1 T3,T6,T8
	X907: Conversion to Decimals				
	X908: Division of Fractions 1		G**	*	T1 T4
COMPREHENSION	X909: Numbers - Whole 2		B** G**	**	T3,T5,T6,T7 T1
	X913: Fractions and Number-Line Points		B** G**	**	T3,T6,T7 T1
	X914: Algorithms				
	X915: Structure of Rationals		G*	**	T5 T1
	X916: Geometry - Constructions[a]			*	T3 T1
	X910: Algebra - Number Properties 1[b]		B*		
	X917: Translation		G**		
APPLICATION	X905: Scientific Notation 1		G*		
ANALYSIS	X911: Numbers - Problems		B*		
	X912: Geometry - Spatial Relations[a]		B* G*		

*p .05 B: boys Modern: T1(SMSG),T2,T3,T4,T5
**p .01 G: girls Conventional: T6,T7,T8

[a] geometry scale
[b] algebra scale

Critical Commentary

Among all studies on mathematical achievement, NLSMA stands out as one of the best planned and executed longitudinal investigations to date. The large number of subjects, the detsiled analysis, the use of schools as data units, and the multi-year testing procedure are important positive features of the study. The availability of the NLSMA data for follow-up investigations is a tribute to the careful work of many people.

The reports of the X-Populations results, howver, suffer from a lack of summarization. The reader is overwhelmed by hundreds of pages of tables which are presented without adequate help in interpreting the thousands of statistics. The NLSMA authors would seem to be in a better position than the reader to provide an appropriate context for interpretation. In particular, although the study is almost certainly too complex to permit a concise statement on the differential effects of conventional and modern textbooks, a clearer indication of trends in schievement patterns across grades is needed.

A few of the conclusions of the authors seem to be inadequately justified. For example, the authors state that "schools that used conventional textbooks during the period covered by these anslyses tended to produce pupils skillful at computation but not high in achievement, relatively, on measures of comprehension, application, or analysis (No. 11, p. 164)." This seems to be an overstatement, since at grades 7 (spring)-8 the single application scale and two of the three analysis scales showed no significant differences across textbook groups. (One wonders why there were so few application and analysis scsles.) For the third analysis scale, X715, both the highest and lowest averages were achieved by "modern" textbook groups. Of the 15 comprehension scales for grades 7 and 8, only eight showed significant differences (only two, X707 and X916, were free of heterogeneity of regression problems). Of these eight the highest adjusted mean was achieved by a conventional text three times and by a modern text five times. If there were no differences, this is what would be expected since there were three conventional texts and five modern texts. However, the lowest adjusted mean for these same scales was achieved by a conventional text five times and by a modern text three times. For grades 4-7 (fall) there were three application and four analysis scales. Conventional texts scored lowest on three of these seven and highest on two. of 20 comprehension scales, 19 showed significant differences. The highest sdjusted mean was achieved by a conventional text three times and by a modern text 16 times, and the lowest adjusted mean was achieved by a conventional text ten times and by a modern text nine times. In light of these figures, some further justification is needed for the authors' conclusions, at least with respect to the application and analysis scales.

Another deficit in the report, at lesst from today's perspective, is the limited attention given to the relationship between sex snd achievement. The sex x textbook interaction at each grade is an imporant analysis, but it does not give any infmation on the relative achievement of boys and girls. All of the analysis of achievement by sex is contained in appendices (Appendix B in each report). The authors do conclude that the scales for which the girls did better than boys (adjusted means) tended to be at a lower level of behavior. At grades 4-6, of seven scales favoring girls, six were computation and one was comprehension. At grades 4-6, boys outscored girls on one computation scale, 15 comprehension scales, one application scale, and three analysis scales. One wonders whether it is possible to determine the approximate grade at which these patterns of differences begin to appear.

A minor inconsistency in the analysis concerns the analysis of contrasts with the SMSG textbook group (T1). In grades 4-6 separate analyses were given for boys and for girls when there was a sex x textbook interaction. However, for grades 7-8 no separate analysis of the contrasts by sex was made when there was a sex x textbook interaction. The authors' justification (e.g., No. 10, p. 153 and No. 11, p. 50) were not entirely convincing.

Too little information was provided on the distinguishing characteristics of the different textbook series. The analyses are interesting as they stand, but they would be far more useful if contemporary textbooks could be compared on important characteristics with those appearing in this study. "Conventional" versus "modern" is too vague a categorization scheme to permit such a comparison.

Finally, the authors are to be commended for their search for additional covariates. Since intact groups were used, this search is important because the validity of the covariate analysis is highly dependent on correct choices of covariates. A wide variety of possible additional covariates was considered (Appendix A in both No. 10 and No. 11), but none of these consistently increased the percentage of variance explained.

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ED 084 114, ED 084 115, ED 084 116, ED 084 117
PATTERNS OF MATHEMATICS ACHIEVEMENT IN GRADES 4, 5, and 6: Y-POPULATION. Kilpatrick, Jeremy; McLeod, Gordon. NLSMA Report No. 12.

PATTERNS OF MATHEMATICS ACHIEVEMENT IN GRADE 9: Y-POPULATION. Kilpatrick, Jeremy; McLeod, Gordon. NLSMA Report No. 13.

PATTERNS OF MATHEMATICS ACHIEVEMENT IN GRADE 10: Y-POPULATION. McLeod, Gordon; Kilpatrick, Jeremy. NLSMA Report No. 14.

PATTERNS OF MATHEMATICS ACHIEVEMENT IN GRADE 11: Y-POPULATION. Kilpatrick, Jeremy; McLeod, Gordon. NLSMA Report No. 15.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by James M. Sherrill, David F. Robitaille, and Douglas T. Owens, University of British Columbia.

1. Purpose

NLSMA was undertaken by SMSG as a "long-term study of the effects on students of various kinds of mathematics programs." NLSMA was funded to "provide information for the further improvement of the school mathematics curriculum, to develop measures of mathematics achievement more sensitive to the wide range of outcomes expected from using various types of textbooks, to investigate the nature of mathematics achievement, to provide information for school personnel, and to gain experience in operating a large scale study in order to inform other investigators wishing to operate similar studies".

Findings for textbook comparisons in the Y-Population of NLSMA are presented in Reports 12-15. The Y-Population is the middle sequence of grades observed in NLSMA. Reports 12-15 present information concerning textbook analyses for grades 7 and 8 (vol. 12), 9 (vol. 13), 10 (vol. 14), and 11 (vol. 15).

2. Research Design and Procedures

The data unit for each variable in the Y-Population analyses was the mean score for the students of a given sex within a particular school using a particular textbook. In years one and two of NLSMA, inclusion in the study required that a text had to be used in at least two schools by at least 200 students in grades 7 and 8. During subsequent years, it was required that a textbook be used in at least two schools, by at least ten students per school and by at least two students of each sex. To be eligible a student was required to have used one of the specified textbooks and to have a complete set of scores for a given year.

Students in the Y-Population were generally higher than average in mental ability, mathematics achievement and socio-economic status.

The number of schools using each textbook group for each year is presented in Table 1.

Table 1

Y-Population Textbook Classifications and Number of Schools

Year	Grade	Textbook Classification (Code/Number of Schools for this Group)	Total
1	7	Modern (G1/137, G2/26, G3/23, G4/10, G6/11, G7/9, G8/2)	218
		Conventional (G5/36)	36
2	8	Modern (G1/133, G2/25, G3/24, G4/10, G6/11, G7/9, G8/3)	215
		Conventional (G5/39)	39
3	9	Modern (G1/95, G2/45, G3/7, G4/81, G5/6, G6/23, G7/22)	279
		Conventional (G8/14)	14
4	10	Modern (T1/44, T2/14, T3/6, T4/38, T5/42, T6/6, T7/8, T8/4)	162
		Conventional (T9/7, T10/11, T11/6, T12/8)	32
5	11	Modern (T1/32, T2/4, T3/77, T4/18, T6/4)	135
		Conventional (T5/14, T7/5, T8/11)	30

One cautionary remark made at the outset was that NLSMA was an observational study, not an experiment. The investigators did not draw random samples of students from existing populations; instead, the population of students in NLSMA was determined by the willingness and ability of local school administrators to obtain groups of students for testing. Furthermore, the NLSMA investigators had no control over the textbooks that the students used since such decisions are matters of local or state educational policy.

Since there was no control over initial differences among textbook groups, multivariate analysis of covariance was chosen as the main statistical procedure.

The data units on each covariate and dependent variable were the school mean for all eligible boys and the school mean for all eligible girls. In the analysis, the scores which were actually used were (1) the sum of the boys' mean and the girls' mean (sum variable), and (2) the difference between the boys' mean and the girls' mean (difference variable). The multivariate analyses of covariance were conducted in the following manner:

Step 1: Test for sex X textbook interactions by using the difference variables and multivariate analysis of covariance.

Step 2: Test for textbook differences. In the absence of sex X textbook interactions, the sum variable form of the data was used for covariates and dependent variables in all the statistical procedures. In the presence of sex X textbook interactions, the analyses were done separately for each sex.

Step 3: Test for sex differences in those variables free of sex X textbook interactions by using the difference variables in multivariate analysis of covariance.

Considerable emphasis was placed on textbook group comparisons. These were handled by statistically independent contrasts, comparing the group mean of an SMSG text group (G1 for Years 1-3, T1 for Years 4-5) with the group mean of each of the other textbook groups. A t-statistic was calculated for each such contrast for each dependent variable having significant variation using adjusted means. In addition, the following statistical procedures were used: (1) multivariate stepwise regression analyses to determine relationships between the vector of covariates and the vector of dependent variables, (2) univariate F's to determine relationships between each dependent variable and the vector of covariates, (3) multiple discriminant analysis to determine a linear function that macimally separated the groups with respect to between-group variation, and (4) multiple R for each dependent variable since R^2 represents the proportion of variance predicted by the covariates.

The testing data were collected using mathematics scales almost all of which were constructed for the study. The mathematics scales were classified according to the content of the items and the level of cognitive behavior they required. The three areas of content were number systems, geometry, and algebra; the four levels of behavior were computation, comprehension, application and analysis.

The timing of the administration of the various tests as well as the content and cognitive level tested are presented in Table 2.

Table 2

	Number Systems	Geometry	Algebra
Computation	1S* 2F** 5F		3S 5F 5S
Comprehension	1S 2F 3S 5F 5S	3S 5S	2F 3S 5S
Application	1S	4S 5F 5S	
Analysis	2F 4F 5S	2F 3S 4F 4S 5F 5S	2F 3S 5S

*Year 1, spring
**Year 2, fall

3. Findings

1. There were no significant sex X textbook interactions for Years 1-3. For Years 4 and 5 there was a significant sex X textbook interaction on the algebra-computation scale. Also for Year 5 there was a significant sex X textbook interaction for a geometry-application scale.

2. For Year 4 the two sexes performed at about the same level on the algebra-computation scale or else the boys performed notably better than the gitls for all textbook groups except T9.

3. Every one of the dependent variables used in each of Years 1-5 had a significant percentage of its variance predicted by the corresponding set of covariates.

4. Almost all of the variables in all five years contributed distinct variance to the multivariate distribution.

5. Multivariate analyses of covariance indicated significant variation in adjusted scores on the dependent variables among the 8 groups used in Year 1. An analogous result was obtained in Years 2-5.

6. In Years 1-2 of the 154 contrasts, 48 were significant ($P < 0.05$) with 26 favoring G_1. In Year 3, 31 of 63 contrasts were significant with 25 favoring G_1. In Year 4, 25 of 77 contrasts were significant with 23 favoring T_1. In Year 5, 4 of the 14 contrasts were significant with 1 favoring T_1.

4. Interpretations

Patterns of Achievement

1. Mathematics achievement is a multivariate phenomenon.

2. In grades 7-9, the conventional textbook groups had similar achievement patterns, but these patterns differed from the modern textbook groups. In grades 7-10, the modern textbook achievement patterns differed considerably among themselves.

3. Of the dependent variables free of sex X textbook interaction many showed significant sex differences (grade 7-8, 21 of 27 dependent variables; grade 9, 5 of 11; grade 10, 9 of 13; grade 11, 4 of 10). In all 5 grades the differences which favored the boys occurred mainly on the analysis and/or application scales. The girls were superior mainly on some of the computation scales.

