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ABSTRACT

This report contains the findings of a two-year experiment with junior high school low achievers in mathematics. The main purpose of the experiment was to develop a program which would relieve low achieving junior high school students from the burdens of computation as much as possible. The experiment was also designed to determine what effect this program had on the participating pupils with respect to mathematics achievement and attitudes toward mathematics when compared to similarly grouped pupils enrolled in the more traditional programs for low achievers. It was found that the more traditional programs improved the students' computational abilities to a higher degree than those students in the experimental program. However, in the author's opinion, the experiment did help the very low achievers to learn some significant mathematics and also created in them a desire to learn. This document previously announced as ED 042 630. (Author/FL)

SMSG REPORTS

No. 7

Final Report on an Experiment with Junior High School Very Low Achievers in Mathematics

William S. DeVenney

Financial support for the School Mathematics Study Group has been provided by the National Science Foundation.

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I INTRODUCTION

This report contains the findings of a two year experiment with junior high school very low achievers in mathematics. The experiment resulted from the Conference on Mathematics Education for Below Average Achievers sponsored by SMSG in Chicago, Illinois, on April 10 and 11, 1964, with financial support from the Cooperative Research Branch of the U. S. Office of Education.[1]

An ad hoc SMSG committee met in May of 1964 to review recommendations from the conference. One of the recommendations of this committee was that SMSG prepare experimental materials for the low achieving junior high school pupil.

An exploratory experiment was conducted during the 1965-1966 and 1966-1967 school years. The encouraging results of the first year of this exploratory experiment led to the decision to try the material and methods developed during that year with a larger number of classes during the school year 1966-1967.

A report on the first year of this larger experiment describing the procedures taken in its organization (including descriptions of the schools, students, teachers, materials, and testing) has been published.[2]

II PROGRAM DEVELOPMENT, 1967-1968

In order to facilitate the transition from junior high school to senior high school, a major objective during the 1967-1968 school year was to move the pupils back into a more traditional classroom environment, both with respect to the material used by the pupils and its handling in the classroom.

Two changes were made in the organization of the material. First, the length of each unit was increased to match those found in the more conventional textbook. Secondly, the format of the material was periodically altered so that during the final three months of the school year the format of the material used by the students was essentially the same as that found in contemporary mathematics texts for junior high school pupils.[3]

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1. School Mathematics Study Group, Conference on Mathematics Education for Below Average Achievers, Stanford, 1964.

2. School Mathematics Study Group, SMSG Reports, No. 6, Preliminary Report on an Experiment with Junior High School Very Low Achievers in Mathematics, Stanford, 1968.

3. A table of contents may be found in Appendix 2.

A. In-Service Seminars

Seminars with the teachers of the experimental classes were held monthly. Between such meetings the project coordinator contacted each teacher and acted in an advisory capacity. No contact was made with the teachers of the control classes.

The seminars served a twofold purpose. First, they enabled teachers to discuss methods of presentation of various subject matter topics and problems encountered by individual teachers. Secondly, they served as a guide for pupil readiness with respect to change in format of both the material and the teaching method.

B. Pupil Testing Program

In September of the 1967-1968 school year, pupils in each experimental class were randomly separated into two groups and re-tested. One group was tested using the SAT Intermediate II tests and the other group was tested using SAT Advanced Tests.[4]

This procedure was followed in order to determine the amount of retention over summer vacation. In addition, it allowed for comparisons to be made which indicated whether the pupils had advanced far enough mathematically so that an advanced test could be used as an indicator of their achievement level. Results of these tests indicated that the SAT Advanced test for junior high school pupils would discriminate as well as the Intermediate tests and were therefore used in the spring post-testing.[5]

Also, SMSG constructed tests on attitude (Opinion Inventory, form SC) and achievement (Mathematics Inventory, form SCII) were administered in the spring to both control and experimental pupils.[6] The classroom teacher administered the tests to the pupils in the experimental classes. The project coordinator administered the tests to the pupils in the control classes.

The following information was also gathered: Sex, I.Q. of each student, the mathematics course the pupil planned to take in his freshman year of high school, and the grade received for the first quarter of the freshman year.

4. The entries in all tables under Stanford Achievement Test are reported in terms of grade placement. All entries in the SMSG tables are raw scores.

5. The complete table for the fall, 1968, testing can be found on page 6.

6. These tests, which are described in Appendix 4, have been reproduced in their entirety in a SMSG technical report. See: School Mathematics Study Group, NLSMA REPORTS, Y-Population Test Batteries, Stanford University, Stanford, California, 1968.

Brief evaluations and comments covering the two years of the experiment were requested, and obtained, from the ten teachers of the experimental classes. These appear in Appendix 3.

III ANALYSIS OF THE 1966-1968 DATA

Because of the small number of classes involved, all the pupils in the experimental classes were pooled into one group and those in the control classes into a second group for all of the statistical analysis which follows in which comparisons between these two groups are made. Students not having data on all pretests and post-tests were deleted from the two year analysis.

Mean Scores for these two groups on the initial measures appear in Appendix 5. None of the differences between the two groups were significant at the .05 level with the exception of ATT3, for which the difference is significant at the .01 level. The calculations are shown in Appendix 6.

A. Gains on the Stanford Achievement Test Scales

Table 1 shows the mean scores for both groups for the fall, 1966, and the spring, 1968 administration of the two SAT scales.

TABLE 1

FALL AND SPRING SCORES - SAT SCALES[7]

Experimental Group

	S.A.T. Intermediate FALL - 1966	S.A.T. Advanced SPRING - 1968
	Mean	Mean
Comp.	46.60	56.75
Appl.	54.82	71.18

Control Group

	FALL - 1966	SPRING - 1968
	Mean	Mean
Comp.	46.08	64.83
Appl.	54.49	72.61

7. In writing the computational program for the analysis of the data, the SAT scale scores were multiplied by 10. Recall that these scores indicate grade placement.

It will be observed that both groups made substantial gains on both scales, with the control group making greater gains than the experimental group.

It was surmised that the post-test scores would depend not only on the pretest scores but also on I.Q., and hence it would be appropriate to adjust the post-test scores for differences in the pretest scores.

A stepwise multiple regression analysis, of the pooled population data was run. Each of the post-tests scales, SAT-Computation, SAT-Applications, SMSG-11, SMSG-12, SMSG-13, SMSG-14, and SMSG-15 served, in order, as the dependent variables and the eight pretest scales on I.Q., SAT-Computation, SAT-Applications, SMSG-1, SMSG-2, SMSG-3, SMSG-4, and SMSG-5 served as the independent variables.

The results, which are shown in Appendix 7, indicate that six best predicting variables, were I.Q., SAT-Computation, SAT-Application, SMSG-1, SMSG-4, and SMSG-5.

The differences on initial measures between the two groups on the six predicting variables were not significant. The calculations are shown in Appendix 8.

Analysis of covariance was attempted in order to compare the gains of the two groups. Regressions of the post-test scores on the five pretest scores and I.Q. were computed. In no case did the regression planes for the two groups significantly differ from parallelism. Analysis of covariance was therefore carried out. Table 2 shows the adjusted means for the two groups. The computations are shown in Appendix 9.

TABLE 2

ADJUSTED MEANS - SAT SCALES

	Experimental	Control
SAT-Comp.*	56.57	65.26
SAT-Appl.	71.07	72.86

*The difference in the adjusted means on the SAT Computation is significant at the .01 level.

B. SMSG-Scales

Appendix 10 shows the mean scores for both groups on the SMSG post tests. Unfortunately, the scales chosen for the post tests were far too difficult for the pupils in both groups. The mean scores on each test for both the experimental and control groups approach so closely those that would occur by chance that it was felt any attempted interpretation of this data would be meaningless.

C. Changes on the Attitude Scales

Table 3 shows the mean scores, for both groups, for the fall, 1966 and spring, 1968 administrations of the attitude scales.

