A STUDY COMPARING ATTITUDES TOWARD MATHEMATICS OF SMSG AND TRADITIONAL ELEMENTARY SCHOOL STUDENTS

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DEDICATION

This study, a humble tribute, is dedicated to Dr. James H. Zant, retiring June 30, 1963. His untiring efforts to improve the position of public school mathematics in Oklahoma will be felt by students and teachers for years to come.

PREFACE AND ACKNOWLEDGMENTS

The purpose of this study was to investigate and compare the attitudes toward mathematics of a group of SMSG mathematics students and a group of traditional arithmetic students. Also, an indication of the two groups creative ability was secured and compared.

Special gratitude is expressed to Dr. James H. Zant, Dr. Edwin E. Vineyard, Dr. James E. Frasier, Dr. Robert A. Hultquist, and Mrs. Helen M. Jones for their valuable guidance and assistance as members of the advisory committee.

I am also indebted to the workers at the Oklahoma State University Computing Center; the responding students who made the study possible; the administrators and teachers in the schools surveyed; and to the following for their help in overcoming specific hurdles involved in the study: Dr. Robert Morrison of the Statistics Department at Oklahoma State University; Dr. Wilbur H. Dutton of the University of California, Los Angeles, for his kindness in allowing me to use the attitude scale developed by him; and Dr. Robert C. Fite of the Oklahoma State University Division of Arts and Sciences Extension for financial assistance rendered during the course of the study.

I am especially indebted to those who gave the most encouragement and sacrificed the most in order for this study to be made, my children and my wife, Mary.

J. P.

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CHAPTER I

THE PROBLEM

Introduction

The world today demands more mathematical knowledge on the part of more people than did the world of yesterday, and the world of tomorrow will make still greater demands. The society of today leans more and more heavily on science and technology. More citizens need to be skilled in mathematics, and the role of mathematics should be more clearly defined as a criterion of good citizenship. Since no one can predict the skills in mathematics needed for success in a given profession, it is important that mathematics be taught today so that students may make adjustments in mathematical knowledge and skills which the future will surely demand.

To achieve this objective, many writing groups have been formed over the past few years. The common ground of these groups seems to be the formulation of curriculum materials which offer students not only the basic mathematical skills but also a deeper understanding of the basic concepts and structures of mathematics.

How are these new materials accepted by the students in our schools today? Do the students achieve more readily and to a higher degree? How do these new curriculum materials compare with the traditional materials in scope and content? The writer of the present study

will consider one of the above aspects of learning and the materials of one of the various writing groups.

This study is concerned with the effect the methods and materials of the School Mathematics Study Group[1] and traditional arithmetic have upon the attitudes of elementary students toward mathematics. A subsidiary concern is the indication of creative thinking ability given by the students.

Statement of the Problem

Stated in hypothetical form, the specific problem is that there exists no significant difference in attitude toward mathematics between a selected group of SMSG students and a group of traditional arithmetic students. The study also investigates whether intelligence, sex, and grade level are variables which indicate significant differences in attitude.

The inclusion of a word fluency question investigates the creative ability of the students and seeks an indication as to whether the different methods and materials, intelligence, sex, and grade level are variables which influence significant differences in creativity.

Scope

This study involves a survey of stated attitudes of 623 students from twenty-four classes. The classes were selected from twelve schools in seven different cities in the general geographical area of

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[1]Hereinafter designated by SMSG. See page 7 of this study for definition.

Oklahoma State University.[2] Twelve of the classes are now studying their second year of the SMSG materials and twelve are classes with no experience in an organized modern program in mathematics.

Limitations

Several limiting factors are apparent in the present study. Since the variables considered in this study are limited to mathematics type, sex, I. Q., and grade level, certain restrictions, as discussed below, must be imposed on the findings and conclusions of the study.

The influence the teacher has on a student's attitude was a major concern and this concern was borne out by research cited in Chapter II. To minimize this influence, the relatively large number of classes was used with correspondingly large number of teachers. However, it should be noted that older research found that teachers exert little effect on the attitude of their students. Manske reports:

> We find, first of all, that pupils rarely significantly reflect the attitudes of their teachers. To those who believe that teachers must be the responsible instruments for fashioning social institutions, this finding will indicate the inefficiency of their present-day bearers of arms.[3]

The total number of students is viewed as limited. Although the traditional students outnumber the SMSG students by 361 to 262, these unequal samples are not regarded as being of major consequence. Snedecor, on groups with different numbers of individuals, states:

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[2]See Appendix B for complete listing of schools and cities.

[3]Arthur J. Manske, The Reflection of Teacher's Attitudes in the Attitudes of Their Pupils, (Columbia University, 1936), p. 51.

> There is no necessity that the two groups be of the same size. In much experimentation it is inconvenient to provide equal numbers of individuals...[4]

However, parts of the statistical analysis are based on a random sample taken from the total data. This procedure allowed the analysis to be made using equal subclass numbers and is explained fully in Chapter IV.

A basic assumption in the present study is that the group interview-questionnaire method, employed to collect the data, did establish the proper rapport to promote free and honest responses from the subjects. As Thurstone states:

> All that we can do with an attitude scale is to measure the attitude actually expressed with the full realization that the subject may be consciously hiding his true attitude or that the social pressure of the situation has made him really believe what he expresses. This is a matter for interpretation. It is something probably worthwhile to measure an attitude expressed by opinions. It is another problem to interpret in each case the extent to which the subjects have expressed what they really believe. All that we can do is to minimize as far as possible the conditions that prevent our subjects from telling the truth, or else to adjust our interpretations accordingly.[5]

Although the data will be analyzed for significance with conclusions drawn from this analysis, all aspects of this study pertaining to creativity are severely limited due to the brevity of the measuring instrument. However, the implications of the results of the creative ability question are far too interesting and provocative to ignore and therefore are included. Interpretations based on these results must be made cautiously.

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[4]George W. Snedecor, Statistical Methods, (Ames, 1946), p. 80.

[5]Louis L. Thurstone, The Measurement of Values, (The University of Chicago Press, 1959), p. 218.

In addition to the foregoing discussion of limits, the writer realizes others exist and the following partially enumerates the total factors affecting the study.

1. No attempt has been made to compare attitude and achievement.
2. No attempt has been made to ascertain the reasons for favorable or unfavorable attitudes.
3. The study has been limited to a small geographical area.

In summary, one must assume that variations exist in the students themselves, in the quality of instruction, in the subject matter content within each group, in the prevailing educational philosophies of the schools from which the samples were drawn, and in the philosophy of the home in which the students have spent most of their lives. Such variations certainly affect the findings of the present study and must be considered when forming conclusions based hereon. However, the effect of such variations of individuals is reduced when the data from the group made up by the individuals is treated statistically. Thus acceptable measures of group performance are obtained. As Wert, Neidt, and Ahmann present:

> The inability to obtain precise measures of human characteristics is a limiting factor whenever the purpose is for counseling an individual, but is a consideration of less importance in research studies involving groups of individuals. Generalizations may be drawn concerning group reaction which are entirely tenable for a group but which would be extremely dubious if applied to any individual within the group.[6]

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[6]James E. Wert, C. O. Neidt, and J. S. Ahmann, Statistical Methods in Educational and Psychological Research. New York: Appleton-Century-Crofts, Incorporated, 1954.

Significance of the Study

The search for those factors which influence achievement in school work comprises an important segment of educational research. Achievement is a component of a productive society; and underachievement is a waste of human resources no society can afford. The determination of such influential factors is the first step in the effective conservation of human abilities. Many studies of mathematical achievement have been conducted; and these have been moderately successful in yielding information useful to those working in the field of curriculum development and other educational areas. In general, however, these studies deal mainly with the achievement of traditional mathematics students and materials and have not afforded the factor of attitude the importance it warrants.

> Discussion of attitudes has come into prominence in late years in educational literature. This has involved the explicit inclusion in the program of the schools of certain objectives, which, while difficult to obtain, are increasingly being regarded as among the most important educational goals. Although the term "attitude" is relatively new as a specific designation, schools have always had ideals and purposes which could have appropriately been classified under such a name. Whereas formerly these aims were regarded as by-products, to be realized automatically, the significant feature today is the attempt to analyze what is meant by these attitudes and to develop instructional procedures that will achieve what is desired.[7]

Working in a pilot study for the Wisconsin Improvement Program, Kaprelian says:

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[7]The Place of Mathematics in Secondary Education, National Council of Teachers of Mathematics, 15th yearbook, (Columbia University, 1940), p. 26.

> The instruments used for measuring the arithmetic competence of children have been, for the most part, various standardized achievement tests. Only during the past few decades, however, has it been recognized that a test of children's attitudes toward arithmetic can be a valuable tool in determining the arithmetic progress of children. There is now reason to believe that the feelings of a pupil toward a subject have a definite bearing on his achievement in the subject. [8]

It is recognized by all concerned that the task of improving the school mathematics curriculum is a never-ending job. Indeed, this is true of all phases of the educational framework. Therefore, values obtained from studies of this type may well provide information which can be used by teachers, administrators, parents, and others in making their own evaluations of the various mathematics programs. It is reasonable to assume that this study, subject to the specified limitations, will supply information previously lacking in the comparative attitudes of SMSG and traditional students.

Clarification of Terms

Selected terms used in this study are defined as follows:

Attitude. The inclinations, feelings, ideas, fears, and convictions of a person about any specific topic will be construed as that person's attitude toward that topic. [9]

SMSG. Common usage predicated the writer's decision to use the initials in this report rather than write out School Mathematics Study Group each time reference is made.

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[8] George Kaprelian, "Attitudes Toward a Television Program-Patterns in Arithmetic," The Arithmetic Teacher, Vol. 8, December, 1961, p. 408.

[9] Louis L. Thurstone, The Measurement of Values, (The University of Chicago Press, 1950), p. 216.

The SMSG project began in the summer of 1958 under the direction of Professor E. G. Begle of Yale University. The goal of the study group was to write textbooks in mathematics for use in the public elementary and high schools. The textbooks themselves were to emphasize the principles and structures of mathematics. The discovery technique was also a goal SMSG sought to inculcate in the materials of study.

SMSG Group. Those students now studying their second year of SMSG materials will be designated, in this report, as the SMSG group.

Traditional Group. Those students who have not studied an organized sequence of any modern program in mathematics will be designated as the traditional group.

Modern Programs in Mathematics. These terms shall indicate methods and curriculum materials developed by the various writing groups with the emphasis of the textbooks upon meaning and understanding of fundamental concepts. Some of the writing groups are, in addition to SMSG, the Ball State Program, the Maryland Project, and the University of Illinois Committee on School Mathematics.

Mathematics-Arithmetic. In this study, mathematics and arithmetic will be denoted by mathematics. This is justified by the fact that arithmetic, for the most part, is operations and computations with the positive integers which are basic to our total mathematical system. However, it should be noted that in administering the survey instrument, both arithmetic and mathematics were used. This was motivated by the familiarity of the SMSG students with the term "mathematics" while the traditional students were more accustomed to the term "arithmetic."

Significant Difference. This common statistical terminology is used often and precisely defined seldom. In this study, significant difference

means that two certain quantities differ by more than can reasonably be attributed to chance variation.

Higher I. Q. Group. Those students surveyed in this report having an I. Q. of 110 or above, as measured by the Otis Quick Scoring Mental Ability Tests, will be designated as the higher I. Q. group.

Lower I. Q. Group. Those students having an I. Q. below 110, as measured by the Otis Tests, will be designated as the lower I. Q. group.

Overview of the Thesis

In Chapter I the writer has attempted to present the nature of the study and give the general hypothesis to be tested. In addition, the scope and limitations have been discussed together with assumptions present in the statistical procedure.

The significance of the study has endeavored to expose the need for the study and to identify some of the stimuli motivating the writer in the inception of this project.

Chapter II will be a report of selected related literature. Although no studies were found attempting a comparison of the two types of mathematics in an attitude sense, some were related in various ways.

Chapter III will describe in detail the specific hypotheses to be tested, the measuring instruments employed, the selection of the subjects of the study, and the procedure for gathering the data.