Profiles of Textbooks

Grades 7-8

1. A clear conclusion from the study was that, "... students are more likely to learn what they have been taught than something else." Each group performed best in those areas stressed in their particular textbooks.

2. The greatest differences among the textbook groups were on dependent variables dealing with computation.

3. No textbook group was shown to be clearly superior in the higher processes of comprehension, application and analysis. This may be due to insensitivity of the scales used or to the texts themselves.

4. The report did not examine the question of student ability X textbook interactions (true for Reports 12-15).

Grade 9

1. NLSMA students who had studied from modern algebra textbooks did not out-perform NLSMA students who had studied from conventional algebra textbooks on the four analysis-level scales. None of the groups did very well on the algebra-analysis scale.

2. Many of the differences can be explained by an examination of how the textbooks treated the topics being tested.

3. The consistent pattern observed in grades 7 and 8 analyses at the computational level was not maintained.

4. The differences among the textbook groups declined.

Grade 10

1. The SMSG Geometry textbook group was above average on the two geometry-application scales common to the Y- and Z-Population.

2. The results for the Y-Population geometry textbook comparison should be viewed as supplements to the corresponding analyses for the Z-Population (Report 16).

3. The differences among the textbooks continues to decline.

4. No clear separation between the modern and conventional textbook groups was observed.

Grade 11

1. The results of the comparisons that occur in both the Y- and Z-Populations were similar.

2. Many different textbooks were used in Grade 11.

3. Students' performance on a scale requiring them to work with inequalities appeared to be almost directly proportional to the attention given to inequalities in the textbook.

4. In both grades 10 and 11, the variation in attention given to coordinate geometry in the different textbooks had little effect on performance on the related scales.

5. The overall performance on the analysis scales of NLSMA was poor.

6. As in grades 7-10, the textbook groups differed more on a "lower process" than on "higher process" scales, where all did poorly.

7. Finally, the pattern of the differences among the textbooks to decline continued. The amount of canonical variation accounted for by the first variate for grades 7-11 was as follows: Grade 7 - 64%, Grade 8 - 72%, Grade 9 - 48%, Grade 10 - 52%, Grade 11 - 37%.

Critical Commentary

One of the major contributions of NLSMA has been in operating a large scale longitudinal study in the field of mathematics education; it probably will serve as a model for future studies of this kind. Another contribution of NLSMA was the provision of some support for the hypothesis that mathematics achievement is a multivariate phenomenon.

The results of the textbook comparison analyses are interpreted with caution in Vols. 12-15. This is as it should be, but it is unfortunate that stronger interpretations could not have been made. For example, although special efforts were made to measure differences in the higher cognitive processes, no consistent patterns of textbook differences were found.

The authors have prefaced each of these volumes with a statement of three cautionary remarks. They point out (1) that NLSMA was an observational study, not an experiment; hence there was no randomization of student or textbook groups; (2) that the analyses were based on a multivariate model of mathematics achievement, thereby making the identification of an overall "winning" or "losing" group irrelevant; (3) that the textbook comparison analyses were only the first in a series of NLSMA analyses.

A number of concerns about Vols. 12-15, some of them related to the cautionary remarks, should be voiced. (1) There was no control over the extent of use of supplementary textbooks and materials, although there was considerable use of such materials in some cases. (2) Disproportionate numbers of schools were selected from certain geographical areas (e.g., California) and from among SMSG users. For example, over 80% of the schools in Years 1 and 2 were SMSG schools. (3) At least one conventional textbook "group" in a given year was really a collection of groups using different conventional texts. (4) Although the authors describe a 3x4 mathematical content by cognitive level matrix, few of the twelve cells were tested in any one year: e.g., only three were tested in Year 1. For the Y-Population two of the cells were never tested. (5) A very large number of the t-statistics was used each year in connection with textbook group contrasts on the dependent variables. This approach increases the likelihood of obtaining spurious results. However, it should be noted that there were many significant t-values found.

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ED 084 118, ED 084 119, ED 084 120
PATTERNS OF MATHEMATICS ACHIEVEMENT IN GRADE 10: Z-POPULATION. Wilson, James W. NLSMA Report No. 16.

PATTERNS OF MATHEMATICS ACHIEVEMENT IN GRADE 11: Z-POPULATION. Wilson, James W. NLSMA Report No. 17.

PATTERNS OF MATHEMATICS ACHIEVEMENT IN GRADE 12: Z-POPULATION. Romberg, Thomas A; Wilson, James W. NLSMA Report No. 18.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by William Nibbelink and Harold Schoen, The University of Iowa.

1. Purpose

The NLSMA Z-Population Achievement Reports present statistical descriptions and analyses of mathematical achievement as measured by tests presented in NLSMA Report No. 3. Report No. 16 deals with tenth-grade geometry; No. 17 deals with eleventh-grade algebra; No. 18 deals with a variety of fourth-year mathematics offerings deemed to exhibit enough common emphases to warrant the construction of tests appropriate to all. These reports present comparisons of textbook groups and examinations of possible interaction effects. Comparisons are based on examining linearly adjusted mathematics achievement scores, with adjustment covariates including measurements of general mental ability and prior-to-treatment measurements of mathematical achievement.

The authors emphasize that any such comparison "is an analysis of existing, intact groups and any such study is basically correlational. Patterns of mathematics achievement related to textbook usage are reported; whether or not these patterns are textbook effects will remain only a hypothesis (NLSMA Report No. 16, page 1)."

2. Rationale

In the early 1960's "experimental textbooks based on the nature and spirit of modern mathematics were being used widely. Most textbook publishers had not had sufficient time to incorporate the modern mathematics point of view, organization and content" into geometry or second-year algebra textbooks. "Hence, the experimental textbooks and the conventional textbooks in use provided an interesting contrast. To examine such contrasts between alternative textbook presentations of mathematics instruction was one of the goals of NLSMA and a major reason the study was initiated (NLSMA Report No. 16, page 2; Report No. 17, page 2)."

3. Research Design and Procedures

"Participation in NLSMA was on a voluntary basis. That is, an appeal was made to school personnel through state supervisors of mathematics instruction, professional journals, and personal correspondence asking the school personnel to volunteer classes of geometry students to participate in NLSMA for three years--grades 10, 11, and 12. The only control NLSMA exercised over these classes was to be able to administer batteries of tests to these same students through grades 10, 11, and 12. Classes were requested from all types of curricula. The choice of which classes to allow NLSMA to follow, the number of such classes, and any decisions regarding the instruction of these classes was left completely to the discretion of the school personnel (NLSMA Report No. 16, page 2)." This initial request yielded an original Z-Population from 215 schools.

School means were used as the units of data for Z-Population textbook comparisons. For grades 10 and 11 there was concern that boys' and girls' achievement patterns may be different. It was determined that the appropriate unit of data for a given dependent variable would be a sum of means, school mean for girls + school mean for boys (NLSMA Report No. 16, pages 24-25).

To quality for the geometry study a school was required to have at least 10 students, including at least 2 boys and at least 2 girls, for whom data on all dependent variables and covariates were reported. Also, it was required that a single textbook fitting one of the NLSMA classifications was used. To qualify for the second-year algebra study the same types of requirements were enforced. To qualify for the fourth-year mathematics study, the requirements on number of students were altered to simply "five or more students". It should be noted that "a school with 10 students would carry as much weight as one with 300 students. The school means data units based on fewer students probably were more sensitive to selection bias--where a school selected students to participate in NLSMA, there was a tendency to choose the more able students (NLSMA Report No. 16, page 17)."

All geometry and second-year algebra textbooks and some fourth-year mathematics textbooks were classified as being either modern, conventional, or transitional and/or modern but quite different. To so classify textbooks "each textbook was examined by members of the NLSMA staff, by members of the SMSG Research and Analysis Section, and by consultants to SMSG (NLSMA Report No. 16, page 8)."

Schools were assigned to textbook groups on the basis of which textbook was in use. "When a school could meet the minimum criteria for both a conventional and a modern textbook, the data for the conventional textbook was dropped (NLSMA Report No. 16, page 13)." This decision was based on the proposition that "the nature and spirit of modern mathematics programs tends to be carried over into classes using conventional textbooks, while there tends to be less opportunity for transfer of point of view and spirit from the conventional classes to the modern (NLSMA Report No. 16, page 13)."

Table 1 presents a further description of Z-Population Textbook Groups as determined by the procedures described above.

Table 1.

Z-POPULATION TEXTBOOK GROUPS

NLSMA Text Group Desig-nation	Grade Level	Classification of text as Modern, Conventional, Transitional	Book(s) Used or Brief Descrip-tion of Book(s) Used	Number of Schools from Group of 215 Initially Identified as Z-Pop. Schools
G1	10	M	Geometry, Parts I & II, SMSG, 1962	109
G2	10	M	Geometry with Coordinates, Parts I & II, SMSG, 1962	13
G3	10	C	Any of 15 texts listed on pages 11-12 of NLSMA Report No. 16 (copyrights: 1953-1962)	34
G4	10	M	UICSM High School Mathematics, Unit 6, Geometry, 1960; UICSM High School Mathematics, Course 2, 1965	12
G1	11	M	Intermediate Mathematics, Parts I & II, SMSG, 1961	62
G2	11	M	Modern Algebra and Trig.: Structure and Method, Book 2, Houghton Mifflin Co., 1963	26
G3	11	C	Algebra, Book 2, Ginn & Co., 1962	11
G4	11	C	Algebra II: A Modern Course, Chas. E. Merrill, 1962	7
G5	11	C	Any of 9 second-year algebra texts listed on pages 13-14 of NLSMA Report No. 17 (copyrights: 1951-1962)	17
G6	11	T	One of two second-year algebra texts listed on page 14 of NLSMA Report No. 17 (copyrights: 1962-1965)	8
G7	11	M	UICSM High School Mathematics, Units 5, 7, 8, 9, University of Illinois Press, 1960-1961	7
G8	11	M	Algebra II, Addison Wesley, 1962	3

CG1A	12	M	Elementary Functions, SMSG, 1960, 1961	36
CG1b	12		Any of 14 functions texts listed on pages 11-12 of NLSMA Report No. 18 (copyrights: 1956-1965)	65
CG2	12		Any of 14 trigonometry texts listed on pages 13-14 of NLSMA Report No. 18 (copyrights: 1943-1962)	47
CG3	12		Any of 6 calculus texts listed on page 15 of NLSMA Report No. 18 (copyrights: 1955-1965)	17
CG4a	12	M	Intermediate Mathematics, Parts I & II, SMSG, 1961	18
CG4b	12	M	Any of 5 advanced algebra texts listed on pages 16-17 of NLSMA Report No. 18 (copyrights: 1961-1963)	29
CG4c	12	C	Any of 12 advanced algebra texts listed on pages 17-18 of NLSMA Report No. 18 (copyrights: 1954-1962)	21
CG5	12		No textbook	99

The multivariate analysis of covariance (MANCOVA) was the central statistical technique used to describe the pattern of variation of the textbook groups on the vector of mathematics achievement scores. Other statistics were used for various reasons. The statistics tests used for grades 10 and 11 are listed below in the order in which they were run and reported: (a) descriptive statistics including means, common within-group correlations, variances, and standard deviations for each textbook group on each variable; (b) regression analysis to determine the relationship between the vector of dependent measures; (c) a multivariate (chi square) test and a univariate (F-statistic) test to check the assumption of homogeneous regression across groups; (d) MANCOVA; (e) t-statistics of the contrast of G1 with each of the other textbook groups for each dependent variable identified in the MANCOVA to have significant adjusted variation across textbook groups; (f) standardized adjusted means for each group for each dependent variable and graphs of the 90 percent confidence band associated with each in order to facilitate comparison; and (g) multiple discriminant analysis to aid in determining those textbook groups that had similar patterns of performance on the dependent variables. For each school a mean for all boys and a mean for all girls were calculated. The final data analysis used combined data for both sexes by generating two new raw scores, the sum and the difference of the boys' and girls' means. The sum variables were used to compare the textbook groups, boys and girls, and the difference variables were used to identify sex x textbook interactions. For grade 12 the question of sex differences and sex x textbook interactions was not pursued.

Restricting attention to grades 10 and 11, the following tests were used as covariates:

PZ027, a 43 item Lorge-Thorndike Verbal Test.

PZ028, a 58 item Lorge-Thorndike Non-Verbal Test.

Z026, a 40 item algebra test.