TABLE 3

FALL AND SPRING ATTITUDE SCALE SCORES

	Experimental Group				Control Group			
	Fall-1966	Spring-1968	Change	t[8]	Fall-1966	Spring-1968	Change	t[8]
Att. 1	20.41	20.06	-0.35	0.65	20.05	19.73	-0.32	0.11
Att. 2	13.16	13.84	0.68	2.57*	13.04	12.05	-0.99	1.12
Att. 3	33.52	34.10	0.58	1.86	31.81	32.23	0.42	1.00
Att. 4	24.71	28.05	3.34	6.49**	24.25	25.28	1.03	0.98
Att. 5	35.33	29.75	-5.58	9.94**	34.40	31.74	-2.66	2.38*
Att. 6	24.79	25.30	0.51	1.27	24.59	23.62	-0.97	1.06
Att. 7	29.70	28.15	-1.55	2.52*	28.96	29.79	0.83	1.65
Att. 8	27.85	31.71	3.86	7.46**	28.40	28.50	0.10	0.41

*Significant at the .05 level.
**Significant at the .01 level.

The large number of significant changes for the experimental group is an indication that the experimental program does in fact differ, in its effect on pupils, from the standard program for low achieving junior high school pupils.

IV DISCUSSION

Retention

In order to determine retention over the summer vacation and also whether the pupils' achievement could be measured with a more advanced scale, pupils in the experimental group were randomly separated into two sub-groups and retested in the fall of 1967. The control classes were not tested at this time.

8. Two tailed t for correlated data.

One sub-group was retested using a prallel form of the SAT Intermediate tests which had been administered in the fall. The second sub-group was retested using the SAT Advanced tests. Table 4 shows the results of this fall testing.

TABLE 4*

CHANGE OCCURING OVER SUMMER VACATION

Experimental Sub-Group 1

	Spring 1967	Fall 1967	Summer Change
	Mean G.P.	Mean G.P.	Mean
Comp.	5.74	5.09	-0.65
Appl.	5.82	6.33	0.51

Experimental Sub-Group 2

	Spring 1967	Fall 1967	Summer Change
	Mean G.P.	Mean G.P.	Mean
Comp.	5.93	5.22	-0.71
Appl.	6.00	6.81	0.81

*Sub-Group 1 is composed of approximately $\frac{1}{2}$ of the pupils in the experimental class who were tested in both the spring and fall with S.A.T. Intermediate Tests. Sub-Group 2 is the balance of the pupils in the experimental classes who were tested in the spring using S.A.T. Intermediate Tests and in the fall using S.A.T. Advanced Tests.

It will be observed that pupils in both sub-groups evidenced substantial losses over the summer in computation and at the same time showed substantial gains in applications.

The mean grade placement in computation for the experimental group in the spring of 1967 was 5.8.* In the spring of 1968, one year later, the mean score in computation was essentially the same (i.e., 5.7). This indicates that in computation it took the entire school year of the eighth grade to regain (within one-tenth year) what was lost over the summer.

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*For discussion purposes, grade placement scores are reported to the nearest one-tenth year.

Although the control classes were not tested in the fall of 1967 there are indications that what had occurred with respect to computation within the experimental group may also have occurred within the control group. The mean grade placement in computation for the control group in the spring of 1967 was 6.4. One year later it was 6.5. These scores imply that either the control group also evidenced substantial losses over the summer which required the entire second year to regain or else the eighth grade year was spent without any meaningful gain in computation.

Computation

Since computational ability is often one of the factors taken into consideration when assigning pupils to ability groups or special mathematics programs, careful observation was made of the relationship of computational ability to achievement in other areas of mathematics.

Analysis of the data for both the first and second years of the experiment indicates that the best predictor of achievement in computation is in fact the students' pretest scores on computation. The amount of variance accounted for by the pretest scores on computation, though, was substantially reduced as the experiment progressed from the first to second year.

On the other hand, regression of post-test scores on the pretest measures show that in no case is computation a significant contributing variable in predicting achievement on any of the other post-test scales. The calculation can be found in Appendices 7 and 11.

The apparent independence of computation with respect to achievement in other areas of mathematics is furthered by observation of Table 1. The figures show the control group having a mean grade placement of 0.8 a year in advance of the experimental group in computation at the end of the two years of the experiment. Yet, there was no meaningful difference in mean grade placement between the two groups on the applications test scores. In that in excess of 70 percent of the items on the applications test require some type of computation, it would seem reasonable to expect that the group with the more advanced computational skills would score higher on the applications scale. Such was not the case in this experiment.

Attitudes

The responses for each item on an attitude scale were assigned values which range from 1 for the most negative response to 4, 5, or 6 (depending upon the number of response choices) for the most positive response. The item scores were then summed to produce the scale score. Scores on attitude scales

1 through 4 can be interpreted directly by observing the amount, (and direction) of change which occurred over the two year period.

For purposes of determining a degree of positiveness (or negativeness), Tables 5 and 6 contain a neutral score for each of the four attitude scales listed. These scores were derived by assigning values of 2.5, 3.0, or 3.5 to items with 4, 5, or 6 response choices respectively. The item scores were then summed to produce the neutral score. The other entries in these tables indicate the amount below (negative) or above (positive) the neutral score each group scored on the listed scales.

TABLE 5

INITIAL SCORES ON ATTITUDE SCALES 1-4
RELATIVE TO A NEUTRAL SCORE - FALL, 1966

	Neutral Score	Experimental Group Mean	Control Group Mean
Att. 1	21.00	-0.59	-0.95
Att. 2	12.50	+0.66	+0.54
Att. 3	28.50	+5.02	+3.31
Att. 4	27.00	-2.29	-2.75

TABLE 6

FINAL SCORES ON ATTITUDE SCALES 1-4
RELATIVE TO A NEUTRAL SCORE - SPRING - 1968

	Neutral Score	Experimental Group Mean	Control Group Mean
Att. 1	21.00	-0.96	-1.27
Att. 2	12.50	+1.34	-0.45
Att. 3	28.50	+5.60	+3.73
Att. 4	27.00	+1.05	-1.72

Scale attitude 1 is designed to measure how well a pupil likes mathematics and considers it important in relation to other school subjects. Initial scores show both groups slightly on the negative side of the neutral score. Final scores show no significant change occurred with either group with respect to this scale.

Scale attitude 2 is designed to measure the pleasure or boredom which a student associates with mathematics performance. Initial scores show both groups slightly on the positive side of the neutral score. Final scores show the experimental group making significant positive gains where as the control group evidenced losses that now places them on the negative side of the neutral score. These changes indicate that for the experimental group the program had the effect of making mathematics more pleasurable where as the programs followed by the control group had the effect of making mathematics duller.

Scale attitude 3 is designed to measure general attitudes toward mathematics. The initial scores show both groups scoring strongly on the positive side of the neutral score, with the experimental group scoring significantly higher than the control group. Final scores on this scale show both groups essentially in the same position as they were initially. Apparently the programs followed by either group did nothing to significantly increase or reduce the initial attitudes measured by this scale.

Attitude 4 is designed to measure the ease or difficulty which a pupil associated with mathematics performance. Initial scores show both groups scoring strongly on the negative side of the neutral score. Final scores show the experimental group making significant gains, shifting to a rather strong position on the positive side of the neutral score. The final score for the control group indicates some (but not significant) gain with the score still remaining on the negative side of the neutral score. These scores imply that at the start of the experiment, pupils in both groups felt that mathematics was difficult. Final scores indicate the pupils in the experimental group now look upon mathematics as being relatively easy whereas the pupils in the control group still look upon mathematics as being difficult.

Whereas scores on attitude scales 1 through 4 were interpreted directly by the amount (and direction) of change, attitude scales 5 through 8 are conceptually related and therefore interpretation of change has been done in pairs. In the same manner, an interpretation of change on attitude 7 is dependent to some extent upon change occurring on attitude 6.

Table 7 shows the initial scores relative to a neutral score. Table 8 shows the final scores relative to a neutral score and also includes the amount (and direction) in which the change occurred.