The content of Chapter IV will be a presentation of the data and an analysis of results obtained. Tables and illustrative devices will be used to enable the reader to grasp quickly the significance the different factors have upon the attitudes of the students. An analysis of variance will allow the writer to hold some of the variables constant

while testing others and also allow for interaction among the variables. In this way, tests of significance will be presented based on sound statistical procedure.

Chapter V will summarize the objectives, the findings, and the conclusions of this study.

CHAPTER II

SELECTED RELATED LITERATURE

No studies were found within the published literature pertaining to the field of attitudes of elementary students in a modern program of mathematics. This particular discovery was viewed as an advantage to the writer in that perhaps the present study is original. However, many of the studies present interesting and valuable information concerning the comparison of SMSG and traditional mathematics and will be reviewed in this chapter. Also, many studies were found on attitudes of traditional students toward mathematics and the relationship of attitudes and other factors toward achievement.

In general, the writer will present the related literature in the two major areas, attitudes toward traditional mathematics of students at the approximate grade level as the subjects of this study, and comparative studies of SMSG and traditional elementary mathematics. Also, selected literature on creative ability will be presented.

Studies Related to Attitudes Toward Mathematics

In a study concerned with the type of junior high school mathematics programs which would stimulate interest in mathematics, Ray[1]

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[1]John James Ray, "A Longitudinal Study of the Effects of Enriched and Accelerated Programs on Attitude Toward and Achievement in Eighth Grade Mathematics and Ninth Grade Algebra" (Unpublished Doctoral Dissertation, Indiana University, 1961).

found that students taking enriched work with written reports feel they have a better chance to express their ideas in mathematics. The enriched program students did not feel projects gave them more of a chance to do independent and creative work; they did, however, like the opportunity oral reports gave them to express their ideas.

Mathematics, in common with all other subjects, is responsible for the social, personal, and moral attitudes of students. Since we teach no course entitled "attitudes," nor should we, this phase of teaching is shared by all. Attitudes can be derived from experiences with mathematics. Teachers foster attitudes in mathematics by the methods and materials they use. In many cases, the idea persists that high achievers also have the more positive attitude toward mathematics. However, a study by Cleveland[2] disputes this claim. He employed the Dutton[3] Attitude Scale to determine that no significant difference in attitude existed between high and low achievers in sixth grade arithmetic. Harrington[4] also reports no significant relationship between attitude toward and performance in a selected mathematics course. In the same study, it was found that teachers are the most influential factors toward forming student attitudes.

Since the literature seems to favor the position that teachers do

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[2]Gerald Arthur Cleveland, "A Study of Certain Psychological and Sociological Characteristics as Related to Arithmetic Achievement" (Unpublished Doctoral Dissertation, Syracuse University, 1961).

[3]See Appendix A for complete scale.

[4]Lester Garth Harrington, "Attitudes Toward Mathematics and the Relationship Between Such Attitudes and Grade Obtained in a Freshman Mathematics Course" (Unpublished Doctoral Dissertation, University of Florida, 1960).

influence attitudes of students, the writer of the present study investigated several reports of teachers' attitudes toward mathematics.

In a study to determine if the attitudes of elementary students surveyed in 1954 had changed, Dutton[5] tested a group of college students in teacher training eight years later. The 1962 subjects were enrolled in undergraduate school and were majoring in elementary education. Practically all had taken Algebra I and II and Geometry in high school, and had completed a lower division arithmetic course and a methods in teaching arithmetic course in college. The main findings of the study are:

1. The attitudes of students toward arithmetic in 1954 were almost identical with attitudes held by students in the 1962 sampling. Two conclusions on this finding seem warranted: (a) these students are the product of a type of teaching which was based upon mechanical, drill procedures; (b) instruction in the teaching of arithmetic at the university level (even when students identified their attitude toward arithmetic) did not change the attitudes held by these students. Will teaching experience and in-service educational programs change the attitudes of teachers who have unfavorable attitudes toward arithmetic?

2. Many students have ambivalent feelings toward arithmetic. The extremes, students with either very positive or very negative attitudes toward arithmetic, are exceptions to the rule.

3. There was not enough evidence found in this study to indicate any pronounced improvement in the instructional programs of public and private elementary schools directed toward the development of positive attitudes of pupils toward arithmetic. Prospective elementary school teachers reflect attitudes developed in a traditionally oriented arithmetic program.

4. Attitudes toward arithmetic, once developed, are tenaciously held by prospective elementary school teachers. Continued efforts to redirect the negative attitudes of these students

[5]Wilbur H. Dutton, "Attitudes of Junior High School Pupils Toward Arithmetic," School Review, Volume 64, January, 1956, pp. 18-22.

into constructive channels have not been very effective. While the best antidote is probably improved teaching in each elementary school grade, continued study should be made of changing negative attitudes toward arithmetic at the university level and through in-service instruction while doing regular classroom teaching.

5. The aspects of arithmetic liked and disliked by prospective school teachers remained approximately the same between 1954 and 1962.[6]

Responses in the same study showed that while feelings toward arithmetic are developed in all the grades, the most crucial years seem to be between grades four and eight.[7] Some of the findings reported by Stright[8] show that a teacher's educational background, recent training, age, or years of experience make no significant difference in attitude toward the teaching of arithmetic, nor of the attitude of the children in the group. All of the teachers surveyed thought arithmetic was of great value and most reported they enjoyed teaching arithmetic.

The meaningful approach to teaching arithmetic is not the result of recent space explorations. This concept has been accepted by educators for more than a decade. Our number system has basic structures which have been the foundations of instruction of many of the better arithmetic teachers. The acceptance of the meaningful approach has been based largely upon psychological premises since experimental

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[6]Wilbur H. Dutton, "Attitude Change of Prospective Elementary School Teachers Toward Arithmetic," The Arithmetic Teacher, December, 1962, pp. 418-424.

[7]Ibid.

[8]Virginia M. Stright, "A Study of Attitudes Toward Arithmetic of Students and Teachers in the Third, Fourth, and Sixth Grades," The Arithmetic Teacher, October, 1960, pp. 280-286.

evidence has been limited until the past two or three years. More evidence is needed to substantiate, or to denounce practices in teaching of arithmetic.

Lyda and Morse[9] used three sections of a fourth grade class to determine if twenty-one planned periods of "meaningful" instruction had any effect upon the attitudes and achievement of the students. The Dutton arithmetic Scale, the Stanford Arithmetic Achievement Test, and the Otis Mental Ability Test were administered both before and after the special instruction; with different forms of the achievement and I. Q. tests used in the pre and post testing. Conclusions of the study implied that when meaningful methods of teaching arithmetic are used, changes in attitude take place. Negative attitudes become positive, and positive attitudes are enhanced. Also, associated with meaningful methods of teaching arithmetic and changes in attitude are significant gains in arithmetic achievement.

An attempt to identify certain factors characteristic of the student possessing a high degree of quantitative understanding in arithmetic concluded, among others, the following statements.

1. There is a significant sex difference in favor of boys on the measure of quantitative understanding utilized. Neither general intelligence nor computational skill account for this difference. It would seem important, therefore, to ensure that the instructional program in arithmetic consider such sex differences as are thought to exist in the areas of interests, attitudes, personality, etc., that may affect the direction and quality of learning.

2. Attitudes toward arithmetic do not provide a reliable index of the level of quantitative understanding. It seems clear

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[9]Wesley J. Lyda and Evelyn Clayton Morse, "Attitudes, Teaching Methods, and Arithmetic Achievement," The Arithmetic Teacher, March, 1963, pp. 258-262.

the content must be developed on the basis of meaning and significance to the learner rather than on the basis of palatability.

3. Substantial relationships exist among the several arithmetic achievements measured and general intelligence. However, the considerable variability shown by individual achievement profiles is evidence of the apparent lack of any "general" arithmetic ability. [10]

Stephens[11] recommends, after a study of attitudes and achievement of junior high school arithmetic students, that the Dutton attitude scale be used to provide another criterion for admission to an accelerated arithmetic class. She also proposes that sixth grade students, with high ability and achievement records, but with low attitude scores, be counseled and placed in seventh grade classes in keeping with the indication of attitude.

Studies Comparing SMSG and Traditional Mathematics

New developments in mathematics that have application in the elementary schools are rare indeed. What, then, is meant by modern programs in arithmetic? Do these programs truly surpass the traditional program in quality and teachability? Do the students achieve to a higher degree? A comparative study of SMSG and traditional students indicates little difference in achievement due to the mathematics, sex, or teacher preparation between the high and low ability groups.

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[10] Robert D. Muscio, "Factors Related to Quantitative Understanding in the Sixth Grade," (Unpublished Doctoral Dissertation, University of California, Berkeley, 1959).

[11] Lois Stephens, "Comparisons of Attitudes and Achievement Among Junior High School Mathematics Classes," The Arithmetic Teacher, November, 1960, pp. 351-356.

> In general this study leads to the questioning of the claims of superiority of the SMSG text-materials. If the tests used in measuring the outcomes are considered valid for this purpose, the traditional materials must be accorded the more effective label. Some advantages for SMSG at the lower level seemed to be indicated.
>
> While not significant, the results seemed to support studies finding boys superior in mathematics.
>
> There was no evidence that institute training for teachers gave the teacher any advantage over other teachers who were otherwise well-trained.[12]

In direct contrast to the preceding report, Ruddell draws the following conclusions from a study of four modern mathematics seventh-grade classes.

1. In no instance did the control group score significantly higher than the experimental group; whereas, the experimental group scored significantly higher on five of the sixteen basic analyses.

2. In every test of a hypothesis the high intelligence group scored significantly higher than the low intelligence group.

3. Significant differences in favor of the high achievers on the arithmetic pretests were obtained in most instances.[13]

The general conclusion from the above findings were that children taught a program of modern mathematics will score higher on various facets of seventh-grade mathematics than students taught a traditional program. Although the four classes for the sample were accelerated students, many of the students had I. Q. and achievement scores more in keeping with a normal group. This would suggest that pupils with

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[12]Robert Vance Shuff, "A Comparative Study of Achievement in Mathematics at the 7th and 8th Grade Levels under Two Approaches, School Mathematics Study Group and Traditional," (Unpublished Doctoral Dissertation, University of Minnesota, 1962).

[13]Arden K. Ruddell, "The Results of a Modern Mathematics Program," The Arithmetic Teacher, October, 1962, pp. 330-335.

average ability could study a modern program in mathematics without suffering any mathematical loss as measured by traditional tests.

Fitzgerald[14] found a large amount of overlap or similarity in performance of children in different grades to learn mathematical concepts. He suggests the traditional school mathematics curriculum neither recognizes nor provides for the amount of variability in capacity to learn mathematics ideas. He also concludes that success in learning experimental materials is closely related to success in other school subjects and especially to performance in mathematics.

Literature Related to Creative Thinking

The motivation for the inclusion of the word fluency question was largely due to a study of creativity and intelligence authored by Getzels and Jackson.[15] The enormity of the implications of convergent and divergent thinking in relation to traditional and modern programs in mathematics would surpass many volumes if prepared in a comprehensive manner. Therefore, in keeping with the limitations stated in Chapter I of the present study, the literature related to creativity will be very selective.

The ability to rearrange and redefine materials for new purposes is an important aspect of any creative process. In fact, the very nature of experimental programs is to use materials in various ways. As long as

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[14]William Morley Fitzgerald, "A Study of Some of the Factors Related to the Learning of Mathematics by Children in Grades Five, Seven, and Nine," (Unpublished Doctoral Dissertation, University of Michigan, 1962).

[15]Jacob W. Getzels and Philip W. Jackson, Creativity and Intelligence, (New York, 1962).

teachers hold to preconceived ideas and resist flexible approaches to problem situations, they deprive themselves and their students of important adventures outside the narrow confines of conformity. "This rigidity, which finds its expression in traditional academic approaches, no longer meets a situation flexibly by redefining its meaning but adheres to a function in disregard of its meaning."[16]

Barron[17], summarizing several studies of creativity, noted that most of the recent research on creative ability and intelligence has tended to support the findings of Getzels and Jackson, that is, a highly creative group tended to achieve slightly better than a highly intelligent group (difference in average I. Q. was 23 points).