Z027, a 16 item geometry test.

Z025, a 29 item test covering number properties, "advanced arithmetic", radicals, etc.

Z114, a 40 item mathematics inventory which includes scales Z101-Z106, Z112, and Z113; most of which are used as dependent variables for the grade 10 analyses of achievement.

Z111, a 50 item test, the STEP Mathematics Test, Form 2B; ETS, Princeton, New Jersey; used as a dependent variable for grade 10 analysis.

Test scales used as dependent variables for grades 10 and 11 are classified in the next section of this abstract, along with information on numbers of items and means.

There are two reasons for restricting attention to grades 10 and 11 at this point. First, including grade 12 would require too much space. Second, the abstractors tend to agree that "the 12th grade mathematics program in this country is so diverse, so variable from school to school, that it is extremely difficult to present any analysis of mathematics performance (NLSMA Report No. 18, page 67)."

4. Findings

Tests (scales) used as dependent variables for grades 10 and 11 are classified as follows by NLSMA. Each entry in the matrix below provides a triplet giving NLSMA test designation; number of items on test; mean for all students. Almost all items on these tests were multiple-choice items with 5 choices per item.

	Number Systems	Geometry	Algebra
COMPUTATION			Z102; 7; 2.45 Z103; 4; 2.03 Z104; 4; 1.03
COMPREHENSION	Z101; 7; 3.44 Z308; 6; 3.43 Z309; 6; 1.99	Z301; 4; 2.17	Z305; 15; 7.86 Z307; 7; 2.96
APPLICATION		Z105; 6; 2.41 Z106; 8; 3.97 Z302; 6; 3.19 Z304; 4; 2.40	Z111; 50; 28.68
ANALYSIS	Z310; 5; 1.89	Z303; 11; 2.42	Z306; 15; 3.23

(Any reader who is interested in examining the Z-Population results carefully is strongly encouraged to study these tests as presented in NLSMA Report Nos. 3 and 6.)

Table 2 displays standardized means for covariates and standardized adjusted means for dependent variables for grades 10 and 11. Of all covariates, only Z027 for grade 10 failed to show differences between groups at a .01 level. This may be related to the fact that the mean for Z027 over all students was low, 5.47 for 16 multiple choice items (NLSMA Report No. 6, page 17).

Table 2.

STANDARDIZED MEANS FOR INDEPENDENT VARIABLES (COVARIATES) AND
STANDARDIZED ADJUSTED MEANS FOR DEPENDENT VARIABLES FOR GRADES 10 AND 11

Group	Standardized Mean on Covariate							Standardized Adjusted Mean on Dependent Variable										
(Grade)	PZ027	PZ028	Z026	Z027	Z025	Z114	Z111	Z106 / Z302	Z105 / Z304	Z102	Z101 / Z308	Z104 / Z305	Z103 / Z307	Z111 / Z306	Z309	Z310	Z301	Z303
G1(1)	47.76	47.44	48.42	49.39	49.35			56.0	56.8	44.6	44.2	48.2	48.9	48.9				
G2(10)	52.20	51.21	50.53	52.74	51.74			42.7	49.8	44.8	50.0	54.4	61.3	50.3				
G3(10)	45.22	44.90	43.02	47.77	41.47			59.8	53.2	46.7	44.7	50.2	39.3	51.9				
G4(10)	54.81	56.47	58.03	50.09	57.46			41.6	40.1	64.0	61.2	47.1	50.5	48.9				
	**	**	**		**			**	**	**	**		**					
G1(11)	55.64	54.83	56.26	55.24	57.66	56.51	55.02	63.6	55.4		49.3	53.5	53.8	49.1	52.1	51.2	48.1	52.2
G2(11)	52.45	50.03	50.71	53.01	50.31	51.45	51.32	58.3	55.9		55.6	58.9	56.7	53.6	54.3	52.0	50.5	50.4
G3(11)	44.64	41.65	38.41	45.34	35.65	38.32	41.49	47.8	51.4		47.9	54.3	45.6	48.7	42.4	49.9	55.8	48.0
G4(11)	46.62	48.62	44.18	49.48	42.78	45.64	48.48	51.1	48.1		54.8	54.3	49.5	46.3	52.3	52.1	56.5	48.0
G5(11)	45.63	43.85	41.93	46.36	40.78	44.66	46.09	44.4	49.1		52.3	52.1	38.4	49.4	45.2	52.3	53.1	49.6
G6(11)	48.86	49.58	53.56	49.97	53.63	51.82	48.47	55.4	48.6		48.2	40.6	50.1	46.8	52.9	49.2	49.2	54.1
G7(11)	60.21	65.25	66.88	57.58	66.99	64.46	62.77	28.5	40.9		45.3	40.9	53.9	57.6	51.8	48.5	40.4	48.6
G8(11)	45.94	46.18	48.08	43.06	52.19	47.15	46.37	50.9	50.5		46.5	45.8	51.9	48.5	49.0	44.9	46.2	49.1
	**	**	**	**	**	**	**	**	**			**	**					

*differences between groups for grade level are statistically significant (p .05) on test named above.

**differences between groups for grade level are statistically significant (p .01) on test named above.

In both grades 10 and 11 the hypothesis of homogeneity of regression was tested using school means as data units for two textbook groups only, since the other groups were smaller than the total number of variables. The hypothesis of homogeneity of regression was found tenable on all dependent variables except Z102 and Z106 for tenth-grade girls, Z302 for eleventh-grade boys, and Z306 for eleventh-grade girls. "This heterogeneity limits the interpretation of the results on the two variables but appeared to be the result of basically unstable regression surfaces in the two smaller groups as a result of the small number of data cases (NLSMA Report No. 16, page 38)." In addition, in grade 11 the heterogeneity is not "consistent across both sexes (NLSMA Report No. 18, page 19)."

For grade 10 "significant sex differences were found on five of the seven dependent variables. The boys scored higher in each case." "These results are in line with a trend found in other NLSMA Reports for boys to show superior performance on the higher cognitive levels (NLSMA Report No. 16, page 78)." For grade 11, the differences favored the girls for algebra scales (comprehension level) and favored the boys for the geometry and numeration scales (application and analysis levels).

5. <u>Interpretations</u>

Concerning sex differences, NLSMA authors state that "Interpretation and comment on this pattern will be left to persons involved in the women's liberation movement (NLSMA Report No. 17, page 95)."

Concerning textbook differences in grade 10, "Perhaps the most significant finding is that the SMSG Geometry textbook group (a modern textbook) and the conventional textbook group showed a similar pattern of achievement. The patterns for the other two textbook groups, both modern, were distinct and appeared to reflect, in part, content unique to each textbook. Both the UICSM Geometry and the SMSG Geometry with Coordinates textbook groups performed relatively low on geometry and measurement scales (NLSMA Report No. 16, page 79)."

Concerning textbook differences in grade 11, "Briefly stated, the modern textbook group profiles showed superior performance on all of the scales while the conventional textbook group profiles were lower in performance on the number properties, inequalities, and geometry scales.... Only a moderate bias is needed...to conclude that for this set of dependent variables, the modern programs represented by the larger textbook group samples were superior to the conventional programs. The smaller textbook groups may represent programs with particular program results (NLSMA Report No. 17, pages 96-97)."

Concerning findings in grade 12, "The analysis of twelfth grade mathematics curriculum patterns found remarkably similar performance on the limited set of dependent variables. Students who do not elect mathematics in twelfth grade, however, even though they have completed three years of mathematics by eleventh grade, were found to have much lower performance (NLSMA Report No. 18, page 72)."

Critical Commentary

Clearly, studies concerned primarily with a unique era and national mood cannot be duplicated. Thus, suggestions regarding what might have been done differently will be few. Instead, a few questions will be raised, questions intended to help anyone who decides to examine the NLSMA Reports closely to determine the substantive significance of the findings.

1. Is it reasonable to attribute achievement patterns by the modern textbook groups to modern mathematics programs for the Z-Population? Judging from copyright dates for materials, such patterns are derived for children whose schooling was "conventional" for the most part.

2. What is the "nature and spirit of modern mathematics programs" which was used to justify considering schools having both modern and conventional programs only under the modern classification (NLSMA Report No. 16, page 13)? Is it the same today as in the early 1960's? Could this "nature and spirit" be a set of teaching strategies, perhaps as old as Socrates, which over time experiences a series of rebirths?

3. Why did so few schools offering conventional mathematics courses agree to participate in the NLSMA Z-Population Study? (Only 34 schools comprised the conventional geometry group, compared to 134 schools comprising the modern group.) Was the appeal perhaps conducted in a manner which made participation more attractive to schools satisfying the conditions for the modern classification? Was the appeal made with equal force to members of a representative sample of schools in the United States? (See NLSMA Report No. 16, page 2.)

4. Were teachers in modern and conventional schools treated differentially? (See NLSMA Report No. 16, pages ix-x.) Was there a possible "effect of differential treatment" which influenced teachers and/or students, or did teachers for one group receive more in-service guidance than for the other?

5. With highly unequal numbers across groups, how much effect did the violation of assumptions for MANCOVA have on the reported outcomes? (See the "Findings" section of this abstract.)

6. For the fourth year, SMSG groups had a higher ratio of boys to girls than non-SMSG groups for both functions courses and advanced algebra courses (NLSMA Report No. 18, page 9). In both cases, such differences in boy-girl ratios are statistically significant ($p<.05$; Chi-Square). For all mathematics courses presented by Report Nos. 16, 17, and 18, data which allowed for making this observation were presented only for functions and advanced algebra. Is this pattern a general one for the Z-Population textbook groups? If so, is it a significant threat to the validity of the results when school means for dependent variables were calculated by using mean for boys + mean for girls?

7. For the fourth year, the number of students considered per school is considerably less for the conventional classification than for the modern (14.5 per school vs. 21.1 per school). Does this suggest that conventional schools tended to be either small or less commited to encouraging students toward pursuing mathematics? Is this a threat to validity which goes beyond the fact that modern and conventional schools tended to be drawn from different geographic areas (NLSMA Report No. 16, page 17; No. 17, page 20; No. 18, page 9)?

8. Were there stated criteria for the classification of textbooks (as modern, conventional, transitional, or other) which would allow for replication of the classification process by others?

9. Did the relatively short tests, often with very low means, grant enough sensitivity for investigating a "wide range of outcomes" as stated in the purposes section of this abstract? With schools used as the units of data, why was an item sampling technique not used?

It is our opinion that the Z-Population Studies of Achievement are limited mainly to forming a basis for generating hypotheses as stated in the purposes of NLSMA, not to reaching conclusions. Alas for these hypotheses, most may belong to an era now spent, regarding both the status of mathematics education in the United States and the relative status of the sexes.

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ED 084 121
NON-INTELLECTIVE CORRELATES OF UNDER- AND OVERACHIEVEMENT IN GRADES 4 AND 6. Travers, K. J. NLSMA Report No. 19.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Elizabeth Fennema, University of Wisconsin - Madison.

1. Purpose

To seek evidence of the relationships of the following three sets of variables to under- and overachievement: (1) pupils' attitudes and backgrounds; (2) teachers' opinions and backgrounds; and (3) school characteristics of curriculum (textbook used) and school-community data (administrative and socio-economic).

2. Rationale

Since achievement is the product of the interaction of the student with the teacher and school, it is essential to have knowledge of how teachers, schools, and pupils interact, in order to understand what is entailed in the learning of mathematics. The study reported in this volume was of an exploratory nature to gain some understanding of this interaction.

3. Research Design and Procedure

A. Identification of Under- or Overachievement

Under- and overachievers were identified through the following steps: (1) Four predictor variables which sampled determinants of mathematics achievement were selected. These were the Verbal and Non-Verbal batteries of the Lorge-Thorndike Intelligence Test, a Computation Scale (a composite of 3 NLSMA Scales), and a Structure of Mathematics Scale (a composite of 2 NLSMA Scales). (2) A regression estimate of the "true" predictor variable scores was obtained by taking into account the unreliability of the measuring instruments. (3) Obtained achievement scores (from the STEP Mathematics Test, Year I, and Stanford Achievement Test, Year III) were regressed onto the predictor variables. (4) Predicted scores were computed for the end of Year I and Year III. (5) Discrepancy scores were obtained for each student for each year by subtracting obtained score from predicted score. An over- or underachiever was defined as one whose discrepancy score was more than one standard error of estimate above or below the regression line.