TABLE 7

INITIAL SCORES ON ATTITUDE SCALES 5-8
RELATIVE TO A NEUTRAL SCORE - FALL 1966

	Neutral Score	Experimental Group Mean	Control Group Mean
Att. 5	28.00	+7.33	+6.40
Att. 6	27.00	-2.21	-2.41
Att. 7	30.00	-0.30	-1.04
Att. 8	28.00	-0.15	+0.40

TABLE 8

FINAL SCORES ON ATTITUDE SCALES 5-8
RELATIVE TO A NEUTRAL SCORE - SPRING 1968

		Experimental Group		Control Group	
	Neutral Score	Mean	Change	Mean	Change
Att. 5	28.00	+1.75	-5.58	+3.74	-2.66
Att. 6	27.00	-1.70	0.51	-3.38	-0.97
Att. 7	30.00	-1.85	-1.55	-0.21	0.83
Att. 8	28.00	+3.71	3.86	+0.50	0.10

Scale attitude 5 is designed to measure how a pupil wishes he were in relation to mathematics. Inspection of Table 7 indicates that initially, pupils in both groups had a strong desire to have a more positive relationship to mathematics. The final scores, shown in Table 8, show a significant reduction in the intensity of this desire on the part of pupils in both groups. There are two interpretations which could account for this reduction in desire. First, if a mathematics program is such that the desires of the pupils are fulfilled and thus they see themselves as being capable pupils, there would no longer be a need to wish for this relationship. This could have the effect of lowering the final scores on this scale. Secondly, it is possible that the mathematical experiences encountered by the pupils were such that they see themselves as not being capable pupils. This could have the effect of lowering their ideals and consequently their performance on this scale.

Attitude 8 is designed to measure how a pupil actually sees himself in relation to mathematics. The scores in Table 7 show no significant difference on initial scores between the two groups, with the experimental group being slightly on the negative side of the neutral score and the control group being slightly on the positive side. The final scores, as shown in Table 8, show the experimental group making significant positive change while the control group made essentially none.

It appears th. . that the program developed for the experimental group has had the effect of lowering the pupils' desire to have a more positive relationship to mathematics by providing him with experiences that allow him to do so. The final score on attitude 8 tends to substantiate this interpretation as it indicates that the pupils' now actually see themselves as more mathematically competent persons.

On the other hand, the programs encountered by the pupils in the control group apparently did not have the same effect, in that the desire for a positive relationship was reduced but the pupils still do not see themselves as being able to function mathematically.

Scale attitude 7 is designed to measure the degree to which mathematics achievement performance is harmed by stressful conditions (e.g., examinations).

Scale attitude 6 is designed to measure the degree to which mathematics achievement is facilitated by stressful conditions (e.g., examinations).

Although the only statistically significant change occurring on these two scales was that of the experimental group on attitude 7, the changes that did occur indicate that the programs do differ in their effect on the pupils.

The final scores for the experimental group on these two tests show a decrease on attitude 7 and an increase on attitude 6. For the control group the change that occurred was just the opposite, that is, there is an increase on attitude 7 and a decrease on attitude 6.

It appears, that the program for the pupils in the experimental group had the effect of reducing the effect of those stressful conditions which, in the past, harmed their mathematical performance while at the same time increased the effect of those stressful conditions that facilitate mathematics achievement. On the other hand, the programs for the pupils in the control group appear to have increased the effect of those stressful conditions which harm mathematical performance while at the same time decrease the effect of those stressful conditions that facilitate mathematical achievement.

There is one further piece of evidence which tends to support the conclusions drawn with respect to the attitude changes of the pupils in this experiment.

Tables 9 and 10 show the initial and final scores of the pupils in both groups compared to the scores of a five percent stratified random sample ($1421 \leq n \leq 1953$) of the pupils in the Y-population of the National Logitudinal Study of Mathematical Abilities (NLSMA).

TABLE 9

COMPARISON OF INITIAL SCORES ON ATTITUDE SCALES WITH NLSMA - Y POPULATION - YEAR 1

	NLSMA-Y Population Fall-Grade 7	Experimental Group Fall-Grade 7	Control Group Fall-Grade 7
Att. 1	21.56	20.41	20.05
Att. 2	15.40	13.16	13.04
Att. 3	36.04	33.52	34.81
Att. 4	28.13	24.71	24.25
Att. 5	33.55	35.33	34.40
Att. 6	27.19	24.79	24.59
Att. 7	26.48	29.70	28.96
Att. 8	33.36	27.85	28.40

TABLE 10

COMPARISON OF FINAL SCORES ON ATTITUDE SCALES WITH NLSMA-Y POPULATION - YEAR 3

	NLSMA-Y Population Fall-Grade 9	Experimental Group Spring-Grade 8	Control Group Spring-Grade 8
Att. 1	20.28	20.06	19.73
Att. 2	14.56	13.84	12.05
Att. 3	34.67	34.10	32.23
Att. 4	27.98	28.05	25.28
Att. 5	31.18	29.75	31.74
Att. 6	25.27	25.30	23.62
Att. 7	26.81	28.15	29.79
Att. 8	32.39	31.71	28.50

It should be noted that the pupils in the NLSMA study do not represent a typical cross section of the students in junior high schools throughout the United States. Rather, they more typically represent, in all respects, that group of pupils usually referred to as "above average".[9]

9. School Mathematics Study Group, NLSMA Reports, No. 9, NON-TEST DATA, Stanford University, Stanford, California, 1968.

Inspection of Table 9 shows both the experimental and control group initial scores on each attitude scale to be drastically different from the scores of the pupils in the Y-population. Table 10 shows that, after two years the scores of the experimental group closely approach those of the Y-population while the control group scores still remain different.

It would be reasonable to conclude that, with the experimental group, attitude changes occurred which produced a group of mathematically well adjusted pupils. It is doubtful that the same conclusion can be drawn for the pupils in the control group.

Freshman Mathematics Classes

Information was gathered on what mathematics course each pupil involved in this experiment would be taking in the freshman year of high school.

Because of the variety of course titles given to the mathematics courses offered for high school freshman and for purposes of this report, students were placed into one of the following course categories based on the following criteria.

(1) Algebra - Those students who would complete a freshman algebra course in one year.

(2) Introduction to Algebra - Students who were placed in classes the intent of which was to prepare the student to take algebra in the sophomore year or students who were placed in classes which covered the content of an algebra course over a two year period.

(3) General Mathematics - Students who were placed in classes the general intent of which was to survey all mathematics through grade 8 along with social utilization of these mathematics.

(4) Mathematics Fundamentals - Students who were placed in classes which emphasized practice in the four fundamental operations with the set of non-negative rationals.

(5) None - Students who were advised to postpone taking any mathematics until their junior or senior year.

The decision as to which of these five classes a pupil would take was usually based on the desire of the pupil coupled with the recommendation and counseling of his junior high school mathematics teacher and the high school counselor.

Tables 11 and 12 indicate the number and percent of pupils taking each of the listed mathematics courses for both the experimental and control group.[10]

TABLE 11

HIGH SCHOOL MATHEMATICS COURSES

EXPERIMENTAL GROUP

	Number of Pupils Taking Course	Percent of Pupils Taking Course
Algebra	36	20.69
Intro. to Aglebra	102	58.62
General Math	12	6.90
Math Fundamentals	5	2.87
None	19	10.92
TOTAL	174	100.00

TABLE 12

HIGH SCHOOL MATHEMATICS COURSES

CONTROL GROUP

	Number of Pupils Taking Course	Percent of Pupils Taking Course
Algebra	11	9.02
Intro. to Algebra	26	21.31
General Math	18	14.75
Math Fundamentals	53	43.44
None	14	11.48
TOTAL	122	100.00

The large number of pupils in the experimental group who planned to take Introduction to Algebra or Algebra as opposed to the large number of pupils the control group who planned to take General Math or Math Fundamentals is another indication that the pupils in the experimental group do in fact see themselves as mathematically capable persons.