The relation of creativity and certain variables believed to be associated with the manifestation of creative ability led to several interesting applications to the present study. Among 335 eighth-grade students, creativity was seen to have a low positive relationship with social acceptance and socio-economic status.[18] Also, creativity was shown to be relatively independent of intelligence, scholastic achievement, and sex.

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[16]Victor Lowenfeld, "Current Research on Creativity," N. E. A. Journal, November, 1958, p. 540.

[17]Frank Barron, "Creativity, What Research Says About It," N. E. A. Journal, March, 1961, pp. 17-19.

[18]Eugene Miller Muss, "An Exploration of the Relationship Between Creativity and Certain Personal-Social Variables Among Eighth-Grade Pupils" (Unpublished Doctoral Dissertation, University of Maryland, 1961).

May[19] studied 718 seventh-grade students in Wisconsin and found no significant difference in creativity due to sex. He also concluded that I. Q. scores are poor predictors of creativity; and of particular interest in this report, he found that the highly creative students liked school as well as the less creative.

The single report found on creativity in relation to a modern program in mathematics was not authenticated by statistics.[20] In essence, the report attempts to acquaint teachers with some of the ideas advocated by the SMSG group and to show how the SMSG material stimulates creative thinking and discovery.

Summary

The material in this chapter has been presented as evidence to support the need for the present study. Studies were cited related to attitudes toward mathematics, comparison of achievement of SMSG and traditional students, and creativity in general.

The attitudinal studies agreed that high performance and high positive attitudes were not necessarily positively correlated. Also, teachers were found to have a strong influence on the formation of students attitudes. Evidence was presented to support the supposition that enduring student attitudes are formed between the grades of four and eight. Meaningful instruction was reported as a factor influencing

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[19]Frank Bradley May, "Creative Thinking: A Factorial Study of Seventh-Grade Children," (Unpublished Doctoral Dissertation, University of Wisconsin, 1961).

[20]Humphrey C. Jackson, "Creative Thinking and Discovery," The Arithmetic Teacher, March, 1961, pp. 107-111.

positive attitudes.

The studies reviewed were not in agreement as to whether SMSG or traditional students achieved best.

In general, the studies agreed that high creative ability is as desirable a factor as high intelligence when considering achievement of students. Also, creative ability was found to be relatively independent of sex.

Now that the gap in knowledge has been exposed by the lack of research in the area of comparative attitudes of SMSG and traditional mathematics students, the writer can examine the problem more closely.

CHAPTER III

EXPERIMENTAL METHODS AND PROCEDURES

As stated earlier, the purpose of this study is to investigate the stated attitudes toward mathematics of a selected group of SMSG and traditional students in grades five and eight. The variables of sex and intelligence are to be examined as possible factors of differentiation, and an indication of each student's creative thinking ability will be procured. The methods and procedures employed in exploring these problems are presented in this chapter.

General Design

In order to conduct the investigation, decisions regarding the following integral steps were necessary.

1. The hypotheses to be tested must be formulated.
2. The instruments, with which to assess the attitudes toward mathematics, to assess the I. Q. scores, and to determine the creativity of the students, must be chosen.
3. The subjects must be located and the data collected.
4. Statistical procedures best fitted to interpret the data must be determined.

The remainder of this chaper will discuss the steps listed above.

Hypotheses to be Tested

The specific hypotheses to be tested are stated below and are the same for grades five and eight. Each hypothesis will be tested separately for each of the two grades.

The Hypotheses are:

I. There is no significant difference in attitude toward mathematics between SMSG and traditional students.

   A. There is no difference in attitude between boys and girls within the different mathematics groupings, that is, between boys and girls in SMSG and between boys and girls in traditional.

   B. There is no difference in attitude between boys and girls overall.

   C. There is no difference in attitude between the higher and lower I. Q. groups overall.

   D. There is no difference in attitude between the higher and lower I. Q. groups within the different mathematics groupings, that is, between higher and lower I. Q. groups in SMSG and between higher and lower I. Q. groups in traditional.

The hypotheses listed under II all refer to subgroupings of the overall SMSG and traditional groups and were tested with the Duncan multiple range test.

II. There is no significant difference in attitude toward mathematics between:

   A. Higher and lower I. Q. boys in SMSG.

   B. Higher and lower I. Q. girls in SMSG.

C. Higher and lower I. Q. boys in traditional.

D. Higher and lower I. Q. girls in traditional.

E. Higher I. Q. boys in SMSG and higher I. Q. boys in traditional.

F. Higher I. Q. boys in SMSG and higher I. Q. girls in traditional.

G. Higher I. Q. girls in SMSG and higher I. Q. girls in traditional.

H. Higher I. Q. girls in SMSG and higher I. Q. boys in traditional.

I. Lower I. Q. SMSG boys and lower I. Q. traditional boys.

J. Lower I. Q. SMSG girls and lower I. Q. traditional girls.

K. Higher I. Q. traditional boys and higher I. Q. traditional girls.

L. Lower I. Q. traditional boys and lower I. Q. traditional girls.

M. Higher I. Q. boys and lower I. Q. girls in traditional.

N. Lower I. Q. boys and higher I. Q. girls in traditional.

III. There is no significant difference in creativity, as indicated by the word fluency test, between SMSG and traditional students.

A. There is no difference in creativity between boys and girls overall.

B. There is no difference in creativity between boys and girls within the different mathematics groupings.

C. There is no difference in creativity between the higher and lower I. Q. groups overall.

D. There is no difference in creativity between the higher and lower I. Q. groups within the different mathematics groupings.

The hypotheses listed under IV all refer to subgroupings of the total groups and were tested with the Duncan multiple range test. These minor hypotheses are listed below.

IV. There is no significant difference in creativity between:

A. Higher and lower I. Q. boys in SMSG.

B. Higher and lower I. Q. girls in SMSG.

C. Higher and lower I. Q. boys in traditional.

D. Higher and lower I. Q. girls in traditional.

E. Higher I. Q. boys in SMSG and higher I. Q. boys in traditional.

F. Higher I. Q. boys in SMSG and higher I. Q. girls in traditional.

G. Higher I. Q. girls in SMSG and higher I. Q. girls in traditional.

H. Higher I. Q. girls in SMSG and higher I. Q. boys in traditional.

I. Lower I. Q. SMSG boys and lower I. Q. traditional boys.

J. Lower I. Q. SMSG girls and lower I. Q. traditional girls.

K. Higher I. Q. traditional boys and higher I. Q. traditional girls.

L. Lower I. Q. traditional boys and lower I. Q. traditional girls.

M. Higher I. Q. boys and lower I. Q. girls in traditional.

N. Lower I. Q. boys and higher I. Q. girls in traditional.

Measuring Instruments

The instruments chosen with which to assess the student's attitude and intelligence were the Dutton Attitude Scale[1] and the Otis Quick-Scoring Mental Ability Tests, Beta Test, Form CM respectively.

This attitude scale was constructed by Dutton[2] in 1954 following the technique of compiling statements reflecting various feelings about mathematics and then subjecting these statements to judges for sorting. Twenty-two statements were selected, from a total list of forty-five, as representative of items showing a strong negative attitude and graduated upward to a strong positive attitude. The bases for selection were: (1) items with a low Q value were selected where the Q value is a measure of ambiguity, (2) statements were chosen to represent an adequate distribution of scale values, (3) an equal number of statements were selected to represent favorable and unfavorable feelings, and (4) two statements were selected very close to the neutral position on the scale.

The techniques of Thurstone and Chave[3] were used by Dutton to determine the scale value for each statement. Scale values assigned are graduated from 1.0 to 10.5 and these represent the extreme negative and positive attitudes respectively. The individual student marks the scale by checking only those statements with which he agrees and the

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[1]See Appendix A for the exact scale.

[2]Wilbur H. Dutton, "Measuring Attitudes Toward Arithmetic," The Elementary School Journal, September, 1954, pp. 24-31.

[3]L. L. Thurstone and E. J. Chave, The Measurement of Attitude, (University of Chicago Press, 1948).

investigator then determines the student's attitude by dividing the total of the scale values of the marked statements by the number of statements marked. It should be noted that the statements are placed on the final instrument in random order as far as scale value is concerned. The method of scoring coincides with the procedures endorsed by Remmers who states:

> By the use of a reasonably large number of items, however, and an average of the scale values of the statements endorsed by any individual as that individual's score, it has been found that this technique yields a reasonably satisfactory attitude measurement.[4]

The purpose of the Otis Beta Test, Form CM is to provide a measure of mental maturity. The test requires only a short period of time to administer and to score and consists of eighty items, including word meaning, verbal analogies, scrambled sentences, logical reasoning, number series, etc.[5] Time necessary to administer the test, including directions, is approximately 40 minutes. The score yielded is called the "Beta I. Q." by the authors and is used in the present study for the purpose of classifying the subjects into higher and lower intelligence groupings.[6]

The creative ability test consisted of one item in which the students were to give "uses" for the two commonplace objects, pencil and paper clip. Getzels and Jackson remark about this test:

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[4]H. H. Remmers, Introduction to Opinion and Attitude Measurement.(New York, 1954) pp. 90-93.

[5]The I. Q. tests were scored by the Oklahoma State University Testing Service.

[6]See page 9 of this report for definition of higher and lower I. Q. groups.

> This test was included in the creative battery because it apparently measures the subject's ability to shift frames of reference, to use the environment in an original manner. Unlike the Word Association Test, where the number of responses is limited by the universe of meanings commonly attached to the word, the Uses Test offers almost limitless opportunities for responding.[7]

Scoring this test was simply a matter of counting the number of different uses the students wrote. Repetitious uses were not allowed, nor were uses not deemed truly useful counted. For example, the response stating that pencils are to write with and pencils are to work problems with was scored as one. The response stating a pencil can be used to stick the baby and make him cry, was not counted. In most cases, the students responded to the creative statement with very interesting and ingenious answers.

Collection of the Data

The criteria for selection of the SMSG group were (1) the students be enrolled in grades five and eight, and (2) these students must now be studying the SMSG materials for their second year. The traditional students were to be (1) enrolled in grades five and eight, and (2) these students were chosen only if they had not studied any organized program of modern mathematics.

The writer is indebted to Dr. James H. Zant, Director of the National Science Foundation, Oklahoma State University, for providing the information necessary to locate schools in which the preceding criteria for selection of subjects were satisfied. Seven schools were

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[7]Jacob W. Getzels and Philip W. Jackson, Creativity and Intelligence, (New York, 1962) p. 200.

used in the investigation, these schools providing 24 classes.[8] Of the 24 classes, twelve used SMSG and materials and twelve used the traditional texts thus providing six classes of SMSG fifth grade students, six classes of SMSG eighth grade students, six classes of traditional fifth grade students, and six classes of traditional eighth grade students.

Contact with the schools was made in person by the writer and, in each case, permission to survey that particular school was given. In this initial meeting with each school administrator, samples of each instrument were explained, testing dates were set, and procedures for testing the students were outlined. It seems worthwhile to mention that all administrators and teachers contacted were most cooperative and sincerely interested in the findings of this study.

The administration of the instruments started with the writer spending a few minutes establishing rapport with the students. After making reasonably sure the proper atmosphere prevailed, the writer explained the tests in general and then in detail regarding marking, identification, grade, sex, etc. The only identification necessary was a number on the attitude scale and a corresponding number on the I. Q. test. The creative ability question was included at the bottom of the attitude scale. In every case, the teacher was invited to leave for a "break" and in nearly all cases this happened. However, the students were told that their responses to the attitude scale would only be seen by the writer and any response made would have no effect whatsoever on their grades. In addition, the writer asked that each student cover his responses with a blank paper to partially control the tendency of

[8]See Appendix B for complete identification.

"best friends" answering alike. The investigator then read the attitude statements aloud with the students reading silently. After each statement, a short time was given for thought, then each student checked the statement if he agreed and left it blank if he did not agree. If the students were uncertain, they were instructed to leave the statement unchecked. A typical statement on the scale is "I enjoy doing problems when I know how to work them well." This statement was one which drew a high percentage of agreement from all groups.