B. Subjects

Students were drawn from the X-Population of the NLSMA study and consisted of those students who were using the SMSG textbook (Modern) or the Holt, Rinehart and Winston textbook (Conventional). Results from testing in the fourth grade (Year I) and sixth grade (Year III) were reported by sex and text. Students were drawn from 57 schools with about 375 teachers (N = 3,527).

C. Independent Variables

The independent variables were pupil, teacher, and school characteristics. The relationships between each independent variable and under- or overachievement were explored somewhat differently.

Pupils' attitudes, performance on cognitive scales and background measures were collected. Attitudes measured were: Arithmetic vs. Non-arithmetic, Arithmetic Fun vs. Drill, Pro-arithmetic Composite, Arithmetic Easy vs. Hard, Actual Arithmetic Self-concept, Ideal Arithmetic Self-concept, Orderliness, Messiness, Facilitating Anxiety, and Debilitating Anxiety. Alpha reliabilities, test-retest correlations from Year I to Year III, and descriptive statistics were presented for the total group and by sex and text (Modern or Conventional). Changes in performance on each scale from Year I to Year III by each sex and each text group were indicated by means, standard deviations and differences. The cognitive measures used were the same as the Predictor variables (Verbal, Non-Verbal, Structure and Computation scales). The pupil background measures analyzed were Sex, Family Breadwinner, Education of Parents, Occupation of Parents, Twin or Triplet, and other language spoken at home. Chi square tests, simple regression analyses, and stepwise regression analyses were the statistical techniques used to explore the relationships between pupil measures and under- or overachievement.

Teacher characteristics collected were background (professional and training, etc.) and measures of certain attitudes. Attitudes measured by the NLSMA Teacher Opinion Questionnaire were: Theoretical Orientation, Concern for Students, Involvement in Teaching, Non-authoritarian, Like vs. Dislike, Creative vs. Rote, and Need for Approval. Means and standard deveiations for Modern and Conventional teachers were also classified according to attitude level from low to high. Mean pupil residual achievement scores were computed for each teacher using the Verbal, Non-Verbal, Computation, and Structured predictors. Teachers were then classified on the basis of mean student residual achievement scores as high, mid, or low effective, and the attitudes which helped discriminate between these groups of teachers were identified by multiple discriminant analyses. Extension analysis techniques were also used to generate rotated factor matrices for background information and attitudes.

Data for participating schools were gathered by using the NLSMA School-Community Questionnaire. The items on this questionnaire were classified into the following general categories: General Administration, Mathematics Instruction, and Socio-Economic Factors. Contingency tables were constructed which showed the association of these categories with the over- and underachievers. Significant relationships were reported.

4. Findings

Findings were summarized by variable studied.

A. Pupils. Changes in attitudes were more pronounced with the Conventional group than with the Modern group. The Conventional group reported more positive attitude changes in view towards mathematics. The Modern group exhibited a decrease in self-concept. All groups showed declines in Facilitating Anxiety: Modern girls showed a marked increase in Debilitating Anxiety while the Conventional boys showed a decrease in Debilitating Anxiety. The intercorrelations of the Verbal and Non-Verbal cognitive scales ranged from .43 to .66. The Structure Scale correlated lowest (around .3) with the other cognitive measures, while the standardized tests intercorrelated highest.

The regression analyses indicated that even with four predictors, the multiple correlation with achievement was only moderate: The Beta Weights were .577 for Computation at the end of Year I and .690 for Structure at the end of Year III. The predictors accounted for roughly half of variance in the criteria. For the STEP Test (standardized criterion measure, Year I) the Lorge-Thorndike Verbal Test was the best single predictor (r = .293). For the Stanford Test (standardized criterion measure, Year III), the Computation Scale was slightly better than the Lorge-Thorndike Verbal Scale (r's = .275 and .189 respectively). The Structure Scale provided little predictive power for any criteria. There was a lack of agreement of classifying students as under- or overachievers on the basis of the three criterion references. The interpretation of the stepwise regression analyses indicated that no single attitude or set of attitudes accounted for much of the variation in the residual achievement scores which had been computed from the regression coefficients for each group. With respect to over- and underachievers, many more significant relationships with attitudes were found for Year III than for Year I. Trends in the data were generally in the direction one would expect, i.e., students who preferred arithmetic over other subjects were frequently found as overachievers. Trends in the relationship between pupil background measures and over- and underachievement were as expected, i.e., children of "white collar" workers were more apt to be overachievers than children of "blue collar" workers.

B. Teachers. Teachers classified as Modern tended to have higher scores on several attitude scales. When teacher effectiveness was measured by computing mean residual scores for pupils using the four predictors, great variability between teachers was found as well as great variability within a teacher according to which achievement measure was used.

C. Schools. Significant relationships were found between many school variables and the three achievement measures. No one achievement scale appeared to exhibit a pattern of relationships strikingly different than the others. However, the standardized tests tended to have slightly fewer relationships to the school variables than did the computation or structure scale. Not all the directions of the relationship were the same for all the scales even though the relationships were significant.

5. Interpretations

There were no conclusions, inferences, implications, or suggestions for further research made by the investigator.

Critical Commentary

The comment found above under 5 (Interpretations) is an accurate summary of this abstractor's comments about this 329-page volume. The importance of the topic under consideration is well recognized and is being continually reinforced as we are bombarded by press releases that speak of the decline in mathematical achievement scores. The theoretical rationale of the study, while sketchy, is adequate. The design of the study including sample, variables, criterion measures, and analyses cannot be faulted except in minor ways. However, this study as it now stands has two major flaws: (1) The reporting of the data is so inadequate that interpretation by the reader is almost impossible. Often tables cannot be interpreted, e.g., in Table 2.2.1 (entitled "Change in Attitude Measure from Grade Four to Grade 6: Modern Test") Means, Standard Deviations and Differences are reported with no indication of what "Difference" means. Another example is in Table 4.2.1 (entitled "Summary of Contingency Tables of School-Community vs. Under- and Over-achievement Groups: General Administration"). Significant Chi squares are reported with an "X" but no indication is given of the direction of the relationship. Since the author omitted concluding remarks himself, this lack of adequate data reporting is extremely serious. (2) There are no interpretive reports by the author. This fact, coupled with the inadequate data reporting, makes this study almost useless. The magnitude of the data makes interpretation difficult, but certainly an attempt should have been made to help the reader understand the implications of this study.

One other area is flawed seriously enough to warrant comment. Sex is included as a variable and treated inadequately. The inclusion of all other variables is justified. At no time is any rationale given for including sex as a variable and date concerning it are included in a capricious manner. Certainly if a variable is important enough to include, some reason for its inclusion should be given. Using sex as a variable without justification tends to perpetuate the belief that the sexes differ in cognitive performance.

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ED 084 122
CORRELATES OF ATTITUDES TOWARD MATHEMATICS. Crosswhite, F. J. <u>NLSMA Report No. 20</u>.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Lewis R. Aiken, Sacred Heart College.

1. <u>Purpose</u>

To examine the results of measures of attitude, self-concept, and anxiety toward mathematics obtained during the first, third and fifth years of the National Longitudinal Study of Mathematical Abilities (NLSMA). The focus was on longitudinal comparisons of scores on the above variables in the subject population.

2. <u>Rationale</u>

Although there have been many studies of the role of affect in mathematics performance, few investigations have involved the repeated measurement of attitudes over long time periods. The research design of NLSMA provided such an opportunity.

This volume reports the results of an analysis, conducted during the summer of 1971, of the NLSMA affective domain data. Preliminary forms of the affective instruments were designed in 1958 and administered to a national sample of SMSG and non-SMSG students in the fall and spring of 1959-60. This initial work led to the establishment of a committee to study Psychological Factors in Mathematics Education (PFME committee) and subsequent development of the NLSMA Attitude Inventory in the early 1960's The ten scales comprising this inventory include four measures of attitude toward mathematics, two measures of self-concept, two measures of anxiety, and two measures of orderliness. The attitude, self-concept, and anxiety scales are printed in Appendixes A, B and C of the report being abstracted These ten scales, plus eight additional items, were administered in the fall of Year 1 and in the fall of Year 3 to the entire NLSMA population, and in the fall of Year 5 to the X- and Y-Populations. The PFME committee conducted a large number of studies involving the attitude inventory, the findings of which are summarized in NLSMA Reports Nos. 1, 4, 5 and 6. The Crosswhite investigation represents a completion of the data analysis which was begun by the PFME committee.

3. <u>Research Design and Procedure</u>

Relationships among the four attitude scales (Math vs. Non-Math, Math Fun vs. Dull, Pro-Math Composite, Math Easy vs. Hard), two anxiety scales (Facilitating Anxiety, Debilitating Anxiety), and two self-concept scales (Actual Math Self-Concept and Ideal Math Self-Concept), three classes of achievement variables (number systems, algebra, geometry) in addition to mathematics grades, and four intelligence variables (verbal classification, vocabulary--verbal analogy, numerical relationships, pictorial analogy) were examined.

The sample employed in these analyses was a five-percent stratified random sample of Year 4 of the NLSMA population. Data from 4953 students (1655 from the X-Population, 2009 from the Y-Population, and 1289 from the Z-Population) were used in the analyses.

4. Findings

Tables 2.1-2.3 of the report present the intercorrelations among the attitude, self-concept, and anxiety scales in the X-, Y-, and Z-Populations. The intercorrelations are fairly substantial and stable across grade levels, increasing slightly at higher grade levels. All of the correlations are positive except those for the Ideal Self-Concept and Debilitating Anxiety Scales.

Tables 2.4-2.6 report the correlations between the eight affective variables and the four intelligence variables in the three populations. All of these correlations are relatively small. The correlations of the eight affective variables with mathematics achievement scores are given in Tables 2.7-2.10. The pattern of correlations suggest a small but significant positive relationship between attitude and achievement in mathematics.

Chapter 2 of this report considers the means on the eight attitude variables at the various grade levels. The significance of changes in these means was determined by correlated groups 5 tests. Also, test-retest correlations on the attitude variables are given. In general, the results of the means analysis indicated that attitudes improved during elementary school, reached a peak during late elementary or early junior-high school, and steadily declined during the secondary-school years.

An analysis of the means on the self-concept and anxiety variables revealed moderate decreases in real and ideal self-concepts, a pronounced decrease in facilitating anxiety, but an increase in debilitating anxiety across grade levels. The finding of substantially larger test-retest correlations on the attitude variables at the higher grade levels points to the increasing stability of attitudes during the high school years. No sex differences were found in these stability coefficients.

Chapter 4 considers the means, standard deviations, and correlated t-statistics separately by sex and grade level within each of the three populations. Although the attitude scores of both boys and girls exhibited the rise and fall pattern noted with the entire population, the mean score profiles across grade levels were far from identical for the two sexes. In general, there was a greater decline in the mean attitudes of girls toward the beginning of junior-high school than for boys. The attitudes of both sexes deteriorated during the secondary school grades, but the decline was greater for girls.

With respect to changes in self-concept and anxiety, the Ideal Self-Concept pattern across grade levels did not change appreciably for girls but became more negative for boys. Although girls and boys did not differ significantly in anxiety in the earlier grades, both groups decreased significantly in facilitating anxiety; this decrease was more severe for girls than for boys. Debilitating anxiety scores, however, were stable across grade levels in the case of boys, but increased for girls.

Chapter 5 compares the attitude profile of students who had used modern mathematics textbooks with the profile of those who had used conventional textbooks. This comparison necessitated a rather severe reduction in sample size, involving separate analyses over only two-year intervals. In the X-Population, the conventional group showed greater attitude increases. In the Y-Population, the modern group showed a greater decline in attitudes during the first two years of the study. No differential effect due to type of textbook used was found during the second two years of study.

Critical Commentary

This study represents a very thorough, statistically sophisticated analysis of fallible data. The fallibility of the data is certainly no fault of the data analyst, and since the conclusions are consistent with those of other studies they should not be dismissed too hastily. The writer of this NLSMA report readily acknowledges the problem of generalizability posed by lack of representative sampling in the initial NLSMA population as well as the sample of that population selected for analysis. He does not mention the facts that the measuring instruments themselves may be faulted due to their brevity and awkward wording in spots, nor that the attitude scales concentrate on the liking for and perceived difficulty of mathematics to the neglect of measuring the extent to which the value of mathematics to society is appreciated. Nor does he concern himself with the questions of whether conditions of inventory administration, geographical area, social class, teacher charactistics, and other important variables are related to scores on the inventory scales. He does confess that the data were rather dated by 1972 (and certainly by 1976!), having been collected at a time of rapid change in education during the 1960's.

