THE EFFECT OF MODERN MATHEMATICS UPON ACHIEVEMENT IN ARITHMETIC COMPUTATION

by

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CHAPTER I

INTRODUCTION

Except, perhaps, for the reading controversy of several years ago that started from "Why Johnny Can't Read", nothing else in curriculum seems to have aroused so much concern as the new mathematics.[1] After passing through the stage of its awesome impact on curriculum planners, teachers, students, and parents, modern mathematics has emerged as a target of criticism concerning its value in the school curriculum.

Current magazine and newspaper articles have aroused public sentiment about the new programs and have even made sport of the puzzling new math. A humorous example of this attention is seen in the following playful, double parody of reading and new math written by Canadian mathematician R. A. Stall as it appeared in Newsweek: "Oh, see, Johnny has a set of marbles. See Johnny's set. Look, look, Billy has a set of marbles. See Billy's set. Here comes Mary. Mary gets all the marbles. Mary gets the union of Johnny's set and Billy's set."[2]

The effectiveness of the modern mathematics program compared to the traditional mathematics program had been a

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[1]Francis J. Mueller, "The Public Image of New Mathematics," The Mathematics Teacher, LIX (November, 1966), 618.

[2]"New Math--Does It Really Add Up?" Newsweek, LXV (May 10, 1965), 112.

recent concern of the teachers, counselors, and administrators at Manhattan Junior High School. The 1968-69 seventh-grade class was the first to have a complete modern mathematics program for everyone in the class with the exception of a few extremely slow students who took a remedial mathematics course which emphasized computational drill. Results on recent achievement tests indicated that seventh grade students were low in achievement skills involving arithmetic computation, arithmetic concepts, and arithmetic applications.[1]

Statement of the Hypothesis and Objectives

It was suspected that the modern mathematics program at Manhattan Junior High has been an influential factor in the low achievement in basic arithmetic skills as measured by the Stanford Achievement Test. It was the objective of this study to form an indication of the effect of modern mathematics on student achievement and to relate the other basic skills in other subject areas as measured by the Stanford Achievement Test to mathematical achievement. It was also the objective of this study to compare general intelligence scores to mathematical achievement.

Definition of Terms

Because there may be some ambiguity or confusion over

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[1] Mrs. Jo Dodge, Manhattan Junior High School Counselor, U.S.D. 383, Manhattan, Kansas.

a few terms, the following interpretations were used:

Modern mathematics or new mathematics refers to the recent approach to mathematics which develops the inherent structure through a study of the systems of numbers as developed from naive set theory. Special characteristics of modern mathematics include an emphasis on precision of definitions, terminology and notations along with a formation and foundation of mathematical concepts.[1]

Traditional mathematics refers to those older programs which concentrate on the method of solving a developed hierarchy of increasingly difficult problems. Generalizations are in the form of laws, axioms, and postulates which the student memorizes.[2]

Basic arithmetic skills are those skills of manipulation and computation with numbers requiring use of the operations of addition, subtraction, multiplication, division and the more complicated use of these skills as measured by the Stanford Achievement Test in computation, concepts, and

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[1]Kenneth E. Brown, "The Drive to Improve School Mathematics," The Revolution in Mathematics Education. A Report of Regional Orientation Conferences in Mathematics (Washington: National Council of Teachers of Mathematics, 1961), pp. 22-7, cited by William Harper Landis, "Secondary Students' Mathematical Competencies in Relation to Employment Tests," (Doctoral Dissertation, University of Southern California, 1967), p. 8, ERIC 016 784.

[2]Ibid.

applications.

CHAPTER II

REVIEW OF THE LITERATURE

Much of the literature pertinent to the topic of modern mathematics deals with its comparison to the traditional mathematics and its effect upon achievement. Another large portion of the current literature is critical of the modern programs and points out the shortcomings of the new mathematics. Before discussion of this pertinent literature, however, it is important to get a recent historical background of the modern mathematics.