The students responded to the creative ability question, following the last statement on the attitude scale, in this manner. The writer allowed time to check the last attitude statement and then firmly instructed the students to turn the paper over. After explaining the word fluency test, the writer allowed three minutes for responses. The attitude and creative ability tests were then passed forward to the writer and subsequently became part of the survey data.

The I. Q. tests were given immediately following the creative question and these were administered as instructed by the Otis manual. The total time for execution of the three instruments was about seventy minutes.

After the data was collected, the writer scored the attitude and creative ability tests while the I. Q. tests were scored by the Oklahoma State University Testing Service. Classification of the data by mathematics, sex, and I. Q. was then accomplished and statistical procedures for analysis were chosen.

Statistical Methods

The classifications involving sex, intelligence, and mathematics type necessitated using a method of statistical analysis allowing the investigator to control part of the factors while testing the others. In this manner possible sources of bias are controlled and the demands of sound experimental design are met. The method used was the analysis of variance of heirarchical classification involving several factors.

> Factorial experiments are used in practically all fields of research. They are great value in exploratory work where little is known concerning the optimum levels of the factors, or even which ones are important.[9]

A statistical procedure was also employed allowing comparison of each subgroup mean with every other subgroup mean. This allowed the investigator to test such groupings as lower I. Q. SMSG girls with higher I. Q. traditional boys. While hypotheses involving all such groupings were not stated, the more important of these factorial comparisons were tested and will be reported. The statistical method allowing such comparisons is Duncan's new multiple range test.[10]

It was believed that the method of selection of subjects, the instruments employed, and the methods of statistical analysis were all within the limits of scientific research. The writer thereby proceeded with the analysis of the data obtaining the results presented in Chapter IV.

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[9]Robert G. D. Steel and James H. Torrie, Principles and Procedures of Statistics, McGraw-Hill, New York, 1960, p. 195.

[10]Ibid. pp. 107-109.

CHAPTER IV

RESULTS OF THE STUDY

In this chapter the data concerning the attitudes and creative ability of the students are presented as determined from the results of the survey instruments. First the attitudes in general, as indicated by the more significant responses and interpreted by percentages, are presented. Then the tests of hypotheses showing comparative attitudes and creative abilities of the two groups are presented as indicated by the analyses of variances and the multiple range test. The means and difference of the means of attitude and creative ability are presented as indicated in the various groupings.

Frequency of Responses

Presentation of the frequency of the responses was deemed to be most meaningful when the responses were represented as percentages of the subgroups. This decision was prompted by the unequal sub-class numbers as shown by Tables I and II.

TABLE I

TOTAL POPULATION AND MEAN I. Q. OF GRADE FIVE STUDENTS CLASSIFIED BY MATHEMATICS, SEX, AND I. Q. [1]

Math	Total	Boys		Total Boys	Girls		Total Girls	Total Higher	Total Lower	Overall Mean I. Q.
		Higher I. Q.	Lower I. Q.		Higher I. Q.	Lower I. Q.				
SMSG	114	34	20	54	34	26	60	68	46	112.7
Traditional	180	25	61	86	43	51	94	68	112	107.4

TABLE II

TOTAL POPULATION AND MEAN I. Q. OF GRADE EIGHT STUDENTS CLASSIFIED BY MATHEMATICS, SEX, AND I. Q. [1]

Math	Total	Boys		Total Boys	Girls		Total Girls	Total Higher	Total Lower	Overall Mean I. Q.
		Higher I. Q.	Lower I. Q.		Higher I. Q.	Lower I. Q.				
SMSG	148	41	25	66	67	15	82	108	40	112.6
Traditional	181	35	57	92	38	51	89	73	108	105.2

[1] Based on Otis.

Responses by Sex Groupings[2]

The greatest disparity indicated by the sex groupings on statement one was between the traditional grade 5 girls (83%) and traditional grade 8 girls (29%). This statement indicates the practicality of mathematics by the solving of problems outside of school.

Lack of confidence in mathematics was the tenor of statement two and drew the highest percentage of endorsement from both the SMSG and traditional grade 8 girls (63%). The grade 5 SMSG boys showed the highest rate of disagreement (33%).

Paradoxically, a greater percentage of the SMSG groups endorsed statement five than did the traditional groups. Statement five is: "I like arithmetic because it is practical;" and the SMSG materials purportedly do not emphasize practicality.

Over 88% of all groupings thought mathematics was as important as any other subject with the SMSG grade 8 boys showing the highest percent of endorsement (97%).

Fear of mathematics is indicated by statement eleven, and the students endorsed this with a range of from 2% (grade 5 traditional girls) to 19% (grade 8 traditional girls).

Extreme dislike, as denoted by statement thirteen which says: "I detest arithmetic and avoid using it at all times," was shown by 4% of the grade five SMSG boys, 8% of the grade five SMSG girls, 22% of grade five traditional boys, 10% of the grade five traditional girls, 5% of

[2]See Tables III and IV for total scale responses by sex.

the grade eight SMSG boys, 4% of the grade eight SMSG girls, 11% of the grade eight traditional boys, and 10% of the grade eight traditional girls.

Knowing how to do problems well elicited a favorable response from all groupings with the lowest percent of agreement being 86 percent.

Extreme liking for mathematics was indicated by statement sixteen and, in general, was favored more by the grade five students than by the eighth graders. Thirty-eight percent of the grade five SMSG girls endorsed statement sixteen while only six percent of grade eight SMSG girls agreed. These represented the high and low percentages of agreement.

Statement eighteen (I am afraid of doing word problems) responses indicated that the SMSG students have much more confidence in solving written problems than do the traditional students. Percentages of seventeen and three represent the degree of endorsement of the SMSG grade five boys and girls, respectively; while the traditional fifth grade boys and girls agreed by 23% and 21%, respectively. The grade eight SMSG boys and girls agreed by 17% and 29%, respectively; while the traditional eight grade boys and girls agreed by 38% and 51%, respectively.

The results of the responses quoted in this section are, in general, in agreement with previous studies with respect to grade eight students; however, disagreements with previous studies do occur in the grade five sex groupings. Percentages of sex grouping endorsements for the total scale are shown in Tables III and IV for grades five and eight respectively.

TABLE III

PERCENTAGES OF GRADE FIVE SMSG AND TRADITIONAL BOYS AND GIRLS RESPONDING TO ATTITUDE STATEMENTS

No.	Attitude Statement (Scale Value in Parentheses)	Percent SMSG		Percent Traditional	
		Boys	Girls	Boys	Girls
1.	I think about problems outside of school and like to work them out. (9.5)	65	68	44	83
2.	I don't feel sure of myself in arithmetic. (3.7)	33	40	57	41
3.	I enjoy seeing how rapidly I can work arithmetic. (8.6)	72	87	65	79
4.	I like arithmetic, but I like other subjects as well. (5.6)	70	73	62	73
5.	I like arithmetic because it is practical. (7.7)	85	77	68	83
6.	I don't think arithmetic is fun, but I always want to do well in it. (4.6)	48	35	73	55
7.	I am not enthusiastic about arithmetic, but I have no real dislike for it either. (5.3)	67	55	78	65
8.	Arithmetic is as important as any subject. (5.9)	94	93	88	94
9.	Arithmetic is something you have to do even though it is not enjoyable. (3.3)	48	50	78	71
10.	Sometimes I enjoy the challenge presented by an arithmetic problem. (7.0)	91	92	65	71
11.	I have always been afraid of arithmetic. (2.5)	7	8	13	2
12.	I would like to spend more time in school working arithmetic. (9.0)	41	53	24	46
13.	I detest arithmetic and avoid using it at all times. (1.0)	4	8	22	10
14.	I enjoy doing problems when I know how to do them well. (6.7)	93	97	86	89
15.	I avoid arithmetic because I am not very good with figures. (3.2)	13	10	26	6
16.	Arithmetic thrills me, and I like it better than any other subject. (10.5)	33	38	22	28
17.	I never get tired of working with numbers. (9.8)	35	60	24	53
18.	I am afraid of doing word problems. (2.0)	17	3	23	21
19.	Arithmetic is very interesting. (8.1)	87	92	66	81
20.	I have never liked arithmetic. (1.5)	4	7	16	5
21.	I think arithmetic is the most enjoyable subject I have taken. (10.4)	37	45	21	32
22.	I can't see much value in arithmetic.	7	5	7	3

TABLE IV

PERCENTAGES OF GRADE EIGHT SMSG AND TRADITIONAL BOYS AND GIRLS RESPONDING TO ATTITUDE STATEMENTS

No.	Attitude Statement (Scale Value in Parentheses)	Percent SMSG		Percent Traditional	
		Boys	Girls	Boys	Girls
1.	I think about problems outside of school and like to work them out. (9.5)	50	54	37	29
2.	I don't feel sure of myself in arithmetic. (3.7)	53	63	46	63
3.	I enjoy seeing how rapidly I can work arithmetic. (8.6)	73	72	62	62
4.	I like arithmetic, but I like other subjects as well. (5.6)	88	79	62	75
5.	I like arithmetic because it is practical. (7.7)	74	68	62	63
6.	I don't think arithmetic is fun, but I always want to do well in it. (4.6)	61	51	68	61
7.	I am not enthusiastic about arithmetic, but I have no real dislike for it either. (5.3)	74	55	63	67
8.	Arithmetic is as important as any subject. (5.9)	97	94	90	94
9.	Arithmetic is something you have to do even though it is not enjoyable (3.3)	74	65	70	64
10.	Sometimes I enjoy the challenge presented by an arithmetic problem. (7.0)	74	83	58	65
11.	I have always been afraid of arithmetic. (2.5)	14	13	13	19
12.	I would like to spend more time in school working arithmetic. (9.0)	21	38	18	19
13.	I detest arithmetic and avoid using it at all times. (1.0)	5	4	11	10
14.	I enjoy doing problems when I know how to do them well. (6.7)	95	94	86	89
15.	I avoid arithmetic because I am not very good with figures. (3.2)	12	15	23	18
16.	Arithmetic thrills me, and I like it better than any other subject. (10.5)	27	6	20	15
17.	I never get tired of working with numbers. (9.8)	12	15	11	20
18.	I am afraid of doing word problems. (2.0)	17	29	38	51
19.	Arithmetic is very interesting. (8.1)	76	65	52	65
20.	I have never liked arithmetic. (1.5)	6	6	12	9
21.	I think arithmetic is the most enjoyable subject I have taken. (10.4)	12	4	16	15
22.	I can't see much value in arithmetic. (3.0)	3	4	3	8

Responses by I. Q. Groupings[3]

The statement: "I don't feel sure of myself in arithmetic was endorsed by 63% of the traditional lower I. Q. grade eight students. This was the approximate percentage of the grade eight SMSG lower I. Q. group (60%), but is a much higher percent of agreement than the fifth grade SMSG higher I. Q. group indicated (28%).

"I like arithmetic because it is practical" again drew highest percentage of agreement from an SMSG group. This time the lower I. Q. fifth graders agreed by 83% and the higher I. Q. traditional fifth graders agreed by 82%. Lowest rate of agreement came from the traditional eighth grade lower I. Q. group (60%).

"Arithmetic is as important as any other subject" reflected the respect all the groups had for mathematics by their extremely high rate of endorsement (88% to 97%).

The challenge presented by a mathematics problem was enjoyed least by the grade eight traditional lower I. Q. group (48%). Both higher I. Q. groups in the eighth grade did enjoy this challenge as signified by their 81% agreement. However, the grade five SMSG students responded most favorably; the higher group had 91% agreement and the lower group agreed by 89%.

Statement eleven (I have always been afraid of arithmetic) motivated some interesting comparisons. None of the traditional grade five higher I. Q. students endorsed this statement; while only 10% of the higher I. Q. traditional eighth graders agreed. These percents are

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[3]See Tables V and VI for total scale responses by I. Q. groups.

contrasted against the corresponding SMSG group's endorsements of 7% and 12% respectively. However, the lower I. Q. traditional groups did endorse the statement by a higher percentage than did the corresponding SMSG groups.