10. At the time polled, a few pupils had not yet decided which mathematics course they intended to take, therefore the tables do not include all pupils in the experiment. Also, it is likely that these figures will change from spring to fall.

Mathematics Grades, First Quarter - Freshman Year

The intent in collecting the first quarter grades of the pupils involved in this experiment was to try to determine whether the improved attitudes toward mathematics by the pupils in the experimental group enabled them to perform better in their mathematics courses as high school freshmen than the pupils in the control group.

The counseling, grouping, scheduling, and grading practices of individual high schools and teachers proved to be so varied that it was impossible to determine whether the improved attitudes did in fact have any effect on pupil performance.

Available first quarter grades, by course, for pupils in both groups can be found in Appendix 12.

V. SUMMARY AND CONCLUSION

The main purpose of this experiment was to develop a program, and appropriate materials, which would relieve the very low achieving junior high school pupil from the burdens of computation as much as possible.

A secondary purpose of this experiment was to determine what effect this program had on the participating pupils with respect to mathematics achievement and attitudes toward mathematics when compared to similarly grouped pupils enrolled in the more traditional programs for the low achiever.

It was found that:

a. At the end of grade eight, pupils in the control group were more advanced in computational skills than the pupils in the experimental group. The grade placement scores, as measured by the computation sub-scale of the S.A.T. Advanced Test, were 6.5 and 5.7 respectively.

b. At the end of grade eight there was no meaningful difference between the control and experimental groups on the applications sub-scale of the S.A.T. Advanced Test, the grade placement scores being 7.3 and 7.1 respectively.

c. Pupils in the experimental group evidenced substantial loss in computational skills over the summer vacation while at the same time experienced gains in their abilities to apply mathematics. Although not tested in the fall of the second year, there is evidence that indicates that the summer loss in computation that occurred with the experimental group also occurred with the control group.

d. At the end of grade eight, the grade placement scores in computation were not meaningfully different from the scores recorded at the end of grade seven, for either group.

e. Evidence indicates that for both groups the entire year of the eighth grade was needed to regain that which was lost in computational skills over the summer vacation.

f. On scales which are appropriate for the ability level of the pupils in this experiment and which measure mathematical concepts different from those of computation and applications, the pupils in the experimental group showed greater gains than those in the control group. These gains were significantly greater on three of the five scales which were administered at the end of grade seven.

g. On psychological scales constructed to measure pupil attitudes toward mathematics, both groups entered junior high school with what could be considered negative attitudes. By the end of grade eight, scores on these same attitude scales indicated that pupils in the experimental group had developed attitudes that could be considered highly positive toward mathematics. On the other hand, pupils in the control group evidenced no such reversal of attitudes. If anything, they now displayed attitudes which could be considered even more negatively oriented than those displayed upon entering junior high school.

It was true that the more traditional programs for these pupils, that is, ones which concentrated on computational skills, did improve the pupils' abilities to compute to a higher degree than those pupils in the experimental program. However, it is questionable whether the difference between the two groups in computational skills is desirable if it comes at the expense of achievement in other topics in mathematics and favorable attitude changes.

In the opinion of this author, the most significant contribution of this experiment is that it demonstrates that it is possible to help the very low achieving junior high school pupil to learn some significant mathematics and at the same time to create in him a desire to learn more.

APPENDIX 1

PARTICIPATING SCHOOL DISTRICTS, SCHOOLS, AND TEACHERS

Experimental Group

CUPERTINO UNION SCHOOL DISTRICT

Collins School-----Mr. R. Sturtevant

Hyde School--------Mr. J. Fullerton

Miller School------Mrs. A. Bixby

MORELAND SCHOOL DISTRICT

Rogers Junior High School-----Mr. D. Hallstrom

SUNNYVALE ELEMENTARY SCHOOL DISTRICT

Mango Junior High School-----Mrs. S. Webb

SANTA CLARA UNIFIED SCHOOL DISTRICT

Juan Cabrillo School-----Mr. H. Neufeld

FREMONT UNIFIED SCHOOL DISTRICT

Hopkins School-----Mr. E. MacArthur

Walters School-----Mr. R. Masuda

SANTA CRUZ ELEMENTARY SCHOOL DISTRICT

Mission Hill Junior High School-----Mr. D. Herman

LOS GATOS ELEMENTARY SCHOOL DISTRICT

R. J. Fisher School-----Mr. J. Fortier

APPENDIX 2

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APPENDIX 3

COMMENTS BY TEACHERS*

(Experimental Group)

1. The biggest factor in evaluating the program is the change in attitude of the students involved. While it has not been a dramatic change, it has been a progressive change, particularly evident after working with the same students for two years. It revolves around their fears. They are not afraid anymore, accepting and placing mathematics in the proper scheme of things. While I cannot say how many now have a love for mathematics, some obviously do. Two students want to be math teachers, four want to take algebra next year, and at least one-half plan to take two or three years of math in high school when only one year is required.

Four students became such discipline problems in the rest of their classes that at mid-year they were included in a program which isolates serious discipline problems from the rest of the student body for the entire day. Two of these students requested to be allowed to continue to attend my math class, and with my permission, were permitted to do so. This was the only class these two boys attended under normal school scheduling. I might add that this involved their staying at school one hour longer than they would have under the discipline program, for the other students in that program were dismissed at one o'clock.

Toward the end of the school year several students became tired of the units approach and wanted a "regular" math book, this and two or three students who constantly lost their unit books were the only negative feelings I felt during the school year. Several students asked if I would come to the high school and teach math. While this was a nice complement, it does point to the need of the underachiever to identify with their teacher.

Finally, in my opinion this has been a very successful program, again particularly in changing student attitudes.

*These comments appear in a random permutation of the order in which the teachers are listed in Appendix 1.

2. Looking at the results of two years of working in the underachievers program I am particularly impressed with the changes in the students. They are a nice, warm, friendly group of kids that no longer fear or hate math. Two years ago they were bitter, frustrated and frightened by math; by no means either warm or friendly. They are not all budding mathematicians but they are now responsive and positive.

Their new attitude is reflected in the fact that every single student going on to high school has elected to take math next year even though they were given the option of taking no math class their freshman year. Two students are repeating 8th grade because of basic immaturity and not being ready for high school. They are both going to take grade level SMSG classes next year.

The students feel secure enough about math and about me to joke around. I am urged to go to high school with them or let them come back here for math. I here comments like:

"If you don't agree with us we won't like math any more"

"... come on, you can't be our pal any more"

"I think I'll flunk 8th grade so I can take another year of math here..."

The ability to joke reflects a security that is new for many of these students. Their security is also reflected in the fact that they bring many of their school problems to math class to be discussed or solved. The students figure that this a safe place to express themselves.

Having almost no experience with math I do not feel qualified to judge their mathematical development. I do know that one student made honorable mention two quarters, one student passed the entrance examination at a private girls high school, at least four of these "underachievers" have been moved from low classes to grade level classes in other subjects during the two years and none have failed to succeed in some way in this class.

I do feel qualified to judge their social and emotional development, having worked with disturbed, remedial and underachieving students before. These students now show a stability they lacked two years ago. They have been successful in this program and they have responded well to success. None of them would go back to their previous kind of math class or transfer from this one. It has been a good program for them and certainly for me.

I feel privileged to have participated in the program, and to have spent two years with a group of "underachievers" who didn't underachieve at all.

3. Teaching S.M.S.G. program for underachievers in mathematics for the past two years has been most rewarding. I have observed seventh graders who were defeated and totally lacking in ability to compute, become interested students, adept at mathematical problem solving.

I contribute the drastic changes in the students of my group to two main factors inherent in the program. First, the emphasis on success experiences did much to rebuild self-confidence in the students' abilities. Secondly, the structured, sequential and prudently selected subject matter seemed to be the material necessary to provide these success experiences.

The written material and the exercises provided excellent opportunity for student interaction and I feel that much was gained from students helping each other, particularly on certain of the problem sets.

It would be presumptious to assume that any program is the panacea or that this particular approach was completely successful in ministering to the needs of each underachiever in my class. However, I feel that this program has reached a number of students who might otherwise have continued to experience only defeat.