Historical Background of Modern Mathematics

In the early fifties, many educators and mathematicians became aware of the deplorable state of the mathematical curriculum in the schools. Emphasis for several decades had been on pedagogy and the various psychological theories of learning with little importance given to content. In addition to this, society was rather indifferent and placed little importance upon mathematics.[1] Hancock studied the evolution of secondary mathematics curriculum and concluded that the aims of mathematics instruction seemed to change to meet the demands of society. During times when society has no pressing

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[1]Ryoichiro Sato, "Commentary on the International Study of Achievement in Mathematics," *The Arithmetic Teacher*, XV (February, 1968), 103-7.

need for mathematics, utilitarian aims were stressed; during periods of severe depression, the cultural aims of mathematics were emphasized; however, during the time when the need for mathematical instruction was readily apparent, attention to aims has diminished and there has been a tendency to assume that whatever mathematics could be taught was justifiable.[1]

The race for space supremacy between the United States and Russia and the increased awareness of technology indicated the need for mathematics instruction. Several special groups were organized to study the mathematics curriculum and make recommendations to improve the curriculum. Some of the more influential groups were the University of Illinois Committee on School Mathematics (UICSM), the Commission on Mathematics of the College Entrance Examination Board (CEEB), and the School Mathematics Study Group (SMSG) which was organized by the American Mathematical Society, the Mathematical Association, and the National Council of Teachers of Mathematics. These groups have aided in the planning and writing of new mathematics textbooks and programs and began the implementation of the present modern mathematics.[2]

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[1]John David Hancock, "The Evolution of the Secondary Mathematics Curriculum: A Critique," (Doctor's Thesis, Stanford University, 1961), Dissertation Abstracts 22:501-502, No. 2, 1961.

[2]Roger K. Meyer, "Modern Mathematics in the Secondary School," (unpublished Master's Report, Kansas State University, 1962), pp. 7-9.

Research of Achievement in Modern and Traditional Programs

Achievement in mathematics has been difficult to determine because of inappropriate or inadequate measuring devices to assess mathematical achievement. Most investigators used tests that were developed earlier even though the new mathematics produced changes in content and objectives. Problems in measurement will continue to exist until the behavioral changes which the new mathematics will produce are described.[1]

Much of the research at this stage of modern mathematics evaluation seems to be contradictory. Some researchers showed the modern program to be superior as Cassels and Jerman did with their experimental groups at the seventh-grade level in student achievement.[2] However, Shuff found just the opposite to be true with the traditional group scoring higher on achievement in his study.[3] Other studies by Flournoy[4]

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[1]Thomas A. Romberg, "Current Research in Mathematics Education," Review of Educational Research, 39 (August, 1969), 473-91.

[2]Russell Cassels and Mas. Jerman, "A Preliminary Evaluation of SMSG Instruction in Arithmetic and Algebra for 7th, 8th, and 9th Grade Pupils," California Journal of Educational Research, (November, 1963), 202-07.

[3]Robert V. Shuff, "A Comparative Study of Achievement in Mathematics at the Seventh and Eighth Grade Levels Under Two Approaches: SMSG and Traditional," (unpublished Doctoral Dissertation, Univ. of Minn., 1962), cited by Holland Payne, "What About Modern Programs in Mathematics?" The Mathematics Teacher, LVIII (May, 1965), 423.

[4]Francis Flournoy, "Understanding Relationships: An Essential for Solving Equations," Elementary School Journal, (January, 1964), 214-17.

and Peck[1] indicate elementary school children studying a modern program of mathematics achieve at least as well on traditionally oriented arithmetic tests as their traditional counterparts. McLaunchlin[2] found that elementary school children who had studied a modern program of arithmetic out-scored their traditional contemporaries on tests featuring traditional mathematics. Hungerman[3] and Graft and Ruddel[4] found similar results among a sample of sixth graders.