Detest for mathematics (statement 13) was endorsed most by the traditional lower I. Q. groups (both 17%). This was in contrast to the higher I. Q. traditional eight graders who agreed by only one percent. However, none of the grade five SMSG higher group or the grade eight SMSG lower group endorsed this statement.

Ambivalent feelings were indicated by all groups with the high rate of endorsement of statement 14 (I enjoy doing problems when I know how to do them well).

Forty-nine percent of the lower I. Q. SMSG fifth-graders indicated that they were thrilled by mathematics and liked it better than any other subject. This same grouping in the eighth grade agreed by only 5%, while in the higher SMSG groups little variation was noted. The higher traditional groups recorded the least variation from fifth to eighth grades, however, with the fifth graders agreeing by 22% and the eighth grade by 21%.

As in the sex groupings, the SMSG students recorded the least fear of word problems (statement 18) with the lower I. Q. groups in both SMSG and traditional exhibiting the most fear.

Complete representation of the total responses of the I. Q. groupings are shown in Tables V and VI for grades five and eight, respectively.

TABLE V

PERCENTAGES OF GRADE FIVE SMSG AND TRADITIONAL HIGHER AND LOWER I. Q. GROUPS RESPONDING TO ATTITUDE STATEMENTS

No.	Attitude Statement (Scale Value in parenthesis)	Percent SMSG Higher	Percent SMSG Lower	Percent Traditional Higher	Percent Traditional Lower
1.	I think about problems outside of school and like to work them out. (9.5)	60	74	75	58
2.	I don't feel sure of myself in arithmetic. (3.7)	28	49	37	56
3.	I enjoy seeing how rapidly I can work arithmetic. (8.6)	78	81	81	67
4.	I like arithmetic, but I like other subjects as well. (5.6)	75	66	68	68
5.	I like arithmetic because it is practical. (7.7)	77	83	82	72
6.	I don't think arithmetic is fun, but I always want to do well in it. (4.6)	34	51	63	64
7.	I am not enthusiastic about arithmetic, but I have no real dislike for it either. (5.3)	59	62	81	65
8.	Arithmetic is as important as any subject. (5.9)	93	94	97	88
9.	Arithmetic is something you have to do even though it is note enjoyable. (3.3)	38	64	74	75
10.	Sometimes I enjoy the challenge presented by an arithmetic problem. (7.0)	91	89	75	64
11.	I have always been afraid of arithmetic. (2.5)	7	9	0	12
12.	I would like to spend more time in school working arithmetic. (9.0)	41	55	37	35
13.	I detest arithmetic and avoid using it at all times. (1.0)	0	15	15	17
14.	I enjoy doing problems when I know how to do them well. (6.7)	94	94	90	87
15.	I avoid arithmetic because I am not very good with figures. (3.2)	10	13	6	21
16.	Arithmetic thrills me, and I like it better than any other subject. (10.5)	26	49	22	27
17.	I never get tired of working with numbers. (9.8)	41	57	46	36
18.	I am afraid of doing word problems. (2.0)	6	15	15	27
19.	Arithmetic is very interesting. (8.1)	88	89	81	70
20.	I have never liked arithmetic. (1.5)	3	9	6	13
21.	I think arithmetic is the most enjoyable subject I have taken. (10.4)	29	57	20	29
22.	I can't see much value in arithmetic.	3	11	0	8

TABLE VI

PERCENTAGES OF GRADE EIGHT SMSG AND TRADITIONAL HIGHER AND LOWER I. Q. GROUPS RESPONDING TO ATTITUDE STATEMENTS

No.	Attitude Statement (Scale Value in Parenthesis)	Percent SMSG Higher	Percent SMSG Lower	Percent Traditional Higher	Percent Traditional Lower
1.	I think about problems outside of school and like to work them out. (9.5)	51	60	45	25
2.	I don't feel sure of myself in arithmetic. (3.7)	58	60	41	63
3.	I enjoy seeing how rapidly I can work arithmetic. (8.6)	71	78	79	50
4.	I like arithmetic, but I like other subjects as well. (5.6)	81	88	77	63
5.	I like arithmetic because it is practical. (7.7)	69	79	66	60
6.	I don't think arithmetic is fun, but I always want to do well in it. (4.6)	57	50	51	74
7.	I am not enthusiastic about arithmetic, but I have no real dislike for it either. (5.3)	63	65	63	67
8.	Arithmetic is as important as any subject. (5.9)	98	88	95	91
9.	Arithmetic is something you have to do even though it is not enjoyable. (3.3)	67	75	56	74
10.	Sometimes I enjoy the challenge presented by an arithmetic problem. (7.0)	81	73	81	48
11.	I have always been afraid of arithmetic. (2.5)	12	18	10	20
12.	I would like to spend more time in school working arithmetic. (9.0)	28	38	23	16
13.	I detest arithmetic and avoid using it at all times. (1.0)	5	0	1	17
14.	I enjoy doing problems when I know how to do them well. (6.7)	94	95	93	83
15.	I avoid arithmetic because I am not very good with figures. (3.2)	12	18	10	28
16.	Arithmetic thrills me, and I like it better than any other subject. (10.5)	19	5	21	14
17.	I never get tired of working with numbers. (9.8)	14	13	14	17
18.	I am afraid of doing word problems. (2.0)	20	33	34	51
19.	Arithmetic is very interesting. (8.1)	67	78	65	54
20.	I have never liked arithmetic. (1.5)	5	8	4	15
21.	I think arithmetic is the most enjoyable subject I have ever taken. (10.4)	6	10	19	13
22.	I can't see much value in arithmetic. (3.0)	4	3	4	6

Findings

Since the procedure of this study was to take the total classroom, in each case as the unit of sampling, disproportionate groupings occurred.[4] While this was not taken to be a serious defect[5] in the study, a sampling procedure to allow equal subclass numbers was evolved and executed in conjunction with members of the Statistics Department of Oklahoma State University. After the data was transferred to the punch cards for the computing machines, a random sample of the cards was drawn giving equal numbers of students in each classification. The analyses of variance were then computed on the International Business Machine 650.

Motivation for the sampling was primarily due to the need for comparison of the mean of a particular subgroup with the mean of any other subgroup. This is possible with the Duncan test when equal numbers of replicates are used, but has not been validated for unequal numbers in any test investigated by the writer.

Analyses of Variance Results

The analysis of variance revealed that a significant difference in attitude toward mathematics exists at the .05 level of confidence between the grade five SMSG students and the grade five traditional students. This difference was due to a more positive attitude by the SMSG students. No interaction between sex and mathematics or between I. Q.

[4]See Tables I and II, p. 33.

[5]See Snedecor, p. 4, Chapter I.

and mathematics was found. However, a difference at the .10 level of confidence was found to exist between boys and girls within the separate mathematics groupings and a difference at the .05 confidence level was found between boys and girls overall. These differences were due to the fact that the girls stated more positive attitudes than did the boys. This was found to be true in both the traditional and SMSG classes and was tested more sensitively with the Duncan test. The Duncan test results are reported later in this chapter with the exact groupings causing the differences precisely identified. The analysis of variance for the grade five attitudes is shown in Table VII.[6]

TABLE VII

ANALYSIS OF VARIANCE FOR GRADE FIVE ATTITUDE SCORES

Source	df	SS	MS	
Total	159	205.23		----
Mathematics	1	6.87	6.87	5.69*
Sex in Mathematics	2	7.01	3.51	2.90
Sex	1	6.28	6.28	5.19*
Sex X Mathematics	1	.73	.73	.60
I. Q. in Sex in Mathematics	4	7.88	1.97	1.63
I. Q.	1	1.87	1.87	1.54
I. Q. X Sex	1	2.13	2.13	1.76
I. Q. X Mathematics	1	3.86	3.86	3.19
I. Q. X Sex X Mathematics	1	.03	.03	.02
Within	152	183.47	1.21	

*Significant at .05 level of confidence.

[6]Throughout this study the writer will use * and ** to mean significance at the .05 level and the .01 level respectively.

No significant difference in attitude toward mathematics between the SMSG and traditional eighth grades was revealed by the analysis. However, a difference at the .10 confidence level was found between the boys and girls overall and was deemed worthy of note since the difference was caused by the grade eight girls. This was directly opposite the findings in grade five. The analysis showing all the tests for significance, is shown as in Table VIII.

TABLE VIII

ANALYSIS OF VARIANCE FOR GRADE EIGHT ATTITUDE SCORES

Source	df	SS	MS	F
Total	119	153.64	----	----
Mathematics	1	2.33	2.33	1.81
Sex in Mathematics	2	4.13	2.07	1.60
Sex	1	3.71	3.71	2.90[1]
Sex X Mathematics	1	.42	.42	.33
I. Q. in Sex in Mathematics	4	3.24	.81	.60
I. Q.	1	.02	.02	.01
I. Q. X Sex	1	.19	.19	.15
I. Q. X Mathematics	1	3.02	3.02	2.36
I. Q. X Sex X Mathematics	1	.01	.01	.00
Within	112	143.95	1.28	----

[1]Significant at the .10 level.

Creative ability of the SMSG and traditional grade five students was only significant at the .10 level for mathematics alone. However, a significant difference (.01 confidence level) was found in the I. Q. groupings. The extensiveness of this difference is shown by Table IX and is due to a pronounced superiority in creativity of the high I. Q. groups.

TABLE IX

ANALYSIS OF VARIANCE FOR GRADE FIVE

CREATIVITY SCORES

Source	df	SS	MS	F
Total	159	308.40	----	----
Mathematics	1	6.40	6.40	3.60[1]
Sex in Mathematics	2	3.40	1.70	.90
Sex	1	2.50	2.50	1.41
Sex X Mathematics	1	.90	.90	.51
I. Q. in Sex in Mathematics	4	29.60	7.40	4.18**
I. Q.	1	25.60	25.60	14.46**
I. Q. X Sex	1	.40	.40	.23
I. Q. X Mathematics	1	.00	.00	.00
I. Q. X Sex X Mathematics	1	3.60	3.60	2.03
Within	152	269.00	1.77	----

**Significant at .01 level of confidence

[1]Significant at .10 level.

The eighth grade analysis revealed significant differences in creativity. These differences were attributed both to the mathematics (.01 level of confidence) alone and to I. Q. (.01 level of confidence). The SMSG students scored significantly higher on the creativity question than did the traditional students and the higher I. Q. students, in agreement with the grade five analysis, scored significantly higher than did the lower I. Q. students. The I. Q. differences were also significant within the mathematics groupings, that is, the higher and lower SMSG students scored significantly different, and the higher I. Q. traditional students scored significantly higher than did the lower I. Q. traditional students. These findings are summarized in Table X.

TABLE X

ANALYSIS OF VARIANCE FOR GRADE EIGHT CREATIVITY SCORES

Source	df	SS	MS	F
Total	119	320.33	-----	-----
Mathematics	1	33.08	33.08	15.31**
Sex in Mathematics	2	4.08	2.04	.94
Sex	1	.42	.42	.19
Sex X Mathematics	1	3.66	3.66	1.69
I. Q. in Sex in Mathematics	4	41.03	10.26	4.74**
I. Q.	1	35.30	35.30	16.34**
I. Q. X Sex	1	1.30	1.30	.60
I. Q. X Mathematics	1	4.42	4.42	2.04
I. Q. X Sex X Mathematics	1	.01	.01	.00
Within	112	242.14	2.16	-----

** Significant at the .01 level of confidence

Duncan Test Results for Grade Five Attitudes

The Duncan multiple range test revealed a significant difference in attitude toward mathematics at the .05 level of confidence between the grade five SMSG lower I. Q. boys and the grade five traditional lower I. Q. boys. The SMSG lower I. Q. boys assigned significantly higher attitude scores than did the traditional group (mean value of 6.88 compared to a mean value of 6.04).

Traditional higher I. Q. boys differed significantly (.05 level) in attitude with traditional higher I. Q. girls in grade five. The boy's mean score was 6.31 compared to 7.10 for the girls.

The most significant difference (.01 level) found in the comparison of these subgroups was between the traditional lower I. Q. boys (mean value 6.04) and the traditional higher I. Q. girls (mean value 7.10). The complete comparison by the Duncan test is shown in Table XI with

capital letters denoting the subgroups.