In my opinion what has been observed thus far merits further study of this particular approach with the mathematics underachiever.

4. My personal opinion of the program again is that it was a complete success in my classroom. In the two years of teaching this class I saw many changes take place. First, and most important of all was a change in attitude. When the class first started two years ago the students were afraid of math. Many of the students held the attitude that math was their most difficult subject, and therefore, why try. As the student gained confidence in himself this negative attitude gradually changed to a more positive one. What helped make this attitude change? It was the material and individual attention provided for each student.

During the two years of this course the students also learned the importance of organization and having better study habits.

I can't think of any improvements needed other than having more problems on each lesson. At times, many students were able to finish before others. Also, it was learned that when the class interest seemed to be going down that a change of units was a good idea.

I feel very fortunate to have had the opportunity to work in this program. I learned a great deal which I am sure will help me in my future teaching.

5. Two years ago I agreed to teach a special course in math to under-achievers because I was interested in seeing if a program of the type indicated would be beneficial to this type of student.

Because I was teaching math in the traditional way to five other classes each day I found it difficult to make the shift once a day to the methods used for this special group. I know that I was not always successful in so doing but tried to follow the suggested outline. Most difficult was going on even though the students had not completely grasped the current ideas.

It is difficult to determine which facit of the program served most to stimulate progress but there can be no doubt that progress was made in understanding concepts of mathematics.

The lack of pressure in the classroom and the encouraging of students to try, by praise rather than threat of poor grades, was no doubt a factor and probably a substantial one. On the other hand the material was in most cases of interest to the students and helped to arouse their curiosity as to solution.

The use of tables by the students and "open book" tests was very helpful in reducing anxiety and is an idea worth extending to any classroom.

Because the reading level of the students was low the vocabulary was too much for them and required both reading and explanation by the teacher. As a result retention was a problem for many of the students.

On the whole I believe the project was very beneficial to the students selected.

It would be interesting to see an evaluation of these classes with a control group of classes using a regular text but employing a philosophy of teaching (all praise-no rejection) paralleling that of the project.

6. The students in this class were quite comparable in terms of ability, behavior, and attitudes to students that usually are in remedial classes. My previous experiences with remedial groups have been that they only rarely become very interested about mathematics, and this interest is for a rather short duration. Herein lies the greatest success of this SMSG program.

Although the degree of interest in the subject continued to fluctuate, I found that the overall level was surprisingly higher and for much longer periods of time. Most of the students in the program made genuine efforts to understand the material and improve their abilitv in working with mathematical concepts and manipulations.

I think there are two major reasons for this departure from the "traditional" attitude of low achievers. The first reason stems from the nature of the material itself. The typical remedial course content is geared to overcoming the student's inability to master operational facts--something the student has usually become completely frustrated by to the point of almost rejecting any further efforts. The SMSG materials removed this obstacle for the students by providing and allowing them at any time to use operational tables. This cleared the way for the introduction of subject materials that were on par with those presented in the regular seventh and eighth grade classes. This, I believe, made it possible for a certain amount of the frustration to disappear, and in its place interest began to grow.

The second major reason for increased interest in mathematics was also related to the student's ability to recognize a degree of success. This was a result of the spiral approach to the presentation of the material. I became aware of this about one third of the way through the second year, when students began to favorably react to the fact that they already knew something about the material in a new unit. I began hearing comments similar to: "This isn't going to be so hard; we had some of this before". As a result, they became rather eager to advance in the new unit.

Although student interest was helped by the spiral approach, there was also an adverse factor that I suspect to be partly related to this same approach. A significant number of students reported that one of the things they did not like about the way the material was presented was that just when they were beginning to understand an idea or unit it was dropped and we started something else. With this in mind it seems that it might have been advisable to remain in an area a little longer in order to foster the pleasure of success. I think it was also true that although they did recognize the material from previous lessons, they did not retain as much of it as we might hope to expect.

The retention factor was probably my greatest disappointment with these students. Something that almost everyone could do on a certain day would often be a mystery to at least half the class two days later. This also was to show up on the standardized tests.

I think there is a link between the retention problem and the criticism the students make about leaving an area too soon. I suggest that each unit be lengthened by tacking several lessons on to the end, thereby providing added drill as well as providing a little more time to taste success.

In all, I believe we are working on the right line of reasoning with this program. Even if there has not been the expected success in attaining the level of achievement, I think this program has a great deal more to offer than any other program for low achievers.

7. The self-confidence and enthusiasm developed in the student by this program is fantastic. Every student at one time or another has stated or indicated it. My great concern is that the program, not being continued in the ninth grade, will lose much of the ground gained in the areas mentioned.

The content and form of the course found acceptance by every student. They appreciated learning the reasoning behind the tricks they had been drilled into learning and using, such as "invert and multiply" in division of rational numbers. More basic yet but as eagerly accepted was the graphic representation of fractions of a whole, equivalency, and the addition, subtraction and multiplication of same. The relationship between rational numbers and percent and the meaning of percent itself came as news to most and their understanding a relief to all.

The greatest testimonial to the impact of the program is the fact that I have been asked to review the justification of certain processes, even though the students knew the processes and how to apply them. This evidences to me a real interest in the "why", a much more substantial and rewarding interest than just the "how".

8. The program is now coming to a close and the key point that bursts to the fore is - we need another year! It seems as if the youngsters in this program are just now coming to a point of security and are willing to exercise a degree of independence. Whereas, some of the earlier concepts required greater amounts of time to explain, the newer concepts required a very brief explanation and the class takes off on its own. One group of four youngsters is actually working a full unit length ahead of the remainder of the class. They are doing well in spite of the fact the concepts are more sophisticated and require great care in manipulation.

Youngsters still do not enjoy much of anything that requires computation of a difficult nature. However, when it comes to concept development, youngsters engage in dynamic discussion and "friendly" argument that has led to some pretty solid thinking along mathematical lines.

I still feel the materials are well laid out and in general easily understood, almost to the degree one would expect in programmed materials. The only criticism I have in looking back over the entire program is that in some places youngsters have gotten bogged down by the sheer number of words used to explain a concept development. However, I must be quick to say, the youngsters have found a way around that when it became a problem. They discussed it with each other, and if that did not suffice, inquired of the instructor. In almost all cases youngsters caught on to concepts only after questions were asked by other members of the class. Therefore, it is my opinion the materials were most effective as youngsters were challenged to ask what it was all about, or what the result of certain alternatives would be.

It is difficult to separate the student reaction from consideration of materials because one of the key observations has been the dramatic change in care of the materials by the students themselves. They do not mark pages as drastically as heretofore and seem to take a kind of pride in possession of the book.

Faculty reaction has been mixed ranging from complete indifference and ignorance of the program to intense interest exhibited by honest inquiry. In general, teachers have been supportive and show greater interest now that the program has come near to a close then they did at its initiation or at the end of the first year.

Administrative reaction has been very supportive and appropriate inquiries have been made from time to time by all members of the administrative team. Administration has also cooperated in a program for higher level youngsters conducted by SMSG and directly involving the high school.

This has been a very worthwhile project in terms of teacher perception of needs for underachievers. It has also helped compensate for the erratic interest patterns and disinterest such youngsters have for computation and repetitious tedium. I can see real hope for underachievers in the future if low pressure requirements using these or similar materials and techniques are employed.

9. I have been extremely pleased with the final outcome of two years work with this group. Of course some children benefited much more than others. The page-a-day worked very well. Some units I used in our other low-average 7th and 8th grade classes and they went very well in those classes. Of the 23 students in the class 7 are planning on taking Algebra I, 1 is going into General Math, and 15 into Intro. to Algebra. The attitude on the part of the students and parents has been very good. Some of the students get a little frustrated at the long units. I feel the program is a little weak in percentage.

The unit on graphing became too difficult too soon. After graphing the Christmas tree and the fish I had the students create their own designs with directions for following. Most of them really enjoyed doing this and I got some great pictures.