Many reasons for the gains in achievement can possibly be attributed to the Hawthorne effect rather than conclusively to the innovation of a modern program. Sparks found other factors which might significantly affect achievement. In comparing the achievement gains of schools taking the Iowa Test of Basic Skills, he found that the schools having the greatest gains required more mathematics study of their students, had students who spent more out-of-class time on

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[1]Hugh I. Peck, "An Evaluation of Topics in Modern Mathematics," The Arithmetic Teacher, X (May, 1963), 277-79.

[2]J. A. McLauchlin, "Can Johnny Still Add?" The Arithmetic Teacher, IX (December, 1962), 432.

[3]Ann D. Hungerman, "Achievement and Attitude of Sixth-Grade Pupils in Conventional and Contemporary Mathematics Programs," The Arithmetic Teacher, 14 (January, 1967), 30-39.

[4]William D. Graft and Arden K. Ruddel, "Cognitive Outcomes of the SMSG Mathematics Program in Grades 4, 5, and 6," The Arithmetic Teacher, 15 (March, 1968), 161-65.

math study, had teachers who were better prepared and had longer tenures, and had greater mutual respect and enthusiasm among students and teachers.[1]

<u>Criticism of the Modern Mathematics Program in the Schools</u>

As more people have become affected by modern mathematics and more people have had an opportunity to examine its content and goals, criticism has fallen heavily. Areas most frequently criticized are those involving the utility of much of the content and the student's ability and readiness to learn that content, the problems in teaching the modern mathematics, and finally the objectives and goals of the current modern mathematics programs.

A danger in the trend of modern mathematics, as viewed by Alfors and 64 other mathematicians, is that the mathematicians who are making the new curriculum are reacting to the previous dominance of mathematical education by professional educators who had stressed pedagogy at the expense of content. This reaction is now leading to the stressing of content at the expense of pedagogy and will be equally ineffective.[2] Kline echoed the same opinion as he denounced

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[1]Jack Norman Sparks, "A Comparison of Iowa High Schools Ranking High and Low in Mathematical Achievement," <u>Dissertation Abstracts</u> 21:1481-82, No. 6, 1960.

[2]Lars V. Ahlfors and Others, "On the Mathematics Curriculum of the High School," <u>The Mathematics Teacher</u>, LV (March, 1962), 191-95.

the role scientists have played in curriculum development:

> The curriculums have been taken over by professional scientists whose aim, judged by the curriculum they have produced, is to train professionals. These reformers assume that mathematics and science are ends in themselves, that students are automatically motivated, and that the goal is to rush the education so that 17-year-olds can start writing research papers . . . .
>
> The professors who have led the new curriculum movements have not even been wise men. Because they are the products of the narrow specialization which is characteristic of modern science education, their ignorance of the cultural significance of science may be excusable. But these men have shown a presumption and an egotism which is almost unbelievable. Most of them had never set foot in a high school or elementary classroom and had even disdained any interest in education. When they did decide to take an interest in curriculum they assumed that education is a simple, obvious matter. Of course the professional scientists have made a fiasco of reform.[1]

Before further criticism is leveled, an examination of some of the new content in modern mathematics might be valuable. Examples of some of the topics in modern mathematics is exemplified in the following: Modern Algebra, Linear Algebra, Point-Set Topology, Algebraic Topology, Finite Mathematical Systems, and Set Theory. These topics are an exceedingly abstract, logical, axiomatic, well-structured system of mathematics.[2] These topics are not

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[1]Morris Kline, "The Liberal Education Values of Mathematics, Science, and Technology for Youth," Addresses and Proceedings (Washington D.C.: National Education Association, 1965), pp. 65-66, cited by Herbert Smith, Curriculum Development and Instructional Materials," Review of Educational Research, 39 (October, 1969), 513.

[2]Howard F. Fehr, "Sense and Nonsense in a Modern School Mathematics Program," The Arithmetic Teacher, 13 (February, 1966), 84.

taught per se in the secondary or elementary schools, but some of their basic content has crept into the curriculum as new mathematics.