TABLE XI

DUNCAN TEST COMPARISONS OF GRADE FIVE MEAN ATTITUDE SCORES

	Subgroup	Mean Attitude Score	Significantly Differs With	Confidence Level	No Difference Between
A.	SMSG higher I. Q. Boys	6.57			B, C, D, E, F, G, H
B.	SMSG lower I. Q. Boys	6.87	F	.05	C, D, E, G, H
C.	SMSG higher I. Q. Girls	7.04	F	.05	D, E, G, H
D.	SMSG lower I. Q. Girls	6.93	F	.05	E, G, H
E.	Traditional higher I. Q. Boys	6.31	G	.05	F, H
F.	Traditional lower I. Q. Boys	6.04	G	.01	H
G.	Traditional higher I. Q. Girls	7.10	H	.05	
H.	Traditional lower I. Q. Girls	6.32			

Duncan Test Results for Grade Eight Attitudes

In agreement with the analysis of variance for grade eight attitudes, no significant differences were found between any of the groupings in the eighth grade. However, the means of each of the subgroups will be presented later in this chapter for comparative purposes.

Duncan Test Results for Grade Five Creativity

Significant differences were found between the higher and lower I. Q. groupings in grade five creativity scores in many of the possible comparisons. The most significant difference (. 01 level) was found between the SMSG higher I. Q. (mean score 4. 35) and the traditional lower I. Q. boys (mean score 2. 90). Also significant at the . 01 level of confidence was the difference between the SMSG higher I. Q. boys and the traditional lower I. Q. girls. Twenty-eight different comparisons are possible using the eight means and considering two at a time, therefore presentation of only those interpretive to the findings of the analysis of variance are included in the text of this report. All comparisons possible, with those significantly different identified, are presented in Table XII.

TABLE XII

DUNCAN TEST COMPARISONS OF GRADE FIVE CREATIVITY SCORES

Subgroup	Mean Creativity Score	Significantly Differs With	Confidence Level	No Difference Between
A. SMSG higher I. Q. boys	4. 35	F, H	. 01	B, C, D, E, G
B. SMSG lower I. Q. boys	3. 15	A	. 05	C, D, E, F, G, H
C. SMSG higher I. Q. girls	4. 05	B, F, H	. 05	D, E, G
D. SMSG lower I. Q. girls	3. 65			E, F, G, H
E. Traditional higher I. Q. boys	3. 50			F, G, H
F. Traditional lower I. Q. boys	2. 90			G, H
G. Traditional higher I. Q. girls	4. 10	B, F, H	. 05	
H. Traditional lower I. Q. girls	3. 10			

Duncan Test Results for Grade Eight Creativity

Pronounced differences were recorded between the SMSG higher and lower I. Q. boys. Their respective creativity mean scores of 5.80 and 4.13 gave a difference significant at the .01 level of confidence. The SMSG higher I. Q. girls (mean score 6.07) differed at the .01 confidence level from the traditional higher I. Q. and lower I. Q. girls (mean scores of 4.27 and 3.80, respectively). The mean score (6.07) of the SMSG higher I. Q. girls also gave significant differences (at .05 level of confidence) when compared to the mean scores of the SMSG lower I. Q. girls (4.80) and the traditional higher I. Q. boys (4.73). All comparisons yielding significant differences and otherwise are presented in Table XIII.

TABLE XIII

DUNCAN TEST COMPARISONS OF GRADE EIGHT CREATIVITY SCORES

	Subgroup	Mean Creativity Score	Significantly Differs With	Confidence Level	No Difference Between
A.	SMSG higher I.Q. boys	5.80	B, F, G, H	.01	C, D, E
B.	SMSG lower I.Q. boys	4.13			D, E, F, G, H
C.	SMSG higher I.Q. girls	6.07	B, F, G, H	.01	D, E
D.	SMSG lower I.Q. girls	4.80	C	.05	E, F, G, H
E.	Traditional higher I.Q. boys	4.73	C	.05	F, G, H
F.	Traditional lower I.Q. boys	3.80			G, H
G.	Traditional higher I.Q. girls	4.27			H
H.	Traditional lower I.Q. girls	3.80			

Tests of Hypotheses for Grade Five and Grade Eight Attitudes

Based on the analyses of variances, the null hypotheses[7] are rejected or not rejected as follows:

Hypothesis I. There is no significant difference in attitude toward mathematics between SMSG and traditional students.

Grade five SMSG students responded significantly higher than did the traditional students, therefore, at the grade five level, hypothesis I was rejected at the .05 level of confidence.

There was no significant difference reported by the eighth grade students, and hypothesis I was not rejected.

Hypothesis I-A. There is no difference in attitude between boys and girls overall.

This hypothesis was rejected at the .05 level for the fifth grade. Girls stated more favorable attitudes than did the boys in grade five. However, in the eighth grade, the boys were only slightly more favorably inclined toward mathematics than were the girls. Hypothesis I-A was not rejected in the eighth grade group.

Hypothesis I-B. There is no difference in attitude between boys and girls within the different mathematics groupings.

As shown by the analyses of variances, no significant difference existed between the boys in SMSG and the girls in SMSG. This was also true for girls and boys in traditional mathematics. Hypothesis I-B was not rejected in either grade.

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[7]See Tables XIV and XV, pp. 57 and 58 for summary of rejected and not rejected hypotheses.

Hypothesis I-C. There is no difference in attitude between the higher and lower I. Q. groups overall.

This hypothesis was not rejected in either grade five or grade eight. The I. Q. grouping seemed to have almost no effect on the student's attitudes.

Hypothesis I-D. There is no difference in attitude between the higher and lower I. Q. groupings within the different mathematics groupings.

No difference was found, and hypothesis I-D was not rejected in either grade.

The minor hypotheses listed under (II) were tested and recorded as follows. There is no significant difference in attitude between:

Hypothesis II-a. Higher and lower I. Q. boys in SMSG.

This statement was found to be true in both grades, hence hypothesis II-a was not rejected.

Hypothesis II-b. Higher and lower I. Q. girls in SMSG. Hypothesis II-b was not rejected.

Hypothesis II-c. Higher and lower I. Q. boys in traditional. Hypothesis II-c was not rejected.

Hypothesis II-d. Higher and lower I. Q. girls in traditional. The higher I. Q. traditional fifth grade girls (mean score . 05 level) differed significantly from the lower I. Q. traditional fifth grade girls (mean score 6. 32). Hypothesis II-d was rejected in the fifth grade but was not rejected in the eighth.

Hypothesis II-e. Higher I. Q. boys in SMSG and higher I. Q. boys in traditional. Hypothesis II-3 was not rejected in either grade.

Hypothesis II-f. Higher I. Q. boys in SMSG and higher I. Q. girls in traditional. Hypothesis II-f was not rejected in either grade.

Hypothesis II-g. Higher I. Q. girls in SMSG and higher I. Q. girls in traditional. Hypothesis II-g was not rejected in either grade.

Hypothesis II-h. Higher I. Q. girls in SMSG and higher I. Q. boys in traditional. Hypothesis II-h was not rejected in either grade.

Hypothesis II-i. Lower I. Q. SMSG boys and lower I. Q. traditional boys. These subgroups differed at the .05 level of confidence in the fifth grade but did not differ in the eighth grade. Hypothesis II-i was rejected in the fifth grade only.

Hypothesis II-j. Lower I. Q. SMSG girls and lower I. Q. traditional girls. Hypothesis II-j was not rejected in either grade.

Hypothesis II-k. Higher I. Q. traditional boys and higher I. Q. traditional girls.

A significant difference (.05 level of confidence) was found between the girls (mean score 7.10) and boys (mean score 6.31) in the fifth grade traditional class. No difference was found at the eighth grade level. Hypothesis II-k was rejected for the fifth grade.

Hypothesis II-l. Lower I. Q. traditional boys and lower I. Q. traditional girls.

No difference was found for hypothesis II-l in either grade, hence it was not rejected.

Hypothesis II-m. Higher I. Q. boys and lower I. Q. girls in the traditional group. Hypothesis II-m was not rejected in either grade.

Hypothesis II-n. Lower I. Q. boys and higher I. Q. girls in the traditional group.

No difference was found in the eighth grade. However, very significant (.01 level of confidence) differences were found in grade five favoring the girls. Hypothesis II-n was rejected in grade five only.

Test of Hypotheses for Grade Five and Grade Eight Creativity Scores

Very significant differences were found in the fifth and eighth grade creative abilities. The findings presented are based on the analyses of variances and the Duncan tests and are subject to the limitations specified in Chapter I.

Hypothesis III. There is no significant difference in creativity between the SMSG and traditional students.

A difference at a lower level of confidence (.10 level) was found between the fifth grade groups, however, hypothesis III was not rejected at this level of confidence. The total SMSG eighth grade group responded to the creativity test with an overall mean of 5.20 which was in contrast to the total traditional eighth grade group's overall mean of 4.15. This difference was significant at the .01 level of confidence and hypothesis III was rejected in the eighth grade due to the mathematics type alone.

Hypothesis III-A. There is no significant difference in creativity between boys and girls overall.

The difference due to sex grouping was not significant and hypothesis III-A was not rejected in either grade.

Hypothesis III-B. There is no significant difference between boys and girls within the different mathematics groupings.

Hypothesis III-B was not rejected in either grade.

Hypothesis III-C. There is no difference between the higher and lower I. Q. grouping overall.

Extremely significant differences (.005 level of confidence) were found due to the intelligence groupings. The higher I. Q. group posted an overall mean score of 4.00 compared to a mean of 3.20 for the

lower I. Q. group in the fifth grade. The higher I. Q. group in the eighth grade had a mean score of 5.22 compared to 4.13 for the mean of the lower I. Q. group. Hypothesis III-C was rejected in both grades.

Hypothesis III-D. There is no difference in creativity between the higher and lower I. Q. groups within the different mathematics groupings.

Again, the I. Q. groups differed significantly (.01 level of confidence) and hypothesis III-D was rejected in both grades. The higher I. Q. group in SMSG was much more creative than the lower I. Q. group in SMSG, and the same was true in the traditional classes.

The minor hypotheses, concerning creativity and listed under (IV), were tested with the Duncan multiple range test. Tests were made for significant differences on the following subgroups:

Hypothesis IV-a. Higher and lower I. Q. boys in SMSG.

Hypothesis IV-a was rejected at the .05 level of confidence in the fifth grade. A more significant difference existed in the eighth grade in favor of the higher I. Q. group. Hence, hypothesis IV-a was rejected in grade eight at the .01 confidence level.

Hypothesis IV-b. Higher and lower I. Q. girls in SMSG.

Again, no difference was found in the fifth grade but hypothesis IV-b was rejected in the eighth grade at the .05 confidence level.

Hypothesis IV-c. Higher and lower I. Q. boys in traditional.

Hypothesis IV-c was not rejected in either grade.

Hypothesis IV-d. Higher and lower I. Q. girls in traditional.

No difference was found in the eighth grade but the fifth grade higher I. Q. girls differed significantly (.05 level of confidence) from the lower I. Q. girls and hypothesis IV-d was rejected in the fifth grade.

Hypothesis IV-e. Higher I. Q. boys in SMSG and higher I. Q. boys in traditional.

Hypothesis IV-e was not rejected in either grade.

Hypothesis IV-f. Higher I. Q. boys in SMSG and higher I. Q. girls in traditional.

A significant difference was not found in the fifth grade. However, the SMSG eighth grade higher I. Q. boys scored significantly higher (mean score 5.80) than did the traditional higher I. Q. girls (mean score 4.27). Hence, hypothesis IV-f was rejected in the eighth grade at the .01 level of confidence.

Hypothesis IV-g. Higher I. Q. girls in SMSG and higher I. Q. girls in traditional.

Again, no difference was found in the fifth grade. However, the eighth grade SMSG girls scored significantly higher (.01 level of confidence) than did their counterparts in the traditional group, hence hypothesis IV-g was rejected in the eighth grade.

Hypothesis IV-h. Higher I. Q. girls in SMSG and higher I. Q. boys in traditional.