My one problem with this group was that there were too many immature students, but even they have shown considerable growth.

I've certainly changed my idea on all students need to memorize their addition tables and multiplication tables. I've convinced the four teachers I work with of this also and we emphasize the use of their being able to construct and use their tables even on tests. It seems to remove one threat during a test. I've mentioned this to our curriculum man at district office. How far its gone I don't know but I'll keep at it.

10. As far as I am concerned this program has been a great success. A program that can salvage at least a third of thirty math students who, for all practical purposes, would have been relegated to two years of "below level" math in junior high and most probably one year of basic math in high school, must be considered a success.

Of the original thirty, twenty-three will have by June 1968 completed two years in the program.

In our district there is a one year math requirement that must be met in order to graduate from high school. As freshmen they have one of four selections they can make: (1) Algebra (2) Introduction to Algebra (3) General Math (4) No Math. If they choose not to take math as freshmen, they have, in effect, selected basic math to be taken as juniors or seniors.

When I questioned my class regarding what math course they (NOT WHAT THEIR PARENTS WANTED) would like to take, they responded in this way:

1. Five students selected Algebra.
2. Seventeen students selected the Introduction to Algebra.
3. One student selected the General Math course.
4. NONE of the students declined to take math as freshmen.

I feel this brief survey demonstrated not only my feelings about the success of this program, but also attitudes and feelings of the students.

During the past two years I have had numerous contacts by parents expressing their surprise and pleasure at the attitudes and successes their children have had in math. One incident which I recall quite vividly was a call I received this spring (1968). A father called to ask me for the secret to my success with his daughter. It seemed she had not been the most highly motivated student in any of her courses with the exception of math. I had to confess his daughter's success and attitude in math was primarily due to the program being presented.

At the end of the first year of this study I had made a statement regarding my philosophy as a teacher. I stated that previous to teaching this class I had felt that whether a student liked or disliked either myself or math was irrelevant. I had felt the relationship between teacher and student should be very rigid and formal. Presently, my philosophy of teaching has changed a great deal because of my experience in this program and I must say it has been for the better. As evidence of this change I offer a comment by my principal during one of my evaluation sessions with him. He stated he had witnessed a change in me since the initiation of this program. He further stated he felt this change had made me a much more effective teacher.

I know because of my experience with this program a growth as a teacher has been in evidence and most importantly, I know the students who have participated have benefited a great deal as well.

APPENDIX 4

SCALE DESCRIPTIONS -- SMSG MATHEMATICS INVENTORY, FORM SC

SM11 NUMBERS-RATIONAL (14 items) This scale is intended to measure understanding of the terminology, notation, and structure of the rational numbers.

EXAMPLE: Which of the following it not the reciprocal of 3.76?

(A) $\frac{1}{3.76}$ (D) $\frac{50}{188}$

(B) $3\frac{1}{76}$ (E) $\frac{25}{94}$

(C) $\frac{10}{37.6}$

SM12 NUMBERS-PROBLEMS (5 items) This scale is intended to measure ability to solve applied problems without the use of algebra.

EXAMPLE: A ball club has won 4 of the 8 games already played. If it wins the next two games, what percent of the games played will it then have won?

(A) 40 (B) 50 (C) 60 (D) 75 (E) 80

SM13 ALGEBRA-SENTENCES 1 (6 items) This scale is intended to measure ability to use an algebraic sentence in solving a problem. The items are designed to be accessible to eighth grade students who have not had a formal course in algebra.

EXAMPLE: One solution of the equation $x^2 - 729 = 0$ is 27. The other solution is

(A) 702 (D) 23

(B) -27 (E) -23

(C) 0

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SM14 <u>ALGEBRA-TRANSLATION 1</u> (4 items) This scale is designed to measure ability to interpret an algebraic sentence and to formulate an algebraic sentence from a verbal sentence.

EXAMPLE: Which one of the following equations expresses the condition that <u>the product of two numbers R and S is one less than twice their sum</u>?

(A) $2(R \times S) - 1 = R + S$

(B) $(R \times S) = 2(R + S) - 1$

(C) $(R \times S) = 2(R + S) + 1$

(D) $(R \times S) - 1 = 2(R + S)$

(E) None of these

SM15 <u>GEOMETRY-MEASUREMENT</u> (7 items) This scale is intended to measure ability to solve problems pertaining to length and area which do not require the use of standard measurement formulas.

EXAMPLE: In a certain triangle, the shortest side is t inches. The longest side is twice the length of the shortest side, and the third side is 6 inches shorter than the longest side. What is the perimeter in inches?

(A) $5t - 6$ (D) $4t + 6$

(B) $4t - 6$ (E) $t - 6$

(C) $3t + 6$

SCALE DESCRIPTIONS -- SMSG OPINION INVENTORY, FORM SC

AT1 <u>MATHEMATICS vs. NON-MATHEMATICS</u> (8 items) This scale is designed to measure how well a student likes mathematics and considers it important in relation to other school subjects.

I like story books ________ than mathematics books.

(A) a lot more (C) a little less

(B) a little more (D) a lot less

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AT2 MATHEMATICS FUN vs. DULL (4 items) This scale is designed to measure the pleasure or boredom a student experiences with regard to mathematics both in an absolute sense and comparatively with other subjects.

Mathematics is fun.

(A) strongly agree (D) disagree
(B) agree (E) strongly disagree
(C) don't know

AT3 PRO-MATHEMATICS COMPOSITE (11 items) The scale is designed to measure general attitude toward mathematics. It is an overall scale including items drawn from scales AT1, AT2, and AT4 and other items not used in these scales.

I can get along perfectly well in everyday life without mathematics.

(A) strongly agree (D) disagree
(B) agree (E) strongly disagree
(C) don't know

AT4 MATHEMATICS EASY vs. HARD (9 items) This scale is designed to measure the ease or difficulty which a student associates with mathematics performance.

No matter how hard I try, I cannot understand mathematics.

(A) strongly agree (D) disagree
(B) agree (E) strongly disagree
(C) don't know

AT5 IDEAL MATHEMATICS SELF-CONCEPT (8 items) This scale is designed to measure how a child wishes he were in his relationship to mathematics.

I wish it were easier for me to talk in front of my mathematics class.

(A) strongly agree (D) mildly disagree
(B) agree (E) disagree
(C) mildly agree (F) strongly disagree

AT6 FACILITATING ANXIETY 1 (9 items) This scale is designed to measure the degree to which mathematics achievement performance is facilitated by stressful conditions (e.g., examinations).

I keep my mathematics grades up mainly by doing well on the big tests rather than on homework and quizzes.

(A) always (D) hardly ever
(B) usually (E) never
(C) sometimes

AT7 DEBILITATING ANXIETY 1 (10 items) This scale is designed to measure the degree to which mathematics achievement performance is harmed by stressful conditions (e.g., examinations).

When I have been doing poorly in mathematics, my fear of a bad grade keeps me from doing my best.

(A) never (D) usually
(B) hardly ever (E) always
(C) sometimes

AT8 ACTUAL MATHEMATICS SELF-CONCEPT (8 items) This scale is designed to measure how a child sees himself in relation to mathematics.

I find it hard to talk in front of my mathematics class.