Whatever else one may claim of NLSMA, its directors were most assuredly honest. Thus, they have readily permitted publication of the results of comparisons which show that the attitudes of modern textbook groups declined more than those of conventional textbook groups - a conclusion which is hardly flattering to SMSG materials. The remaining findings--substantial correlations among attitude measures, low but significant correlations between attitudes and achievement, the rise and fall of attitudes across grade levels, and a greater decline in the attitudes of girls than boys in junior high school--are now well known but were not generally realized before being demonstrated by NLSMA.

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ED 084 130
TEACHER EFFECTIVENESS IN MATHEMATICAL INSTRUCTION. Begle, E. G.; Geeslin, William E. NLSMA Report No. 28.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by John Gregory, University of Florida.

1. Purpose

This report presents analyses of NLSMA data designed to "display the range of variation in effectiveness among Year 1 NLSMA teachers and then to search for characteristics of these teachers that account for part of this variation in effectiveness."

2. Rationale

A four-page review of research (ending in 1970) was reviewed under the titles of: a. "Identifying the Effective Teacher," b. "Measuring Change in Student Achievement, " and c. "Identifying Characteristics of Effective Teachers.

3. Research Design and Procedure

The sample consisted of the approximately 60% of the teachers involved in NLSMA during Year 1 and Year 2 who returned the Teacher Opinion Questionnaire (see NLSMA Report No. 9), and their students (from Year 1, X-, Y-, and Z-Populations; from Year 2, X- and Y-Populations). This constituted 1405 teachers from Year 1 and 1478 teachers from Year 2.

All students were tested at the end of the year to provide the two criterion measures of computation and comprehension ability. A series of tests (see NLSMA Reports Nos. 4, 5, and 6), administered at the beginning of the year or earlier, served as pretests of student ability. The tests differed for each population and from Year 1 to Year 2 due to differing content curricula. The pretests served as predictor variables for the criterion variables. Regression analyses yielded an "expected score" for each child for each of the two criterion variables. These expected scores led to the identification of a HI and LO group for each teacher (HI: greater than the mean expected score for the given population; LO: less than or equal to the mean expected score).

The average differences between HI students' actual and predicted computation (comprehension) scores yielded teacher effectiveness scores (EFF HI computation; EFF HI comprehension). Similarly, EFF LO computation and EFF LO comprehension scores were computed for each teacher.

Four additional teacher measures were computed. The were:

EFF HI computation minus EFF LO computation
EFF HI comprehension minus EFF LO comprehension
EFF LO comprehension minus EFF LO computation
EFF HI comprehension minus EFF HI computation

Teacher characteristic measures obtained from the Teacher Opinion Questionnaire were used in stepwise regression analyses to discover other relationships to any of the eight effectiveness scores. These eleven variables included, among others, years of teaching experience, major in college, concetn for students, attitude toward mathematics, and whether or not the teacher had children of his or her own.

The stepwise regression analyses were completed separately for each of twelve teacher groups: X-, Y-, or Z-Populations crossed with modern or conventional textbook crossed with teacher sex. Correlations between first- and second-year effectiveness scores were also computed to determine stability or effectiveness as defined by the process described above.

4. Findings

Although substantial variance for each effectiveness score was found to exist, teacher characteristics did not account for a significant percentage of the variance. In cases for which a statistucally significant percentage of variance was accounted for (as exhibited by multiple R^2), the percentage is too low to be of value in practical school decisions.

Fairly large percentages of variance for some teacher effectiveness difference scores were accounted for by the teacher characteristics, but no distinct pattern could be ascertained.

It was also found that teacher effectiveness scores were not very stable from Year 1 to Year 2.

(The report contains 123 pages of numerical data and statistical results of the analyses.)

5. Interpretations

The major conclusion made by the authors (in the three pages devoted to summary and discussion) is that it was not possible to demonstrate that the teacher characteristics, which many people have felt to be important, have an effect on learning.

Critical Commentary

The authors of the report and the results from other investigations conducted since the data collection stage of this report, lead to several questions.

(1) If data relative to the verbal environment of the classroom had been analysed, might more of the variance in EFF scores been accounted for? Data of this type would include the manner in which the teacher acts toward and reacts to students (affective behavior). Taxonomic level behavior of the students as exhibited by teacher questions and/or student responses would also be data of this type. Analysis of the linguistic quality of the verbal environment provides a third source of data of this type. The emphasis of this

analysis is how the teacher, in particular, says what he says rather than what is said (for example, use of logical connectives, use of lecture preceding questions, and the use of silence).

(2) Although two teachers use the same textbook and have similar personal characteristics, they can differ with regard to the sequencing of instruction, both within a given lesson and within a given content unit. This leads to a second question: If data relative to the planning and delivery of the mathematical content had been obtained in terms of the sequence of instructional moves, might more variance in EFF scores have been accounted for?

The variables referred to would include the number of examples presented prior to, or following, a definition of a concept or a description of a mathematical process. The use of counter-examples and eliciting interpretations through comparison and contrast would also be examples of these planning and delivery variables.

(3) Are there variables other than the achievement measured by the instruments used in NLSMA which would provide more stable effectiveness measures? Of particular concern to the authors of the report on this point is the possible effect of subject matter, student characteristics, and instructional objective variation on the stability of the EFF scores.

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ED 084 131
FOLLOW-UP STUDY OF NLSMA Z-POPULATION. Branca, Nicholas. NLSMA Report No. 30.

Expanded Abstract and Analysis Prepared Especially for I.M.E. Arthur Coxford, The University of Michigan.

1. Purpose

The purpose was to assess Z-Population (grades 10-12) opinions on a number of questions pertaining to mathematics achievement, attitudes, careers, school instruction, textbooks, teachers, et cetera in the fourth year of the NLSMA 5-year study. In particular the study sought to determine if there were differences in opinions on selected topics related to the type of text materials used in grades 10-12: conventional or modern. Finally the study sought to determine which, if any, variables discriminated groups of students categorized on their responses to several individual questionnaire items.

2. Rationale

Whereas the X and Y populations remained in school for the 5 years of NLSMA testing, the Z-Population was in school for only three years of the study. The SMSG Panel on Tests sought to continue collecting information on the Z-Population by means of a questionnaire to be administered one year after completion of grade 12. This would provide information different from any collected for the X- and Y-Populations.

3. Research Design and Procedure

Several topics for the questionnaire were suggested by the SMSG Panel on Tests. Additionally, an UISCM follow-up instrument was consulted in preparing the preliminary questionnaire. The preliminary questionnaire was piloted with 200 high school graduates and 100 junior college students. Resultant data were analyzed and used to revise the questionnaire. The final questionnaire was mailed to 13,080 students in the Z-Population. Of these, 6625 returned completed questionnaires, 6372 did not respond, and 83 returned incomplete questionnaires. Further attempts were made to obtain responses from a 198-person random sample of initial non-respondents. One hundred fifty-nine students responded to this special mail and telephone survey. Thirty nine did not respond or could not be reached.

The 198-subject random sample of non-respondents was carried out so that the investigators could determine whether the 6625 respondents were representative of the 13,080 surveyed Z-Population members. A chi square analysis and seven of 22 multiple t tests of NLSMA Tests data for respondents and non-respondents were statistically significant. The results were deemed sufficient to conclude that the results from the initial questionnaire were not generalizable to the entire Z-Population follow-up group, but only to the group that responded initially. These results led the investigators to analyze the initial respondent and random sample group data individually and to make only informal comparisons between the two.

For analysis, the respondents were partitioned on the type of mathematics textbooks used in high school mathematics.

<u>S(Some years)</u>: Respondents used modern or conventional texts (but not both) for their mathematics instruction of 1, 2 or 3 years (a mathematics course was elected at least one of the tenth-, eleventh- or twelfth-grade years);

<u>E(Every year)</u>: Respondents used modern texts for 3 years or conventional texts for 3 years. That is, a mathematics course was elected every year in high school, grades 10-12.

The second dimension for a two-way classification was one of the following five:

a) Intended choice of profession: math or math related vs. all others

b) Intended college major: math vs. physical sciences or engineering vs. all others

c) Indication of high school math text clarity

d) Indication of high school math text level of difficulty

e) Indication of high school math text relevancy of material.

These two-way classifications were analyzed by chi-square.

A second set of analyses were carried out to determine which of 42 variables (22 previously measured and 20 questionnaire) discriminated certain groups of respondents. The groupings were:

I. Respondents intending to specialize in math vs. respondents intending to specialize in physical science or engineering

II. Respondents intending to specialize in math vs. respondents intending to specialize in areas non-related to math

III. Respondents planning to enter a strongly math related career vs. respondents planning to enter a non-math related career.

4. <u>Findings</u>

Of the twenty chi-square analyses carried out, the following showed statistical significance:

Initial Respondents.

1. S(some years) by Choice of College Major (b)

2. S(some years) by Textbook Clarity (c)

3. S(some years) by Textbook Difficulty (d)

4. E(every year) by Type of Career Planned (a).

Random-Sample Respondents.

No significant chi-square analyses.

DISCRIMINANT ANALYSES

For discriminant analysis I, 11 of the 42 variables differentiated. The first five were:

1. preparation for post-high school science

2. preparation for post-high school math

3. disposition to take math courses

4. anagrams

5. attitude toward Algebra I

For discriminant analysis II, 12 of the 42 variables discriminated. The first five were:

1. disposition to take math

2. math vs. non-math

3. numeration 2

4. independent math study since high school

5. informal geometry 2

For discriminant analysis III, 18 of the 42 variables discriminated. The first five could not be included because the appropriate table was missing from the original document.

Descriptive data for initial respondents and random sample respondents were also reported. They cannot be included here.

5. Interpretations

The descriptive data on the questionnaire responses suggest the following generalizations:

1. All respondents (initial and random sample) rated themselves less favorably in school work as the level of schooling increased.

2. All respondents indicated that the degree of difficulty of their mathematics increased as the level of schooling increased.

3. All respondents indicated an increasing dislike for mathematics as the level of schooling increased.

4. The popularity of mathematics in relation to other school subjects decreased as school level advanced.

5. The majority of respondents indicated that their high school mathematics courses stimulated them, their high school teachers made mathematics interesting, their high school teachers followed the text closely, their courses prepared them for post-high school work, and mathematics ranked as one of the top three most important school subjects.

The chi-square analyses led to the following observations:

1. The modern math text users S(some years) planned to choose math, physical science or engineering as college major.

2. The three-year modern math users E(every year) planned more math-related careers than conventional text users.

3. The conventional text users E(every year) rated their textbooks clearer.

4. The modern text users E(every year) rated their textbooks more difficult.

The discriminant analyses led to the following observations:

1. For each pair of groups, the disposition to take math courses distinguished the groups with the math-related group showing the greater disposition.

2. Respondents planning to enter engineering or physical science major were significantly less disposed to take math courses than were those planning a math major.

Critical Commentary

This is an interesting study worth of careful study. The descriptive data deserve careful examination to gain clues as to how students view their teachers, texts, etc. It would be valuable to have a similar study today. This reviewer would conjecture that the tesults would be substantially different.

Two shortcomings of the report are:

1. Table 4.27 was missing from the document examined.

2. The use of a p value of .0532 as significant (see page 94 and pages 109-110).

Arthur Coxford
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ED 084 132
CHARACTERISTICS OF SUCCESSFUL INSIGHTFUL PROBLEM SOLVERS. Dodson, Joseph W. NLSMA Report No. 31.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Frank K. Lester, Jr., Indiana University.

1. Purpose

This study was designed to characterize successful "insightful" problem solvers in terms of four categories of variables: (1) mathematics achievement variables; (2) student cognitive and affective variables; (3) teacher background and attitude variables; and (4) school, community, and curriculum variables.