Hypothesis IV-h was rejected in the eighth grade only. Mean scores of 6.07 and 4.73 differed at the .01 level of confidence in favor of the SMSG girls.

Hypothesis IV-i. Lower I. Q. SMSG boys and lower I. Q. traditional boys.

Hypothesis IV-i was not rejected in either grade.

Hypothesis IV-j. Lower I. Q. SMSG girls and lower I. Q. traditional girls.

Hypothesis IV-j was not rejected in either grade.

Hypothesis IV-k. Higher I. Q. traditional boys and higher I. Q. traditional girls.

No difference was found and the hypothesis was not rejected at either grade level.

Hypothesis IV-l. Lower I. Q. traditional boys and lower I. Q. traditional girls.

Hypothesis IV-1 was not rejected in either grade.

Hypothesis IV-m. Higher I. Q. boys and lower I. Q. girls in traditional.

Hypothesis IV-m was not rejected in either grade.

Hypothesis IV-n. Lower I. Q. boys and higher I. Q. girls in traditional.

A significant difference was not found in the eighth grade, however, the fifth grade girls differed at the .05 confidence level from the lower I. Q. boys in the fifth grade. Hence, hypothesis IV-n was rejected at the .05 level in the fifth grade, and was not rejected in the eighth grade.

Tables XIV and XV present all the hypotheses in summarized form, showing levels of rejections for those rejected, for the fifth and eighth grades attitude and creativity scores, respectively.

TABLE XIV

TABULATED HYPOTHESES CONCERNING

ATTITUDE SCORES

	Hypothesis - No significant differences in attitude between:	Grade 5 Reject	Grade 5 Level	Grade 8 Reject	Grade 8 Level
I.	SMSG and traditional students	Yes	.05	No	
IA.	Boys and girls overall	Yes	.05	No	
IB.	Sexes within mathematics groups	No		No	
IC.	I. Q. groupings overall	No		No	
ID.	I. Q. groupings within mathematics	No		No	
IIa.	Higher I. Q. and Lower I. Q. SMSG boys	No		No	
IIb.	Higher I. Q. and Lower I. Q. SMSG girls	No		No	
IIc.	Higher I. Q. and Lower I. Q. SMSG boys	No		No	
IId.	Higher I. Q. and Lower I. Q. traditional boys	No		No	
IIe.	Higher I. Q. SMSG boys and higher I. Q. traditional boys	No		No	
IIf.	Higher I. Q. SMSG boys and higher I. Q. traditional girls	No		No	
IIg.	Higher I. Q. SMSG girls and higher I. Q. traditional girls	No		No	
IIh.	Higher I. Q. SMSG girls and higher I. Q. traditional boys	No		No	
IIi.	Lower I. Q. SMSG boys and lower traditional boys	Yes	.05	No	
IIj.	Lower I. Q. SMSG girls and lower I. Q. traditional girls	No		No	
IIk.	Higher I. Q. traditional boys and higher I. Q. traditional girls	Yes	.05	No	
IIl.	Lower I. Q. traditional boys and lower I. Q. traditional girls	No		No	
IIm.	Higher I. Q. traditional boys and lower I. Q. traditional girls	No		No	
IIn.	Lower I. Q. traditional boys and higher I. Q. traditional girls	Yes	.01	No	

TABLE XV

TABULATED HYPOTHESES CONCERNING

CREATIVITY SCORES

	Hypothesis - No significant difference in creativity between:	Grade 5 Reject	Level	Grade 8 Reject	Level
III.	SMSG and traditional students	No		Yes	.01
IIIA.	Boys and girls overall	No		No	
IIIB.	Sexes within mathematics groups	No		No	
IIIC.	I. Q. groupings overall	Yes	.005	Yes	.005
IIID.	I. Q. groupings within mathematics	Yes	.01	Yes	.01
IVa.	Higher I. Q. and lower I. Q. SMSG boys	Yes	.05	Yes	.01
IVb.	Higher I. Q. and lower I. Q. SMSG girls	No		No	
IVc.	Higher I. Q. and lower I. Q. traditional boys	No		No	
IVd.	Higher I. Q. and lower I. Q. traditional girls	Yes	.05	No	
IVe.	Higher I. Q. SMSG boys and higher I. Q. traditional boys	No		No	
IVf.	Higher I. Q. SMSG boys and higher I. Q. traditional boys	No		Yes	.01
IIg.	Higher I. Q. SMSG girls and higher I. Q. traditional girls	No		Yes	.01
IIh.	Higher I. Q. SMSG girls and higher I. Q. traditional boys	No		Yes	.01
IIi.	Lower I. Q. SMSG boys and lower I. Q. traditional boys	No		No	
IIj.	Lower I. Q. SMSG girls and lower I. Q. traditional girls	No		No	
IIk.	Higher I. Q. traditional boys and higher I. Q. traditional girls	No		No	
III.	Lower I. Q. traditional boys and lower I. Q. traditional girls	No		No	
IIm.	Higher I. Q. traditional boys and lower I. Q. traditional girls	No		No	
IIn.	Lower I. Q. traditional boys and higher I. Q. traditional girls	Yes	.05	No	

Comparison of Means

The tables in this section are presented to expedite the reader's grasp of the responses of the different subgroupings. The writer was particularly interested in the difference of the means of corresponding groups between the fifth and eighth grades and this information can be quickly gained by referring to the following tables. Statistical analysis was not attempted for scores involving the two different grades since many uncontrollable variables would have been introduced. Therefore, Tables XVI through XIX present information without an attempt at interpretation.

TABLE XVI

MEANS AND MEANS OF MEANS OF GRADE FIVE ATTITUDES SCORES

Mathematics Group	Boys		Girls		Means of Means	Overall Grade 5 Mean
	Higher I. Q.	Lower I. Q.	Higher I. Q.	Lower I. Q.		
SMSG	6.57	6.87	7.04	6.93	6.85	
Traditional	6.31	6.04	7.10	6.32	6.44	6.65
Difference[1]	+.26	+.83	-.06	+.61	+.41	

[1]In tables XVI - XIX, plus (+) indicates SMSG highest.

TABLE XVII

MEANS AND MEANS OF MEANS OF GRADE EIGHT

ATTITUDE SCORES

Mathematics Group	Boys		Girls		Means of Means	Overall Grade 5 Mean
	Higher I. Q.	Lower I. Q.	Higher I. Q.	Lower I. Q.		
SMSG	6.17	6.37	5.84	6.23	6.15	
Traditional	6.31	5.91	5.78	5.50	5.88	6.01
Difference	-.14	+.46	+.06	+.73	+.27	

TABLE XVIII

MEANS AND MEANS OF MEANS OF GRADE FIVE

CREATIVITY SCORES

Mathematics Group	Boys		Girls		Means of Means	Overall Grade 5 Mean
	Higher I. Q.	Lower I. Q.	Higher I. Q.	Lower I. Q.		
SMSG	4.35	3.15	4.05	3.65	3.80	
Traditional	3.50	2.90	4.10	3.10	3.40	3.60
Difference	+.85	+.25	-.05	+.55	+.40	

TABLE XIX

MEANS AND MEANS OF MEANS OF GRADE EIGHT

CREATIVITY SCORES

Mathematics Group	Boys		Girls		Means of Means	Overall Grade 8 Mean
	Higher I. Q.	Lower I. Q.	Higher I. Q.	Lower I. Q.		
SMSG	5.80	4.13	6.07	4.80	5.20	4.68
Traditional	4.73	3.80	4.27	3.80	4.15	
Difference	+1.07	+.33	+1.80	+1.00	+1.05	

In Tables XX and XXI, it seems worth while to note, with one exception which was no change, the grade five students professed a much more positive attitude than did the grade eight students.

TABLE XX

DIFFERENCES OF MEANS BETWEEN GRADE FIVE AND GRADE EIGHT SMSG ATTITUDE SCORES

Mathematics Group	Grade	Boys		Girls		Means of Means
		Higher I. Q.	Lower I. Q.	Higher I. Q.	Lower I. Q.	
SMSG	5	6.57	6.87	7.04	6.93	6.85
SMSG	8	6.17	6.37	5.84	6.23	6.15
Difference[1]		-.40	-.50	-1.20	-.70	-.70

[1]In Tables XX - XXIII, plus (+) indicates grade 8 highest.

TABLE XXI

DIFFERENCE OF MEANS BETWEEN GRADE FIVE AND GRADE EIGHT TRADITIONAL ATTITUDE SCORES

Mathematics Group	Grade	Boys		Girls		Means of Means
		Higher I. Q.	Lower I. Q.	Higher I. Q.	Lower I. Q.	
Traditional	5	6.31	6.04	7.10	6.32	6.44
Traditional	8	6.31	5.91	5.78	5.50	5.88
Difference		.00	-.13	-1.32	-.82	-.56

The group indicating the smallest loss of interest in mathematics was the traditional lower I. Q. boys. The greatest loss was recorded by the traditional higher I. Q. girls. The overall change in attitude, from the fifth to the eighth grades, was -.70 in SMSG and -.56 in the traditional group.

Tables XXII and XXIII present the relative change in the creativity and, as might be expected, the grade eight students did noticeably better than did the fifth graders.

TABLE XXII

DIFFERENCE OF MEANS BETWEEN GRADE FIVE AND GRADE EIGHT SMSG CREATIVITY SCORES

Mathematics Group	Grade	Boys		Girls		Means of Means
		Higher I. Q.	Lower I. Q.	Higher I. Q.	Lower I. Q.	
SMSG	5	4.35	3.15	4.05	3.65	3.80
SMSG	8	5.80	4.13	6.07	4.80	5.20
Difference		+1.45	+.98	+2.02	+1.15	+1.40

TABLE XXIII

DIFFERENCE OF MEANS BETWEEN GRADE FIVE AND GRADE EIGHT TRADITIONAL CREATIVITY SCORES

Mathematics Group	Grade	Boys		Girls		Means of Means
		Higher I. Q.	Lower I. Q.	Higher I. Q.	Lower I. Q.	
Traditional	5	3.50	2.90	4.10	3.10	3.40
Traditional	8	4.73	3.80	4.27	3.80	4.15
Difference		+1.23	+.90	+.17	+.70	+.75

The most significant thing about Tables XXII and XXIII is that the higher I. Q. girls in SMSG made the greatest gain in creativity (2.02) while their counterparts, the higher I. Q. girls in traditional, made the least gain (.17) in creativity.

Summary of Chapter IV

This chapter has presented the findings of the present study as interpreted by: (1) percentages of responses of the compared groups to the attitude statements, (2) the results of the analyses of variance and the Duncan test applied to testing the hypotheses, and (3) tables showing means, means of means, and differences of means of all the subgroups.

Significant differences were found in the fifth grade attitudes at the .05 level of confidence due to the following:

1. The SMSG students exhibited more positive attitudes than did the traditional students.
2. The girls, overall, stated more positive attitudes than did the boys.
3. The higher I. Q. traditional girls stated more positive attitudes than did the lower I. Q. traditional girls.
4. The lower I. Q. SMSG boys showed more positive attitudes than did the lower I. Q. traditional boys.
5. The higher I. Q. traditional girls stated more positive attitudes than did the higher I. Q. traditional boys.

In addition, the fifth grade higher I. Q. traditional girls differed at the .01 level of confidence with the lower I. Q. traditional boys. This again was due to a more positive attitude shown by the girls.

The eighth grade attitude scores were not significantly different at a level of confidence necessary for the writer to reject any of the hypotheses. However, a difference in attitude at the .10 level was found between the boys and girls, overall, and was due to the higher attitudes of the boys.

Highly significant differences were found in the creative ability of the students. These are summarized below by grade level and were due, in the fifth grade, to the following:

1. The higher I. Q. groups, overall, scored much higher (.005 level) than did the lower I. Q. groups.
2. The higher I. Q. groups in both SMSG and traditional scored much higher (.01 level) than did the lower I. Q. groups in SMSG and traditional, respectively.
3. The higher I. Q. SMSG boys and girls both scored significantly higher (.05 level) than did their corresponding lower I. Q. groups, respectively.
5. The higher I. Q. traditional girls scored higher (.05 level) than did the lower I. Q. traditional boys.