(A) strongly agree (D) mildly disagree
(B) agree (E) disagree
(C) mildly agree (F) strongly disagree

APPENDIX 5

INITIAL MEASURES BY GROUPS

	EXPERIMENTAL (N = 235)		CONTROL (N = 116)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.
SEX*	1.49	0.50	1.50	0.50
I.Q.	100.83	10.67	101.89	11.66
COMP.**	45.86	10.05	46.72	9.99
APPL.**	54.05	13.49	56.50	13.92
SMSG 1	2.08	1.58	2.30	1.53
SMSG 2	3.35	1.81	3.41	1.99
SMSG 3	1.66	1.30	1.86	1.44
SMSG 4	3.56	1.74	3.83	1.88
SMSG 5	0.73	0.83	0.71	0.83
ATT. 1	20.39	4.40	19.91	5.76
ATT. 2	13.17	4.21	13.09	4.39
ATT. 3	33.56	5.40	31.76	6.79
ATT. 4	24.68	6.03	24.31	6.78
ATT. 5	35.51	5.64	34.48	6.83
ATT. 6	24.77	5.46	24.68	6.29
ATT. 7	29.79	6.61	29.00	7.43
ATT. 8	27.85	6.34	28.54	7.46

*Boy = 1 Girl = 2

**These scores have been multiplied by 10 for programming purposes.

APPENDIX 6

ANALYSIS OF VARIANCE -- INITIAL SCORES

UNIVARIATE ANOVA ON -- SEX

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	.00	1	.00	.00
WITHIN	79.00	314	.25	
TOTAL	79.00	315		

UNIVARIATE ANOVA ON -- STUDENT IQ

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	74.85	1	74.85	.62
WITHIN	37873.18	314	120.62	
TOTAL	37948.03	315		

UNIVARIATE ANOVA ON -- PRE COMP

SOURCF OF VARIATION	SS	DF	MS	F
BETWEEN	49.00	1	49.00	.48
WITHIN	34566.31	341	101.37	
TOTAL	34615.30	342		

UNIVARIATE ANOVA ON -- PRE APPL

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	376.77	1	376.77	2.02
WITHIN	63677.87	341	186.74	
TOTAL	64054.65	342		

UNIVARIATE ANOVA ON -- PRE-SMSG 1

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	2.47	1	2.47	1.01
WITHIN	833.72	341	2.44	
TOTAL	836.19	342		

UNIVARIATE ANOVA ON -- PRE-SMSG 2

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	.44	1	.44	.12
WITHIN	1208.29	341	3.54	
TOTAL	1208.73	342		

UNIVARIATE ANOVA ON -- PRE-SMSG 3

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	3.19	1	3.19	1.75
WITHIN	621.25	341	1.82	
TOTAL	624.44	342		

UNIVARIATE ANOVA ON -- PRE-SMSG 4

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	3.90	1	3.90	1.22
WITHIN	1092.55	341	3.20	
TOTAL	1096.44	342		

UNIVARIATE ANOVA ON -- PRE-SMSG 5

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	.02	1	.02	.02
WITHIN	237.77	341	.70	
TOTAL	237.78	342		

UNIVARIATE ANOVA ON -- PRE-ATTI 1

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	17.30	1	17.30	.72
WITHIN	8156.70	341	23.92	
TOTAL	8174.00	342		

UNIVARIATE ANOVA ON -- PRE-ATTI 2

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	.33	1	.33	.02
WITHIN	6196.73	341	18.17	
TOTAL	6197.06	342		

UNIVARIATE ANOVA ON -- PRE-ATTI 3

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	247.89	1	247.89	7.03
WITHIN	12018.14	341	35.24	
TOTAL	12266.03	342		

UNIVARIATE ANOVA ON -- PRE-ATTI 4

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	11.19	1	11.19	.29
WITHIN	13185.67	341	38.67	
TOTAL	13196.86	342		

UNIVARIATE ANOVA ON -- PRE-ATTI 5

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	93.97	1	93.97	2.63
WITHIN	12196.03	341	35.77	
TOTAL	12290.00	342		

UNIVARIATE ANOVA ON -- PRE-ATTI 6

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	4.10	1	4.10	.14
WITHIN	10260.90	341	30.09	
TOTAL	10265.00	342		

UNIVARIATE ANOVA ON -- PRE-ATTI 7

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	65.76	1	65.76	1.46
WITHIN	15340.64	341	44.99	
TOTAL	15406.40	342		

UNIVARIATE ANOVA ON -- PRE-ATTI 8

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	36.02	1	36.02	.80
WITHIN	15444.01	341	45.29	
TOTAL	15480.03	342		

APPENDIX 7

STEPWISE REGRESSION - Year 2

1. Dependent Variable -- Post Comp.

Independent Variables	Mult. R	Increase in RSQ
Pre Comp.	0.4841	0.2343
Pre Appl.	0.5367	0.0538
Pre SMSG 1	0.5557	0.0207
Pre SMSG 4	0.5690	0.0150
Pre SMSG 5	0.5739	0.0056

2. Dependent Variable -- Post Appl.

Independent Variables	Mult. R	Increase in RSQ
Pre Appl.	0.5645	0.3187
Pre SMSG 1	0.5820	0.0201
Student IQ	0.5925	0.0124
Pre SMSG 5	0.5990	0.0077

3. Dependent Variable -- SMSG 11

Independent Variables	Mult. R	Increase in RSQ
Pre Appl.	0.3810	0.1452
Pre SMSG 1	0.4318	0.0413
Pre SMSG 5	0.4453	0.0118

4. Dependent Variable -- SMSG 12

Independent Variables	Mult. R	Increase in RSQ
Pre Appl.	0.3407	0.1161

5. Dependent Variable -- SMSG 13

Independent Variables	Mult. R	Increase in RSQ
Pre SMSG 1	0.2425	0.0588
Student IQ	0.2928	0.0269
Pre SMSG 5	0.3067	0.0083

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6. Dependent Variable -- SMSG 14

Independent Variables	Mult. R	Increase in RSQ
Pre Appl.	0.1624	0.0264
Pre SMSG 5	0.1892	0.0094
Pre SMSG 1	0.2120	0.0091
Pre Comp.	0.2366	0.0110

7. Dependent Variable -- SMSG 15

Independent Variables	Mult. R	Increase in RSQ
Pre Appl.	0.1462	0.0214

APPENDIX 8

ANALYSIS OF VARIANCE

UNIVARIATE ANOVA ON -- STUDENT IQ

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	-0.38	1	-0.38	-0.00
WITHIN	31472.37	252	124.89	
TOTAL	31472.00	253		

UNIVARIATE ANOVA ON -- PRE COMP

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	14.12	1	14.12	0.14
WITHIN	25718.50	252	102.06	
TOTAL	25732.62	253		

UNIVARIATE ANOVA ON -- PRE APPL

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	5.81	1	5.81	0.03
WITHIN	42897.44	252	170.23	
TOTAL	42903.25	253		

UNIVARIATE ANOVA ON -- PRE SM1

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	0.01	1	0.01	0.00
WITHIN	629.66	252	2.50	
TOTAL	629.67	253		

UNIVARIATE ANOVA ON -- PRE SM4

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	2.55	1	2.55	0.83
WITHIN	777.49	252	3.09	
TOTAL	780.05	253		

UNIVARIATE ANOVA ON -- PRE SM5

SOURCE OF VARIATION	SS	DF	MS	F
BETWEEN	0.12	1	0.12	0.18
WITHIN	174.73	252	0.69	
TOTAL	174.85	253		

APPENDIX 9

ANALYSIS OF COVARIANCE

DEPENDENT VARIABLE -- POST COMP 3

RAW SCORE REGRESSION WEIGHTS				
VARIABLE	GROUP 1	GROUP 2	POOLED	TOTAL
I.Q.	-0.01	0.17	0.05	0.06
PRE COMP	0.58	0.44	0.53	0.53
PRE APPL	0.14	0.17	0.17	0.18
PRE SM1	1.68	1.00	1.43	1.46
PRE SM4	1.91	0.74	1.50	1.35
PRE SM5	-1.30	-1.62	-1.35	-1.45
RSQ	0.39	0.29	0.36	0.33
R	0.63	0.54	0.60	0.58
F	18.50	4.78	23.02	20.40

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
Regression	21497.70	6.	3582.95	22.18
Treatment Means	4002.16	1.	4002.16	24.77
Heterogeneity of Regression	610.48	6.	101.75	0.63
Error	38777.47	240.	161.57	
TOTAL	64887.81	253.		