2. Rationale

Although considerable research has been devoted to the study of problem solving, very little is understood about the problem-solving process because students typically exhibit very little observable behavior while working on problems. In addition, many of the measures of problem-solving ability are restricted to measures of ability to solve routine problems which appear in mathematics textbooks. Measures of this type often do not assess a student's ability to solve problems that require original thought. A key feature of this study is that the problems involved are considered to be nonroutine and are intended to be a challenge to the problem solver. There is growing interest within the mathematics education community in the development of curricula and associated instructional techniques which enhance the student's ability to solve nonroutine problems. Before such curricula and instructional techniques can exist, a better understanding must be gained of the processes of problem solving and how these processes develop. Specifically, research is needed which relates problem solving ability to student characteristics, thereby providing a basis for hypothesizing conditions for success in problem solving and enabling curriculum writers to select appropriate activities for instruction in problem solving.

3. Research Design and Procedure

A multivariate research design was chosen to determine "... the relevance of 77 concomitant variables for the ability to solve insightful mathematics problems and to determine which of these variables discriminate best among ability groups (p. 3)." The study used data from the NLSMA Z-Population since the insightful mathematics problems which comprised the criterion test were administered only to this population. Concomitant variables were chosen from among mathematical and nonmathematical variables hypothesized by NLSMA as being related to mathematical ability. The specific variables used in this study were those whose scales had been administered to the entire Z-Population and were appropriate for use in the statistical analyses. These variables were classified as Type A (mathematical achievement variables), Type P (psychological variables - cognitive processes and attitudes), and Type D (non-test data - teacher background and attitude, school-community characteristics, mathematics curriculum variables, and socio-economic index). Most of the insightful mathematics problems were selected from four NLSMA scales: Insightful Geometry, Algebraic Equations - Insight 1, Number Properties 1, and Analysis 2. The restriction of the population to include only those students in the Z-Population who took mathematics in grade 11 as well as other requirements reduced the number of students in the sample for the study to 1123. Most of the analyses for the study were performed with this sample size.

On the basis of the students' performance on the criterion test, students were placed into six ability groups. Three subtests of the criterion test were formed in order to obtain information on students' performance in geometry, algebra, and number properties and relations. Ability groups were formed for each of the three subtests using the same procedure used for determining ability groups for the overall criterion test.

Two main statistical models were imployed to analyze the data: univariate analysis of variance and discriminant analysis. The analysis of variance was used to determine which of the concomitant variables, considered separately, discriminate among ability groups at a significant level. Discriminant analyses were performed to determine which variables discriminated "best" among ability groups on the criterion test and the three subtests with the effect of several variables considered simultaneously.

Three sets of ANOVAs were performed with the entire sample. The first set included one-way ANOVAs for each concomitant variable with the criterion test scores as the factor with six levels. The second set included ANOVAs for a 4x4 factorial design with algebra and geometry subtest scores as factors. These ANOVAs determined which variables discriminated among algebra ability groups, which discriminated among geometry ability groups, and the degree to which there was interaction between performances on these two subtests for each variable. The third set included ANOVAs for a 3x2 factorial design for each variable with scores on the number subtest as one factor and sex as the other. These ANOVAs indicated which of the variables discriminate among ability groups for the number subtest. Sex was used merely as a control variable. The variables used in the discriminant analyses were chosen from among the variables which indicated highly significant differences among ability groups as a result of the series of ANOVAs.

4. Findings

The most significant results can be listed in terms of the strongest characteristics of successful insightful mathematics problem solvers:

(1) They performed higher on all of the mathematics achievement tests than did poorer problem solvers.

(2) They did well in solving problems requiring considerable synthesis.

(3) They were very proficient in solving algebraic equations.

(4) They performed high on verbal and general reasoning tests.

(5) They were good at determining spatial relationships.

(6) They resisted distraction, saw critical elements, and were field independent.

(7) They were divergent thinkers.

(8) They had positive attitudes toward mathematics.

(9) They viewed themselves as good mathematics students.

(10) Their teachers had the most credits beyond the BA degree and had the highest degrees.

(11) Their families had relatively high incomes.

(12) Salaries were higher for beginning teachers in their communities than salaries of teachers in the communities of poorer problem solvers.

(13) The population of their communities had recently changed.

(14) Their socio-economic index was about the same as that of poorer problem solvers.

Interpretations

The following interpretations of the results were made:

(1) Efforts to develop insightful problem solving ability should include exposing students to advanced topics in both algebra and geometry that involve a great deal of synthesis.

(2) Solving routine algebraic equations helps to provide the necessary "tools" for solving problems.

(3) Mathematics study which is limited to acquiring only basic ideas and skills is not likely to produce proficient problem solvers.

(4) Mathematics educators should not ignore opportunities to enhance the development of reasoning ability. Teachers should be encouraged to provide experiences which challenge their students' reasoning ability.

(5) Teachers may profit from the use of an approach to problem solving similar to that prescribed by Polya. Such an approach might enhance divergent thinking and students' ability to visualize spatial relationships.

(6) The development of positive student attitudes toward mathematics should be an important goal of teachers concerned with developing problem solving ability.

(7) Expending effort to keep students' environment organized and orderly may impede problem solving.

Critical Commentary

The research reported in this study was the first to be done by someone other than the NLSMA research staff and consultants using the NLSMA data bank. The research served as the basis for the investigator's doctoral thesis; this Report was adapted from his thesis. In several respects, this research is exemplary. The investigator is to be commended for having chosen such a significant problem for his doctoral thesis. The rationale for the study, the literature review, and the description of the procedures used are all extremely well done. Also, the research design and the statistical analysis techniques employed are most appropriate, and the investigator is careful to point out various limitations of the study. This abstractor recommends this report as a reference to persons interested in identifying variables which are related to mathematical problem solving. However, the study does have some limitations and shortcomings.

Problem solving research has been notorious for the lack of consistency of results upon which to build a general theory of problem solving. This is due in part to the fact that so many different kinds of problems have been used from one research study to the next. The reader should bear in mind the nature of the problems used in this research when attempting to generalize the results to different kinds of problems and beyond the population used in this study. There is also reason to believe that several of the problems are not "insightful" problems. The reader should look at the investigator's definition of an insightful problem and sample problems included on the criterion test before deciding if the conclusions drawn are appropriate.

Perhaps the most difficult task for a problem-solving researcher lies with interpreting results and drawing conclusions. The overwhelming amount of data generated by this study and the complexity of the statistical models employed made it even more difficult to make sense out of the results. It is evident in a few instances that the investigator had some difficulty interpreting the results. For example, the suggestion that "... the solution of routine algebraic equations should be stressed to provide the necessary tools for solving problems (p. 106)" does not appear to be based on the findings of this research. In general, however, the interpretations and conclusions are provided cautiously and only after thoughtful reflection.

Finally, it is encouraging to find discriminant analysis being used in mathematics education research, and used appropriately. Far too little use is made of this and other multivariate statistical techniques to investigate research problems involving several variables.

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ED 084 133
THE EFFECTS OF DIFFERENT MATHEMATICS CURRICULUM ON SCIENCE ACHIEVEMENT IN SECONDARY SCHOOL. Bridgham, Robert G. NLSMA Report No. 32.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by William M. Fitzgerald, Michigan State University

1. Purpose

To determine the effects of using "new" and "traditional" mathematics curriculum materials on achievement in science as measured by the College Board Test in Biology, Chemistry and Physics.

2. Rationale

"... a fuller evaluation of curricula in mathematics would consider not only achievement in mathematics, but in the sciences as well.

One 'side effect' of the new curricula in mathematics - their effect on achievement in the sciences - is the focus of the study reported here. Achievement in the sciences is clearly outside the primary target area of the new mathematics curricula and is more obviously related to other factors, such as the substance and effectiveness of science teaching. An effect of different curricula in mathematics on achievement in the sciences is likely to be small and elusive. If one were found, however, it would provide a substantial argument for or against the use of new curricular materials in mathematics, since it would suggest a difference in the transfer ability of the students' mathematical competence to other areas of thought and action."

3. Research Design and Procedure

The study was conducted on those students from the Y-population who took the College Board Examinations in Biology, Chemistry or Physics and for whom complete data were available. The sizes of the groups taking the exams were 426 in Biology, 505 in Chemistry and 228 in Physics.

The data which were available included scores from the achievement and aptitude tests from the seventh and eighth grade, sex, median income, years of mathematics, and the proportion of the mathematics curriculum that was traditional.

"Although a correlational analysis was used in the study, prediction of the College Board achievement held only secondary interest. Rather, partial correlations were used to determine whether the type of mathematics curriculum experienced by the students was related to science achievement after the effects of student input were accounted for. Thus, in each analysis, student aptitude and achievement were partialled out first, then sex and the exonomic index, and finally the number of years of mathematics completed." (p.5)

4. <u>Findings</u>

When none of the other variables are partialled out of the analysis, the correlations between the proportion of traditional mathematics studied and the scores on the biology, chemistry and physics exams were -.20, -.24 and -.22 ($p \leq .05, .01, .01$). These correlations remained significant after partialling out junior high school achievement scores and sex. However, in all these cases, the correlations dropped beneath significance when the affluence of the students community was controlled. When the economic index was not considered in the analysis, and the other variables were controlled, the correlations were -.13, -.15 and -.22 ($p \leq .05, .01, .01$).

There is a brief discussion about the predictability of junior high school data on the College Board Examinations.

5. <u>Interpretations</u>

The author comments: "The partial correlations indicate that students whose secondary mathematics curriculum was more modern tend to have higher achievement in the sciences. The correlations are not large, and the effects they suggest are not great, but considering their consistency and the likelihood of finding no effect at all, they indicate an important edge for the "new" curricular materials in mathematics. Collectively, the results suggest that the mathematical competence gained by students in their studies in the secondary school are somewhat more transferable to other contexts, such as those associated with learning and problem solving in the sciences, if the students' curriculum is more modern.

"These results are straightforward and consistent. But the picture changes markedly if the affluence of a student's community is taken into account. When community affluence is partialled out along with the other input variables, the correlations between type of mathematics curriculum and science achievement drop markedly. All of the residual partial correlations ($r = -.09$ for physics, $r = -.04$ for chemistry, and $4 = -.09$ for biology) lack statistical or practical significance.

"What can be said, then, of the effect of type of mathematics curriculum that seems so clear when community affluence is ignored? Now the inference to be made is not at all clear. The problem is, at root, that type of mathematics curriculum and community affluence tend to be associated. Is the apparent effectiveness of the more modern mathematics curricula only an illusion, a mistaking of effects really due to community wealth on College Board achievement scores in the sciences? No choice between these options is warranted by the data in hand.

"The available data provide some comfort to those who have espcused the new mathematics; if there is an effect, it favors students who have had more of the 'new math'. Whether the data speaks of a curriculum effect or only of the importance of a student's community is unclear, however. It seems likely that, given the size of the prospective effect, and the difficulty of disentangling community and curriculum factors in one of 'nature's experiments,' only a true (and rather large) experiment will be capable of determining whether the type of mathematics curriculum students experience really does have an effect on their achievement in science." (p.12)

Critical Commentary

The study was obviously carefully done and represents a clever use of existing data to answer some interesting questions.

It is probably asking too much to expect the content and emphasis of a textbook to have a very significant effect on student achievement when other factors such as the teacher's perception of his role in the classroom are ignored.

It would be interesting to ask the complementary question of how does the study of science affect the learning of mathematics or how do the interactions of mathematics and its applications affect the learning of both.

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MATHEMATICS EDUCATION RESEARCH STUDIES REPORTED IN RESEARCH IN EDUCATION
April - June 1975

ED 099 204 Howlett, Kenneth Donn. A Study of the Relationship Between Piagetian Class Inclusion Tasks and the Ability of First Grade Children to Do Missing Addend Computation and Verbal Problems. 108p. Not available from EDRS. Available from University Microfilms (74-8376).

ED 099 205 Akkerhuis, Gerard. A Comparison of Pupil Achievement and Pupil Attitudes with and without the Assistance of Batch Computer-Supported Instruction. 77p. Not available from EDRS. Available from University Microfilms (74-9052).

ED 099 238 Poulsen, Sten C. Study Skills and Mathematics Achievement. Report No. 2. 28p. MF and HC available from EDRS.

ED 099 415 Scardamalia, Marlene. Mental Processing Aspects of Two Formal Operational Tasks: A Developmental Investigation of a Quantitative Neo-Piagetian Model. 11p. MF and HC available from EDRS.

ED 099 716 Hartlage, Patricia L.; Hartlage, Lawrence C. Classroom Correlates of Neurological "Soft Signs". 9p. MF and HC available from EDRS.