In the eighth grade, the differences in creative ability were due to the following:

1. The SMSG students scored significantly higher (.01 level) than did the traditional students.
2. The higher I. Q. groups, overall, scored much higher (.005 level) than did the lower I. Q. groups.
3. The higher I. Q. SMSG boys and girls scored higher (.01 and .05 levels, respectively) than the lower I. Q. SMSG boys and girls.

4. The higher I. Q. SMSG boys scored much higher (. 01 level) than did the higher I. Q. traditional girls.
5. The higher I. Q. SMSG girls scored significantly higher (. 01 level) than did either the higher I. Q. boys or girls in the traditional groupings.

The writer will present, in Chapter V, the conclusions and recommendations of the present study based on the findings of Chapter IV.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Review of the Study

The major objective of this study was to investigate and compare the attitudes toward mathematics of a group of SMSG students with the attitudes toward mathematics of a similar group of traditional students. A minor purpose was to compare the creative ability, as indicated by a question on word fluency of the two groups. A hierarchical classification was set up within each of the two groups using sex and I. Q. as the determining factors. On the basis of a statistical analysis designed for this classification, the conclusions below were formulated.

Conclusions of the Study

On the basis of this research and subject to the specified limitations, the following conclusions were made:

1. SMSG materials tend to foster a better attitude toward mathematics at the grade five level than does traditional arithmetic.
2. Since no significant difference in attitude was found in the two groups in the eighth grade, and since the SMSG materials are reportedly a more rigorous and precise approach to mathematics, the writer concluded that the SMSG materials might well be used more extensively resulting in at least as good

an attitude shown as in traditional mathematics. Concisely, this means that more rigorous and more precise curriculum materials can be used in mathematics without loss, by the students, of a positive attitude toward these materials.

3. Based on studies reviewed in Chapter II, generally girls have a poorer attitude toward mathematics than boys. This was not found true in this study since the SMSG girls, overall, indicated more positive attitudes than did their counterparts in traditional. Therefore, the writer concluded that the SMSG materials do foster a more positive attitude among the girls in both grades.
4. SMSG materials do not tend to hold students interests better than the traditional materials during the transitory period from the fifth to the eighth grades.
5. Since no significant difference in attitudes was found due to the I. Q. classification, the writer concluded that the SMSG materials can be presented to average students without causing apparent negative attitudes on the student's part. This is a rather far-reaching conclusion and, with substantiation by further research, should have great implications for textbook adoption committees in the future.
6. High I. Q. students are more capable of divergent thinking than are low I. Q. students.
7. Based on the findings of this study, a definite relationship exists between SMSG mathematics and the ability to think creatively. This possibly is due to the "discovery method" of presenting new topics in the modern programs in mathematics. Regardless of the cause, however, the writer

concluded that the effect was worthy of consideration in the plans of future textbook writers.

Recommendations for Further Research

The writer of the present study is of the opinion that discoveries were made, in this research, that are highly important and significant to curriculum workers in the field of elementary mathematics. However, much more research can and should be done to further clarify the areas considered in this paper. The writer recommends the following specific areas for immediate and continued research:

1. More studies should be conducted comparing all phases of education in light of modern and traditional approaches to teaching. A study specifically dealing with the "discovery method" of presenting new mathematical concepts might well be very valuable.
2. Research should be conducted in the area of loss of positive attitude between certain grade levels. What can be done to minimize this development of complacency? What can be done to better equate and hold positive attitudes of boys and girls?
3. More research is needed to illuminate the manner in which students acquire interests and attitudes. At which grade level can these abstractions first be identified?
4. More research is needed in field of attitudes and achievement. Do positive attitudes overcome a lack of aptitude for mathematics?
5. More use should be made of attitude scales in guiding and counseling students at all grade levels. Should a student with a

negative attitude toward a subject be urged to continue in a field dependent upon that subject?

6. More research should be conducted in the field of creative thinking. This simple statement belies the extreme importance and opportunity the writer of the present study believes is embodied in this area. The very intriguing area of convergent and divergent thinking could and should be studied in conjunction with the modern programs in mathematics. Can creative ability be developed or at least enhanced in students by methods and materials? If so, and if modern curricular programs do augment this region of human development, should educators not consider this in the development of the total school curriculum?

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APPENDIX A

ATTITUDE SCALE AND CREATIVITY INSTRUMENT

(Scale values added when report was written)

Name Circle One: Boy Girl G_____ A_____
M I
School Grade: 5 8 S_____ C

Circle the statement with which you agree.

1. I think about (arithmetic-mathematics) problems outside of school and like to work them out. (9.5)
2. I don't feel sure of myself in (arithmetic-mathematics). (3.7)
3. I enjoy seeing how rapidly and accurately I can work (arithmetic-mathematics). (8.6)
4. I like (arithmetic-mathematics), but I like other subjects as well. (5.6)
5. I like (arithmetic-mathematics) because it is practical. (7.7)
6. I don't think (arithmetic-mathematics) is fun, but I always want to do well in it. (4.6)
7. I am not enthusiastic about (arithmetic-mathematics), but I have no real dislike for it either. (5.3)
8. (Arithmetic-mathematics) is as important as any subject. (5.9)
9. (Arithmetic-mathematics) is something you have to do even though it is not enjoyable. (3.3)
10. Sometimes I enjoy the challenge presented by an (arithmetic-mathematics) problem. (7.0)
11. I have always been afraid of (arithmetic-mathematics). (2.5)
12. I would like to spend more time in school working (arithmetic-mathematics). (9.0)
13. I detest (arithmetic-mathematics) and avoid using it at all times. (1.0)
14. I enjoy doing problems when I know how to work them well. (6.7)
15. I avoid (arithmetic-mathematics) because I am not very good with figures. (3.2)
16. (Arithmetic-mathematics) thrills me, and I like it better than any other subject. (10.5)
17. I never get tired of working with numbers. (9.8)
18. I am afraid of doing word problems. (2.0)
19. (Arithmetic-mathematics) is very interesting. (8.1)
20. I have never liked (arithmetic-mathematics). (1.5)
21. I think (arithmetic-mathematics) is the most enjoyable subject I have taken. (10.4)
22. I can't see much value in (arithmetic-mathematics). (3.0)

In this test you are to list as many <u>different</u> <u>uses</u> as you think of for the following objects. You will have 3 minutes.

Example: BRICK -- door stop, build house, throw at target, etc.

1. PENCIL --

2. PAPER CLIP

TOTAL RESPONSES OF GRADE FIVE STUDENTS ON ATTITUDE SCALE SHOWING PERCENT OF ENDORSEMENT IN EACH GROUP

	SMSG (N_1 = 114)						Traditional (N_2 = 180)					
	Boys		Girls				Boys		Girls			
Attitude Statement	Higher	Lower	Higher	Lower	Total	% N_1	Higher	Lower	Higher	Lower	Total	% N_2
1	21	14	20	21	76	67%	14	24	37	41	116	64%
2	9	9	10	14	42	37%	9	40	16	23	88	49%
3	25	14	28	24	91	80%	21	35	34	40	130	72%
4	26	12	25	19	82	72%	15	38	31	38	122	68%
5	29	17	24	22	92	81%	19	40	37	41	137	76%
6	13	13	10	11	47	41%	18	45	25	27	115	64%
7	19	17	21	12	69	61%	22	45	33	28	128	71%
8	32	19	31	25	107	94%	25	51	41	47	164	91%
9	13	13	13	17	56	49%	19	48	31	36	134	74%
10	30	19	32	23	104	91%	19	37	32	35	123	68%
11	3	1	2	3	9	8%	0	11	0	2	13	7%
12	12	10	16	16	54	47%	7	14	18	25	64	36%
13	0	2	0	5	7	6%	6	13	4	7	30	17%
14	31	19	33	25	108	95%	23	51	38	46	158	88%
15	5	2	2	4	13	11%	4	18	0	6	28	16%
16	7	11	11	12	41	36%	5	14	10	16	45	25%
17	8	11	20	16	55	48%	7	14	24	26	71	39%
18	4	5	0	2	11	10%	2	18	8	12	40	22%
19	28	19	32	23	102	89%	19	38	36	40	133	74%
20	2	0	0	4	6	5%	2	12	2	3	19	11%
21	8	12	12	15	47	41%	4	14	11	19	48	27%
22	2	2	0	3	7	6%	0	6	0	3	9	5%

TOTAL RESPONSES OF GRADE EIGHT STUDENTS ON ATTITUDE SCALE SHOWING PERCENT OF ENDORSEMENT IN EACH GROUP

	SMSG (N_1 = 148)						TRADITIONAL (N_2 = 181)					
	Boys		Girls				Boys		Girls			
Attitude Statement	Higher	Lower	Higher	Lower	Total	% N_1	Higher	Lower	Higher	Lower	Total	% N_2
1	19	14	36	8	77	52%	20	14	13	13	60	33%
2	21	14	42	10	87	59%	11	31	19	37	98	54%
3	29	20	48	11	108	73%	31	26	27	28	112	62%
4	36	22	52	13	123	83%	25	32	31	36	124	69%
5	29	20	45	11	105	71%	22	35	26	30	113	62%
6	25	15	37	5	82	55%	18	45	19	35	117	65%
7	31	18	37	8	94	64%	20	38	26	34	118	65%
8	41	23	65	12	141	95%	34	49	35	49	167	92%
9	32	17	40	13	102	69%	21	43	20	37	121	67%
10	31	18	57	11	117	79%	20	24	30	28	111	61%
11	5	4	8	3	20	14%	3	9	4	13	29	16%
12	5	9	25	6	45	30%	8	9	9	8	34	19%
13	3	0	3	0	6	4%	1	9	0	9	19	10%
14	40	23	62	15	140	95%	31	48	37	42	158	87%
15	3	5	10	2	20	14%	4	17	3	13	37	20%
16	16	2	5	0	23	16%	11	7	5	8	31	17%
17	5	3	10	2	20	14%	3	7	7	11	28	15%
18	3	8	19	5	35	24%	10	25	15	30	80	44%
19	30	20	42	11	103	70%	19	29	29	29	106	59%
20	3	1	3	2	9	6%	2	9	1	7	19	10%
21	4	4	3	0	11	7%	8	7	6	7	28	15%
22	2	0	2	1	5	3%	1	2	2	5	10	5%

APPENDIX B

CITY, SCHOOL, GRADE, AND SECTION OF TOTAL SAMPLE AS CODED FOR STATISTICAL COMPUTATION ON IBM 650

Coding Key

City and Code #	School and Code #	Grade	Section
Stillwater - 1	Will Rogers - 1	05	1
	Westwood - 2	05	1
	Jefferson - 3	05	1
	Jr. High - 4	08	1
			2
			3
Cushing - 2	Wilson - 1	05	1
			2
Drumright - 3	Lincoln - 1	05	1
		08	1
	Edison - 2	05	1
		08	1
Sand Springs - 4	Garfield - 1	05	1
			2
			3
	Jr. High - 2	08	1
			2
			3
Perkins - 5	Grade School - 1	05	1
			2
Guthrie - 6	Fogarty Jr. - 1	08	1
			2
Enid - 7	Waller Jr. - 1	08	1
			2

Mathematics -- SMSG is # 1 - Traditional is # 2

S - (Sex) -- Boys - #1 - Girls - #2

A - (Attitude Score) Possible scores range from 1.0 to 10.5
Neutral score is 5.75

I - (I. Q. score on the Otis Quick-Scoring Mental Ability Tests, Form CM, Beta Test). I. Q. $\geq$ 110 is #1, I. Q. $<$ 110 is #2.

C - (Creativity Ability as indicated by the question on Word Fluency)

Responses to statements on Dutton Attitude Scale -- If marked -assign number 2 -- If not marked -assign number 1.

VITA

JACK PHELPS

Candidate for the Degree of

Doctor of Education

Thesis: A STUDY COMPARING ATTITUDES TOWARD MATHEMATICS OF SMSG AND TRADITIONAL ELEMENTARY SCHOOL STUDENTS

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