One potent topic of the newly discovered content of modern mathematics that is influencing school curriculum is set theory. In a recent article Geddes and Lipsey explained that, while the concept of set promises clarification, simplification, and unification in the teaching of mathematics, the use of sets did present some hazards. Some of these hazards were: (1) forcing the student to take the term of set as undefined because of the complexity of set theory, (2) confusing the student by the use of apparently contradictory terms such as "a set is undefined and is a well-defined collection of objects," (3) confusing students on the concept of addition with the similar idea of union, and (4) leading the student to illogical conclusions and confusion because some of set theory's assumptions are based upon paradoxical situations or lead to paradoxical conclusions.[1]

Fehr has examined parts of the new mathematics curriculum and concluded that many of its advanced notions are complete nonsense for elementary school mathematics. Some

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[1]Dorothy Geddes and Sally I. Lipsey, "The Hazards of Sets," The Mathematics Teacher, LXII (October, 1969), 454-59.

particular areas of nonsense mentioned by Fehr include the early introduction of sets through the use of letters and brace notation. While children should be learning to write numbers, they are struggling to make so-called curly-cue braces. Even though the recognition of collections of things is essential, the learning of the theory of sets is non-essential in the learning of school mathematics.[1]

A further area of nonsense as seen by Fehr was the introduction of formal logic into elementary school mathematics. Individuals need to experience and understand number, number relations, and geometrical figures a great deal before they see the need for reasoning about the acquired knowledge and sense how it may be arranged in formal structures. In education our emphasis is on understanding, use, and skill, not on abstract patterns. All past and present research on human learning indicates that until the human mind has acquired a vast reservoir of experimental knowledge and has matured to a mental age of ten or eleven years, the ability to do two-way reflective thinking is absent, and it is impossible to understand formal logic. With this in mind, Venn diagrams in set relations and Euler's circles in logical classifications is sheer nonsense before a mental

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[1]Fehr, op. cit., p. 84-85.

age of eleven years.[1]

Some of Bruner's thinking on the nature of human learning pointed in the same direction as Fehr has mentioned. When the child is in the concrete operational stage that Piaget described between the ages of six and ten years of mental age, he is able to give structure to the things he encounters, but he is not yet readily able to deal with possibilities not directly before him or not already experienced. It is futile to attempt to pass the child from his concrete thinking to more adequate modes of thought by presenting formal explanations based on a logic that is distant from the child's manner of thinking and sterile in its implications for him.[2]

Modern mathematics, in its use of symbolism, has attempted to pass the child into a more formal mode of thought. However, Bruner was aware that even though secondary school children could operate at this symbolic level alone, there was danger in simply instructing and learning at this level. This danger becomes readily apparent when, in the learning or problem solving, the symbolic method fails the person. At this time, he needs to be able to function

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[1] Ibid.

[2] Jerome S. Bruner, The Process of Education (Cambridge: Harvard University Press, 1961), pp. 37-38.

in a manipulative fashion.[1]

Further specific criticism of the modern mathematics content was also leveled by Fehr. He felt that the teaching of place systems of numeration to other bases than the decimal, and the computational algorisms in these other bases is nonsense. He argued that across the nation and the world in science and business, social circles and professions, the one number system that is used is the decimal system and this is the system that 95 per cent of the population will use for the rest of their lives, probably everyday. Granted, other systems are used in digital computers and special scientific studies, but to educate elementary school children as if everyone would become a computer programmer is not even logical. That learning other bases will help a student understand the base ten is a good hypothesis, but it has never been tested. Fehr concluded his argument on bases by pointing out that if generalizations on notations of number systems is deferred to high school, the use of algebra can make them a simple and easy matter to comprehend.[2]

As modern mathematics was introducing a new set of

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[1]Jerome S. Bruner, Towards a Theory of Instruction (Cambridge: Harvard University Press, 1966), cited by Thomas E. Kieren, "Activity Learning," Review of Educational Research, 39 (October, 1969), 513.