ED 100 516 Meacham, Merle L. All Those Independent Variables. 23p. MF and HC available from EDRS.

ED 100 705 Miller, Patty L.; Phillips, E. Ray. Development of a Learning Hierarchy for the Computational Skills of Rational Number Subtraction. 13p. MF and HC available from EDRS.

ED 100 718 Zalewski, Donald L. An Exploratory Study to Compare Two Performance Measures: An Interview-Coding Scheme of Mathematical Problem Solving and a Written Test. Part 1. Technical Report No. 306. 99p. MF and HC available from EDRS.

ED 100 719 Zalewski, Donald L. An Exploratory Study to Compare Two Performance Measures: An Interview-Coding Scheme of Mathematical Problem Solving and a Written Test. Part 2. Technical Report No. 306. 125p. MF and HC available from EDRS.

ED 100 963. Tripp, Laurence I.; And Others. An Exploration of Specific Transfer Properties of Different Instructional Sequences Designed for Use in Teaching Selected Principals of Conditional Logic. 22p. MF and HC available from EDRS.

ED 101 017 Ozenne, Dan G.; And Others. Achievement Test Restandardization: Emergency School Aid Act (ESAA) National Evaluation. 136p. MF and HC available from EDRS.

ED 101 473 O'Reilly, Robert. Classroom Climate and Achievement in Secondary School Mathematics Classes. 18p. MF and HC available from EDRS.

ED 101 957 Mitchelmore, Michael C. Development and Validation of the Solid Representation Test in a Cross-Sectional Sample of Jamaican Students. 20p. MF and HC available from EDRS.

ED 101 993 Marlin, Herbert. Evaluation Report 1-A-1: Overview, Design and Instrumentation. 42p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 101 994 Herbert, Martin. Evaluation Report 1-A-2: External Review of CSMP Materials. 36p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 101 995. Holz, Alan; And Others. Evaluation Report 1-B-1: Mid-Year Test Data: CSMP First Grade Content. 60p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 101 996 Karmos, Joseph S. Evaluation Report 1-B-2: End-of-Year Test Data: CSMP First Grade Content. 72p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 101 997 Martin, Herbert; And Others. Evaluation Report 1-B-3: End-of-Year Test Data: Standard First Grade Content. 81p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 101 998 Martin, Herbert; And Others. Evaluation Report 1-B-4: End-of-Year Test Data: CSMP Kindergarten Content. 36p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 101 999 Martin, Herbert; And Others. Evaluation Report 1-B-5: Test Data on Some General Cognitive Skills Related to CSMP Content. 49p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 102 000 Martin, Herbert; And Others. Evaluation Report 1-B-6: Summary Test Data: Detroit Schools. 29p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 102 001 Karmos, Joseph S.; And Others. Evaluation Report 1-C-1: Teacher Training Report. 72p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 102 002 Holz, Alan; And Others. Evaluation Report 1-C-2: Observation of CSMP First Grade Classes. 62p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 102 003 Herbert, Martin; And Others. Evaluation Report 1-C-3: Mid-Year Data from Teacher Questionnaires. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 102 004 Holz, Alan; And Others. Evaluation Report 1-C-4: End-of-Year Data from Teacher Questionnaires. 89p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 102 005 Holz, Alan; And Others. Evaluation Report 1-C-5: Interviews with CSMP Kindergarten Teachers. 117p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 102 006 Baraszcz, Edward; Martin, Herbert. Evaluation Report 1-C-6: Analysis of Teacher Logs. 64p. Not available from EDRS. Available from CEMREL, Inc.; ERIC/SMEAC (on loan).

ED 102 024 Godfrey, Leon D. A Study of the Rote-Conceptual and Reception-Discovery Dimensions of Learning Mathematical Concepts. Part 1. Technical Report No. 307. 85p. MF and HC available from EDRS.

ED 102 025 Godfrey, Leon D. A Study of the Rote-Conceptual and Reception-Discovery Dimensions of Learning Mathematical Concepts. Part 2. Technical Report No. 307. 129p. MF and HC available from EDRS.

ED 102 029 Math Fundamentals: Selected Results from the First National Assessment of Mathematics. 56p. MF and HC available from EDRS.

MATHEMATICS EDUCATION RESEARCH STUDIES REPORTED IN JOURNALS AS INDEXED BY CURRENT INDEX TO JOURNALS IN EDUCATION
April - June 1975

EJ 107 794 Fennema, Elizabeth. "Sex Differences in Mathematics Learning: Why???" Elementary School Journal, v75 n3,pp183-190, Dec 74.

EJ 107 809 Brainerd, Charles J. "Inducing Ordinal and Cardinal Representations of the First Five Natural Numbers." Journal of Experimental Child Psychology, v18 n3, pp520-534, Dec 74.

EJ 108 002 Webb, Leland F.; Sherrill, Majes M. "The Effects of Differing Presentations of Mathematical Word Problems Upon the Achievement of Preservice Elementary Teachers." School Science and Mathematics, v74 n7, pp559-565, Nov 74.

EJ 108 007 Wollman, Warren; Karplus, Robert. "Intellectual Development Beyond Elementary School V: Using Ratio in Differing Tasks." School Science and Mathematics, v74 n7, pp593-613, Nov 74.

EJ 108 229 Harris, Mary B.; Liguori, Ralph A. "Some Effects of a Personalized System of Instruction in Teaching College Mathematics." Journal of Educational Research, v68 n2, pp62-66, Oct 74.

EJ 108 374 Ehrenpreis, Walter; Scandura, Joseph M. "The Algorithmic Approach to Curriculum Construction: A Field Test in Mathematics." Journal of Educational Psychology, v66 n4, pp491-498, Aug 74.

EJ 109 775 Collis, Kevin F. "The Development of a Preference for Logical Consistency in School Mathematics." Child Development, v45 n4, pp972-977, Dec 74.

EJ 109 955 Carpenter, Thomas P. "Measurement Concepts of First- And Second-Grade Students." Journal for Research in Mathematics Education, v6 n1, pp3-13, Jan 75.

EJ 109 956 Lester, Frank K. "Developmental Aspects of Children's Ability to Understand Mathematical Proof." Journal for Research in Mathematics Education, v6 n1, pp14-25, Jan 75.

EJ 109 957 Gregory, John W.; Osborne, Alan R. "Logical Reasoning Ability and Teacher Verbal Behavior Within the Mathematics Classroom." Journal for Research in Mathematics Education, v6 n1, pp26-36, Jan 75.

EJ 109 958 Hancock, Robert R. "Cognitive Factors and Their Interaction with Instructional Mode." Journal for Research in Mathematics Education, v6 n1, pp37-50, Jan 75.

EJ 109 959 Fuson, Karen. "The Effects on Preservice Elementary Teachers of Learning Mathematics and Means of Teaching Mathematics Through the Active Manipulation of Materials." Journal for Research in Mathematics Education, v6 n1, pp51-63, Jan 75.

EJ 111 029 Becker, Sheila. "The Performance of Deaf and Hearing Children on a Logical Discovery Task." Volta Review, v76 n9, pp530-536, Dec 74.

EJ 111 439 Okonji, M. O. "The Development of Logical Thinking in Preschool Zambian Children: Classification." Journal of Genetic Psychology, v125 n2, pp247-256, Dec 74.

EJ 111 534 Hademenos, James G. "A Comparative Study of Piaget-Type Conservation Tasks." School Science and Mathematics, v74 n8, pp680-686, Dec 74.

The NLSMA Reports

The 32 reports of the National Longitudinal Study of Mathematical Abilities (Nos. 1-28 and 30-33), were published by the School Mathematics Study Group. While the reports have all been listed in ERIC's Resources in Education, none are at this time available from the ERIC Document Reproduction service. They are, however, available on a loan basis from the ERIC Information Analysis Center for Science, Mathematics and Environmental Education. The Reports may also be purchased from:

A. C. Vroman, Inc.
2085 East Foothill Boulevard
Pasadena, California 91109

All 32 reports are listed on the following pages, with a brief annotation.

Wilson, James W.; Cahen, Leonard S.; and Begle, Edward G. (Eds.) NLSMA Report No. 1, Parts A and B, X-Population Test Batteries. 1968. 505p. Part A, $1.62; Part B, $1.63. (ERIC: ED 044 277, SE 009 436)

Contains most of the tests administered to fourth graders at the start of the study in 1962.

Wilson, James W.; Cahen, Leonard S.; and Begle, Edward G. (Eds.) NLSMA Report No. 2, Parts A and B, Y-Population Test Batteries. 1968. 553p. Part A, $1.62; Part B, $1.63. (ERIC: ED 044 278, SE 009 437)

Contains most of the tests administered to seventh graders at the start of the study in 1962.

Wilson, James W.; Cahen, Leonard S.; and Begle, Edward G. (Eds.) NLSMA Report No. 3, Z-Population Test Batteries. 1968. 336p. $2.00. (ERIC: ED 044 279, SE 009 438)

Contains most of the tests administered to tenth graders at the start of the study in 1962.

Wilson, James W.; Cahen, Leonard S.; and Begle, Edward G. (Eds.) NLSMA Report No. 4, Description and Statistical Properties of X-Population Scales. 1968. 248p. $1.50. (ERIC: ED 044 280, SE 009 439)

Contains descriptions and statistical properties of test scales used with students in grades 4 through 8. Each scale, designed to measure a specified content or psychological area, is briefly identified and described, example items are given, and statistical information is listed for the scale and items from a 5 percent stratified random sample of the total NLSMA X-Population.

Wilson, James W.; Cahen, Leonard S.; and Begle, Edward G. (Eds.) NLSMA Report No. 5, Description and Statistical Properties of Y-Population Scales. 1968. 326p. $1.50. (ERIC: ED 044 310, SE 010 181)

Contains descriptions and statistical properties of test scales used with students in grades 7 and 8. Each scale, designed to measure a specified content or psychological area, is briefly identified and described, example items are given, and statistical information is listed for the scale and items from a 5 percent stratified random sample of the total NLSMA Y-Population.

Wilson, James W.; Cahen, Leonard S.; and Begle, Edward G. (Eds.) NLSMA Report No. 6, Description and Statistical Properties of Z-Population Scales. 1968. 188p. $1.50. (ERIC: ED 044 281, SE 009 440)

Contains descriptions and statistical properties of test scales used with students in grades 10 through 12. Each scale, designed to measure a specified content or psychological area, is briefly identified and described, example items are given, and statistical information is listed for the scale and items from a 5 percent stratified random sample of the total NLSMA Z-Population.

Romberg, Thomas A. and Wilson, James W. NLSMA Report No. 7, The Development of Tests. 1969. 391p. $2.50. (ERIC: ED 084 112, SE 016 669)

Describes the processes used for deciding what should be measured, when, and how. Work of the SMSG Panel on Tests for collecting test items, conceptualizing scales, pilot testing, and analyzing pilot test data is reviewed. The development of a model for mathematics achievement, which classifies test scales by mathematics content and levels of cognitive behavior, is discussed. Procedures for the development of the fall and spring batteries for each of the five years of the study are detailed. The selection and development of cognitive processes tests, attitude instruments and role inventories are also included, and the development of the schedule for psychological testing is described. Reports of the First and Second Conferences on Tests and a listing of the NLSMA Scales on Tape are included as appendices.

Wilson, James W.; Cahen, Leonard S.; and Begle, Edward G. (Eds.) NLSMA Report No. 8, Statistical Procedures and Computer Programs. 1972. 221p. $3.00. (ERIC: ED 084 113, SE 016 670)

Discussion of many of the programs from the SMSG Computer Program Library as it existed in June, 1972. Major programs included involve item analysis, attitude item analysis, scale scoring, correlation and t-test, stepwise regression, homogeneity of regression, and factor analysis. Besides a discussion of each, information on parameter set-up along with sample input and sample output is given. Actual line-by-line program listings are not included. However, a concluding analysis paper explains the use of the program library and gives the call name and function for each available program.

Wilson, James W.; Cahen, Leonard S.; and Begle, Edward G. (Eds.) NLSMA Report No. 9, Non-Test Data. 1968. 139p. (ERIC: ED 044 282, SE 009 441)

Identifies the variables which have been formed from the non-test data collected in NLSMA, presenting a comprehensive description of the NLSMA population in contexts other than mathematics achievement and psychological characteristics. Data were included on school-community characteristics, curriculum patterns, and geographic distribution. The report is intended as a reference for the study and should be used in conjunction with the preceding eight NLSMA reports.