DEPENDENT VARIABLE -- POST APPL 3

RAW SCORE REGRESSION WEIGHTS				
VARIABLE	GROUP 1	GROUP 2	POOLED	TOTAL
I.Q.	0.11	0.33	0.18	0.18
PRE COMP	0.15	0.15	0.14	0.14
PRE APPL	0.68	0.36	0.60	0.60
PRE SM1	1.11	1.44	1.36	1.37
PRE SM4	-0.28	0.11	-0.05	-0.08
PRE SM5	3.40	-1.21	2.04	2.02
RSQ	0.43	0.25	0.37	0.36
R	0.66	0.50	0.60	0.60
F	21.37	3.92	23.64	23.51

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
Regression	29775.45	6.	4962.57	23.62
Treatment Means	172.35	1.	172.35	0.82
Heterogeneity of Regression	1542.70	6.	257.12	1.22
Error	50423.51	240.	210.10	
TOTAL	81914.00	253.		

DEPENDENT VARIABLE -- SMSG 11

RAW SCORE REGRESSION WEIGHTS				
VARIABLE	GROUP 1	GROUP 2	POOLED	TOTAL
I.Q.	-0.01	0.04	0.01	0.01
PRE COMP	0.02	0.01	0.01	0.01
PRE APPL	0.03	0.03	0.04	0.04
PRE SM1	0.22	0.18	0.22	0.22
PRE SM4	0.08	-0.01	0.05	0.03
PRE SM5	-0.02	-0.66	-0.23	-0.24
RSQ	0.23	0.29	0.22	0.21
R	0.48	0.54	0.46	0.46
F	8.62	4.62	11.32	10.84

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
Regression	169.92	6.	28.32	11.43
Treatment Means	22.66	1.	22.66	9.14
Heterogeneity of Regression	27.97	6.	4.66	1.88
Error	594.63	240.	2.48	
TOTAL	815.17	253.		

DEPENDENT VARIABLE -- SMSG 12

RAW SCORE REGRESSION WEIGHTS				
VARIABLE	GROUP 1	GROUP 2	POOLED	TOTAL
I.Q.	-0.01	0.02	0.00	0.00
PRE COMP	-0.00	0.00	-0.00	-0.00
PRE APPL	0.03	0.01	0.03	0.03
PRE SM1	-0.04	0.02	-0.02	-0.02
PRE SM4	0.06	0.03	0.06	0.06
PRE SM5	0.02	-0.09	-0.01	-0.01
RSQ	0.15	0.13	0.13	0.13
R	0.39	0.37	0.35	0.35
F	5.19	1.77	5.88	5.91

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
Regression	35.90	6.	5.98	5.92
Treatment Means	0.74	1.	0.74	0.73
Heterogeneity of Regression	6.95	6.	1.16	1.15
Error	242.46	240.	1.01	
TOTAL	286.05	253.		

DEPENDENT VARIABLE -- SMSG 13

RAW SCORE REGRESSION WEIGHTS				
VARIABLE	GROUP 1	GROUP 2	POOLED	TOTAL
I.Q.	0.01	0.02	0.01	0.01
PRE COMP	-0.00	0.00	-0.00	-0.00
PRE APPL	0.00	0.00	0.01	0.01
PRE SM1	0.16	-0.02	0.11	0.11
PRE SM4	0.02	0.04	0.03	0.03
PRE SM5	-0.09	-0.22	-0.13	-0.12
RSQ	0.12	0.10	0.10	0.10
R	0.35	0.31	0.32	0.32
F	4.03	1.21	4.60	4.58

SOURCE OF VARIATION	AJD. SS	DF	ADJ. MS	F
Regression	24.22	6.	4.04	4.55
Treatment Means	1.06	1.	1.06	1.19
Heterogeneity of Regression	3.59	6.	0.60	0.68
Error	213.09	240.	0.89	
TOTAL	241.969	253.		

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DEPENDENT VARIABLE -- SMSG 14

RAW SCORE REGRESSION WEIGHTS				
VARIABLE	GROUP 1	GROUP 2	POOLED	TOTAL
I.Q.	0.01	-0.00	0.01	0.00
PRE COMP	-0.01	-0.01	-0.01	-0.01
PRE APPL	0.00	0.02	0.01	0.01
PRE SM1	0.10	-0.01	0.06	0.06
PRE SM4	0.04	0.02	0.03	0.03
PRE SM5	-0.16	-0.02	-0.12	-0.12
RSQ	0.08	0.10	0.06	0.06
R	0.28	0.32	0.25	0.25
F	2.34	1.30	2.69	2.68

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
Regression	11.94	6.	1.99	2.67
Treatment Means	0.37	1.	0.37	0.49
Heterogeneity of Regression	4.21	6.	0.70	0.94
Error	179.03	240.	0.75	
TOTAL	195.55	253.		

DEPENDENT VARIABLE -- SMSG 15

RAW SCORE REGRESSION WEIGHTS				
VARIABLE	GROUP 1	GROUP 2	POOLED	TOTAL
I.Q.	0.00	0.00	0.00	0.00
PRE COMP	-0.00	-0.03	-0.01	-0.01
PRE APPL	0.01	0.02	0.01	0.01
PRE SM1	0.11	-0.04	0.06	0.06
PRE SM4	0.03	0.09	0.05	0.04
PRE SM5	0.01	0.10	0.05	0.05
RSQ	0.05	0.08	0.04	0.04
R	0.22	0.29	0.19	0.19
F	1.38	1.06	1.58	1.54

SOURCE OF VARIATION	ADJ. SS	DF	ADJ. MS	F
Regression	13.31	6.	2.22	1.54
Treatment Means	2.54	1.	2.54	1.76
Heterogeneity of Regression	7.40	6.	1.23	0.86
Error	345.72	240.	1.44	
TOTAL	368.97	253.		

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APPENDIX 10

MEAN SMSG-SCALES-SPRING 1968

	Experimental	Control
SMSG-11	4.13	4.76
SMSG-12	1.35	1.21
SMSG-13	1.17	1.03
SMSG-14	0.83	0.75
SMSG-15	1.95	2.16

APPENDIX 11

STEPWISE REGRESSION - Year 1

1. Dependent Variable -- Post Comp.

Independent Variables	Mult. R	Mult. R^2	Increase in R^2
Pre Comp.	.67	.45	.45
Pre SMSG 4	.72	.51	.06
Pre Appl.	.73	.53	.02
Days Abs.	.74	.54	.01
Pre SMSG 1	.74	.55	.01
Pre Att 6	.75	.56	.01

2. Dependent Variable -- Post Appl.

Independent Variables	Mult. R	Mult. R^2	Increase in R^2
Pre. Appl.	.72	.51	.51
Reading	.74	.54	.03
Pre Att 2	.75	.56	.02
Pre SMSG 4	.76	.57	.01

3. Dependent Variable -- Post SMSG 1

Independent Variables	Mult. R	Mult. R^2	Increase in R^2
Pre Appl.	.43	.18	.18
Pre SMSG 1	.50	.25	.07
Reading	.53	.28	.03
Pre Att 4	.54	.29	.01
Pre Att 7	.56	.31	.02

4. Dependent Variable -- Post SMSG 2

Independent Variables	Mult. R	Mult. R^2	Increase in R^2
Pre SMSG 4	.30	.09	.09
Pre SMSG 2	.36	.13	.04
Pre SMSG 3	.40	.16	.03
I Q	.43	.18	.02

5. Rep. Variable -- Post SMSG 4

Independent Variables	Mult. R	Mult. R^2	Increase in R^2
Pre SMSG 4	.48	.23	.23
Reading	.54	.29	.06
Pre SMSG 1	.56	.32	.03

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APPENDIX 12

MATHEMATICS GRADES, FIRST QUARTER - FRESHMAN YEAR

	A	B	C	D	F	Total
Experimental Group						
Algebra	0	4	16	13	0	33
Intro. to Algebra	0	5	25	37	20	87
General Math	0	0	0	2	2	4
Fundamentals	0	2	2	4	2	10
No Math						48
Control Group						
Algebra	2	4	3	2	1	12
Intro. to Algebra	2	5	11	18	2	38
General Math	1	1	7	7	1	17
Fundamentals	1	6	16	14	4	41
No Math						9