[2]Fehr, op. cit., p. 84.

terminology with its new content, Morris Kline had reported to Newsweek that the first course of one program asked students to learn over 700 precise definitions. This he considered pure pedantry.[1] Fehr pointed out the emphasis upon the distinction between number and numeral, even though there is a theoretical distinction, can become confusing and without the distinction no serious misconception arises in using the two words synonymously. It appears the use of a precise language and its corresponding formalized structure could be substituting a new rote formalization for the old rote learning of so-called mathematical facts in arithmetic.[2]

One of the prominent concerns among educators has been that the new math was primarily designed for the superior student. Professor Carl D. Allendoerfer of the University of Washington and one of the pioneers of the new mathematics admits that the first programs were intended for the use of the upper classes.[3]

Acceleration seems to be one of the main goals of new mathematics programs without extreme concern as to the improvement of the total learning situation for each

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[1]"New Math--Does It Really Add Up?" Newsweek, LXV (May 10, 1965), 112.

[2]Fehr, loc. cit.

[3]"New Math--Does It Really Add Up?" Newsweek, LVX (May 10, 1965), 112.

individual student. In 1963, the Cambridge Conference Report, a proposal which was initiated by 29 prominent mathematicians and scientists, presented changes they felt should be made in precollege mathematics programs during the next few decades. The main conclusion of the report as stated by Adler was that the student who had worked through the full thirteen years of the program would emerge with the equivalent of three years of top-level college training today.[1] Stone responded to the report by saying that it was unrealistic and unimaginative, and that it should have presented more profound modifications.[2]

With the concern that some of the content of the new mathematics may be nonsense and that all children may not have sufficient mental development and readiness to learn the new mathematics, a further criticism has emerged expressing the point of view that students may become deficient in fundamental, computational skills. Max Beberman, the respected University of Illinois professor, who helped develop a widely used new mathematics program, fears that, by overemphasizing the basic, fundamental skills, schools

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[1]Irving Adler, "The Cambridge Conference Report: Blueprint or Fantasy?" The Mathematics Teacher, 13 (March, 1966), 179.

[2]Marshall H. Stone, "Review of Goals for School Mathematics," The Mathematics Teacher, 58 (April, 1965), 353-360.

may be raising a generation of kids who can't even do computational arithmetic.[1] This is clear, if modern mathematics is badly taught, confused concepts are planted and individuals may emerge who can't even keep their check stubs figured.[2]

Pressure to publish modern mathematics textbooks with an emphasis upon the new content has created an additional problem for the new program. Smith in a recent article pointed out that the readability level of secondary material is too high and has too great a range. Some sections of the textbooks that were studied fell within the fourth-grade-and-below category while others would be appropriate for a college graduate student. Progression from the easy to the more difficult was not a strong point of the material studied. Throughout the books there was a scattering of the very easy and the very difficult. Smith felt that this was a definite drawback and that students should not be penalized in mathematics for their shortcomings in reading.[3]

A major shortcoming of many modern mathematics programs

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[1]"New Math--Does It Really Add Up?" Newsweek, LXV (May 10, 1965), 112.

[2]"Trials of New Math," Time, LXXXV (January 22, 1965), 38.

[3]Frank Smith, "The Readability of Junior High School Mathematics Textbooks," The Mathematics Teacher, LX (April, 1969), 290-91.

has been their lack of applications and relationship to real world problems. Kline strongly stated that physical problems arouse enormous interest in students and that by presenting mathematics as part of man's effort to understand and master his world, we are giving students a valid reason for studying mathematics. He emphasized that only about one-tenth of one per cent of our high school students become mathematicians. To hold the interest of the other 99.9 per cent it is obviously important that they obtain some knowledge of how mathematics can help them in their future lives.[1] Ahlfors reiterated Kline's position and stated that modern mathematics must be careful to introduce new terms by sufficient concrete preparation followed by genuine, challenging applications and not by thin and pointless material.[2]

Another criticism of the new mathematics program came from the fact that many youngsters who could best profit from the new curriculum were being taught by teachers who had not mastered the material themselves. In a study by Kipps it was found that one- to two-thirds of the teachers tested incorrectly answered items on the least common multiple; exponential notation; set relations; equivalent fractions,

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[1]Morris Kline, "A Proposal for the High School Mathematics Curriculum," The Mathematics Teacher, LIX (April, 1966), 330.