Carry, L. Ray and Weaver, J. Fred. NLSMA Report No. 10, Patterns of Mathematics Achievement in Grades 4, 5, and 6: X-Population. 1969. 210p. $2.00. (ERIC: ED 044 283, SE 009 442)

Identifies differential patterns of mathematics achievement which could be ascribed to different mathematics textbook series used by groups of pupils over a three-year span covering grades 4, 5, and 6. Comparisons are presented for six textbook series on 38 measures of mathematics achievement.

Carry, L. Ray. NLSMA Report No. 11, Patterns of Mathematics Achievement in Grades 7 and 8: X-Population. 1970. 190p. $1.50. (ERIC: ED 045 447, SE 010 447)

Identifies differential patterns of mathematics achievement which could be ascribed to different mathematics textbook series used by groups of students over a two-year span. Comparisons are made for eight textbook groups at the end of grade 7, at the beginning of grade 8, and at the end of grade 8. Forty-one measures of mathematical achievement were used as dependent variables.

McLeod, Gordon K. and Kilpatrick, Jeremy. NLSMA Report No. 12, Patterns of Mathematics Achievement in Grades 7 and 8: Y-Population. 1969. 148p. $1.50. (ERIC: ED 084 114, SE 016 671)

Considers comparisons made for the Y-Population from achievement test data collected at the end of grade 7 and again at the end of grade 8. Twenty-seven measures of mathematical achievement were used as dependent variables.

Kilpatrick, Jeremy and McLeod, Gordon K. NLSMA Report No. 13, Patterns of Mathematics Achievement in Grade 9: Y-Population. 1971. 101p. $1.50. (ERIC: ED 084 115, SE 016 672)

Considers comparisons made for the Y-Population from achievement test data collected at the end of grade 9 and again at the beginning of grade 10. Only the two-thirds of the population using a first-year algebra textbook are included in this study. Thirteen measures of mathematical achievement were used as dependent variables.

McLeod, Gordon K. and Kilpatrick, Jeremy. NLSMA Report No. 14, Patterns of Mathematics Achievement in Grade 10: Y-Population. 1971. 109p. $1.50. (ERIC: ED 084 116, SE 016 673)

Considers comparisons made for the Y-Population from achievement test data collected at the end of grade 10 and again at the beginning of

grade 11. Only the approximately 60 percent of the population that completed a geometry course in grade 10 are included in this study. Ten geometry scales, concentrating on higher-level skills than are usual in achievement testing, were used as dependent variables.

Kilpatrick, Jeremy and McLeod, Gordon K. NLSMA Report No. 15, Patterns of Mathematics Achievement in Grade 11: Y-Population. 1971. 91p. $1.50. (ERIC: ED 084 117, SE 016 674)

Considers comparisons made for the Y-Population from achievement test data collected at the end of grade 11. Only the approximately 45 percent of the original population that had completed beginning algebra, geometry, and advanced algebra are included in this study. Twelve mathematics content scales, appropriate to all three courses, were used as the dependent variables.

Wilson, James W. NLSMA Report No. 16, Patterns of Mathematics Achievement in Grade 10: Z-Population. 1972. 115p. $1.50. (ERIC: ED 084 118, SE 016 675)

Considers comparisons made for the Z-Population from achievement test data collected at the end of grade 10. Only the approximately 80 percent of the original population that completed a one-year course in plane geometry are included in this study. Seven mathematics content scales, rather than a "geometry test," were used as the dependent variables.

Wilson, James W. NLSMA Report No. 17, Patterns of Mathematics Achievement in Grade 11: Z-Population. 1972. 78p. $1.50. (ERIC: ED 084 119, SE 016 676)

Considers comparisons made for the Z-Population from achievement test data collected at the end of grade 11. Only the large portion of the original population that completed a second-year algebra or intermediate mathematics course in this year are included in the study. Ten scales, designed to sample the range of mathematics achievement after three years of college preparatory mathematics, were used as the dependent variables.

Romberg, Thomas A. and Wilson, James W. NLSMA Report No. 18, Patterns of Mathematics Achievement in Grade 12: Z-Population. 1972. 78p. $1.50. (ERIC: ED 084 120, SE 016 677)

Considers comparisons made for the Z-Population from achievement test data collected at the end of grade 12. Two different types of comparisons were performed: comparisons between different types of curricula and comparisons between textbook groups within a particular curricula. Ten mathematical scales, associated with topics important in most of the curriculum groups, were used as the dependent variables. Questions of significance are discussed separately for the various conditions of the analyses.

Travers, Kenneth J. NLSMA Report No. 19, Non-Intellective Correlates of Under- and Overachievement in Grades 4 and 6. 1971. 330p. $2.00. (ERIC: ED 084 121, SE 016 678)

Presents a sequence of analyses that explore the relationships between mathematics achievement and three sets of variables: pupil, teacher, and school for students in grades 4 and 6. Achievement criteria used were computation, structure, and a standardized test. No extensive attempt was made to interpret the data.

Crosswhite, F. Joe. NLSMA Report No. 20, Correlates of Attitudes toward Mathematics. 1972. 111p. $1.50. (ERIC: ED 084 122, SE 016 679)

Examines measures of attitude, self-concept, and anxiety as outcomes of mathematics instruction for students in grades 4 through 12. Specific area analyzed were (1) grade distribution and stability of attitudes, (2) patterns of intercorrelation among attitude variables, (3) correlation of attitude with achievement profiles for sex and textbook groups. The attitude, self-concept, and anxiety scales are included in the document.

Wilson, James W. and Begle, Edward G. (Eds.) NLSMA Report No. 21, Parts A, B and C, Correlates of Mathematics Achievement: Attitude and Role Variables. 1972. 1,453p. Part A, $2.50; Part B, $2.50; Part C, $2.50. (ERIC: ED 084 123, SE 016 680)

Contains the correlates classified as attitude and role variables for students in grades 4 through 12. Almost all of the three parts of the report consist of the descriptive statistics and the two-way analysis of variance for each classification variable by achievement variable pair, for each sex x textbook sample where significance was reached. No interpretation of the results is given. The report is intended to serve as a reference for further inquiry.

Wilson, James W. and Begle, Edward G. (Eds.) NLSMA Report No. 22, Parts A, B and C, Correlates of Mathematics Achievement: Cognitive Variables. 1972. 1,485p. Part A, $2.50; Part B, $2.50; Part C, $2.50. (ERIC: ED 084 124, SE 016 681)

Contains the data on correlates classified as cognitive variables for students in grades 4 through 12. Almost all of the three parts of the report consist of the descriptive statistics and the two-analysis of variance for each classification variable by achievement variable pair, for each sex x textbook sample where significance was reached. No interpretation of the results is given. The report is intended to serve as a reference for further inquiry.

Wilson, James W. and Begle, Edward G. (Eds.) NLSMA Report No. 23, Parts A, B and C, Correlates of Mathematics Achievement: Teacher Background and Opinion Variables. 1972. 1,399p. Part A, $2.50; Part B, $2.50; Part C, $2.50. (ERIC: ED 084 125, SE 016 682)

Contains the data on correlates classified as teacher background and opiniou variables for graders 4 through 12. Almost all of the three parts of the report consist of the descriptive statistics and the two-way analysis of variance associated with each classification variable by achievement variable pair, for each sex x textbook sample where significant was reached. No interpretation of the results is given.

Wilson, James W. and Begle, Edward G. (Eds.) NLSMA Report No. 24, Parts A, B, C and D, Correlates of Mathematics Achievement: School-Community and Demographic Variables. 1972. 1,883p. Part A, $2.50; Part A, $2.50; Part B, $2.50; Part C, $2.50, Part D, $2.50. (ERIC: ED 084 126, SE 016 683)

Contains the data on correlates classified as school-community and demographic variables for students in grades 4 through 12. Almost all of the four parts of the report consist of the descriptive statistics and the two-way analysis of variance associated with each classification-variable-by-achievement variable pair, for each sex x textbook sample where significance was reached. No interpretation of the data is given. The report is intended to serve as a reference for further inquiry.

Wilson, James W. and Begle, Edward G. (Eds.) NLSMA Report No. 25, Parts A, B and C, Correlates of Mathematics Achievement: Teacher Assigned Grades. 1972. 1,367p. Part A, $2.50; Part B, $2.50; Part C, $2.50. (ERIC: ED 084 127, SE 016 684)

Contains the data on correlates classified as teacher-assigned grades for students in grades 4 through 12. Almost all of the three parts of the report consist of the descriptive statistics and the two-way analysis of variance associated with each classification variable by achievement variable pair, for each sex x textbook sample where significance was reached. No interpretation of the results is given. The report is intended to serve as a reference for further inquiry.

Wilson, James W. and Begle, Edward G. (Eds.) NLSMA Report No. 26, Correlates of Mathematics Achievement: Summary. 1972. 213p. $2.00. (ERIC: ED 084 128, SE 016 685)

A summary of NLSMA Reports Nos. 21-25, presented as an aid in searching for patterns across various correlates, various mathematical achievement measures, and various samples. In the original analyses, students were grouped into three ability levels and possible correlates were considered as classification variables: the resulting data were considered through a two-way analysis of variance. Findings are presented in the form of individual, 2x2 matrices for each set of variables. No attempt is made to interpret the results. The report is intended to serve as a resource document to suggest hypotheses and further lines of inquiry.

Begle, Edward G. NLSMA Report No. 27, The Prediction of Mathematics Achievement. 1972. 144p. $2.00 (ERIC: ED 084 129, SE 016 686)

Discusses the attempts to determine which of many variables had significant predictive power for student achievement on various mathematical scales. A stepwise regression analysis with a three-stage elimination was used to identify the best predictors. In the first series of analyses, most of the significant predictors were mathematical scales. A second series was used to determine the best psychological predictors. Finally, the mathematical and psychological predictors are merged and the total results presented.

Begle, Edward G. and Geeslin, William Edward. NLSMA Report No. 28, Teacher Effectiveness in Mathematics Instruction. 1972. 146p. $2.00. (ERIC: ED 084 130, SE 016 687)

Concentrates on the analysis of the relationship between teacher characteristics and student achievement in the first year of the X-, Y-, and Z-Populations (students in grades 4, 7 and 10) and in the second year of the X- and Y-Populations (students in grades 5 and 8). A regression analysis approach was used to study teacher effectiveness with respect to computation and to comprehension separately.

Branca, Nicholas A. NLSMA Report No. 30, Follow-up Study of NLSMA Z-Population. 1972. 143p. $2.00. (ERIC: ED 084 131, SE 016 688)

An analysis of a follow-up survey conducted on the Z-Population approximately one year after the students completed grade 12. Students were grouped according to type of mathematics textbooks used and an extended series of Chi-square analyses performed. The data resulting from these analyses are given and a discussion presented that does not attempt to explain all of the observed trends. Instruments used to collect information are included.

Dodson, Joseph W. NLSMA Report No. 31, Characteristics of Successful Insightful Problem Solvers. 1972. 139p. $2.00. (ERIC: ED 084 132, SE 016 689)

A dissertation that sought to identify characteristics correlated with solving insightful problems, meaning nonroutine and challenging problems but not tricks or puzzles. A review of the literature indicated a number of variables, whose ability to discriminate among ability groups of problem solvers was then determined. Data from the Z-Population were used.

Bridgham, Robert G. NLSMA Report No. 32, The Effects of Different Mathematics Curricula on Science Achievement in the Secondary School. 1972. 13p. $0.50. (ERIC: ED 084 133, SE 016 690)

Focuses on the effect of new mathematics curricula on achievement in science. Those students from the Y-Population who had taken the College Board science tests in biology, chemistry, or physics were the subjects. Partial correlations were used to determine whether the type of mathematics curriculum was related to science achievement after the effects of student aptitude, achievement, sex, economic index, and number of years of mathematics were partialled out. Correlation matrices for biology, chemistry, and physics are presented separately.

Wilson, James W. and Begle, Edward G. (Eds.) NLSMA Report No. 33, Intercorrelations of Mathematical and Psychological Variables. 1972. 106p. $1.50. (ERIC: ED 084 134, SE 016 691)

Listing of correlation coefficients where each mathematical scale has been paired with each psychological scale. Besides each correlation matrix, a rotated factor matrix is given from the performed factor analysis. No attempt is made to interpret any of the data.