[2]Ahlfors, op. cit., p. 195.

decimals, and per cents; estimation; representing coordinate points; logic; and geometric concepts.[1]

One of the strongest philosophical arguments defending the modern mathematical program has been Bruner's famous and bold hypothesis that "any subject can be taught effectively in some intellectually honest form to any child at any stage of development." However, Bruner did state that his hypothesis had not been proven; but since there was no evidence refuting it, it can be used and is, in fact, essential in his thinking about the nature of curriculum.[2] It appears that some makers of modern mathematics programs have broadly defined intellectually honest and have assumed that if anything can be taught, then it should be taught.

The lack of objectives is a fitting final criticism. It seems that many modern math planners know where they are going generally, or at least want to go on their journey in the Rolls Royce of content, but do not know how to tell when they arrive. Many of the new mathematics programs presented for the elementary school has a smattering of set theory, logic, and mathematical terminology which is presented without well-conceived goals to which this knowledge can be

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[1]Carol Kipps, "Elementary Teachers' Ability to Understand Concepts Used in New Mathematics Curricula," The Arithmetic Teacher, XV (April, 1968), 367-70.

[2]Bruner, The Process of Education, p. 35.

directed. The makers of the new programs should have found it sensible to first define acceptable, proper, and desirable objectives which could be achieved through proper mathematical study.[1]

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[1]Fehr, op. cit., p. 85.

CHAPTER III

PROCEDURE

The procedure used to determine the effect of modern mathematics on the achievement of seventh grade students at Manhattan Junior High School included the selection of the sample, the use of a measuring device, and the research procedure and design used to carry out the project.

Description of the Sample

The sample consisted of 400 students, an independent sample of 100 students from each seventh grade class at Manhattan Junior High for each of four years from 1967 to 1970. The subjects, both boys and girls, were selected randomly by choosing every fourth name from an alphabetical list of all seventh grade students for each year. The 100 subjects for 1967 were selected first, then 1968, then 1969, and finally 1970.

Measuring Device

The instrument used to measure mathematical achievement was the Stanford Achievement Test, 1964 edition, Form W for seventh-grade. Scores in the eight areas of the test were included in the study. These areas were: Paragraph Meaning, Spelling, Language, Arithmetic Computation, Arithmetic Concepts, Arithmetic Applications, Social Studies, and

Science. The reliability coefficients for the mathematical part of the test ranged from .86 to .93 as presented by Riedesel.[1]

The instrument used to measure the intelligence quotient (IQ) of each student was the Short Form of the California Test of Mental Maturity.

Research Procedure and Design

To collect the data the experimenter obtained the files from the counselors at both Manhattan High School and Manhattan Junior High School. In these files the results of the California Test of Mental Maturity and the Stanford Achievement Test of the seventh grade were recorded. From these files the following information was placed on computer cards: (1) Identification number, (2) the year the subject was in the seventh grade, (3) the intelligence quotient score, (4) sex, (5) paragraph meaning percentile score, (6) spelling percentile score, (7) language percentile score, (8) arithmetic computation percentile score, (9) arithmetic concepts percentile score, (10) arithmetic applications percentile score, (11) social studies percentile score, and (12) science percentile score.

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[1]C. Alan Riedesel, "Stanford Achievement Tests: Arithmetic Tests," *The Sixth Mental Measurements Yearbook*, ed. O. K. Buros (Highland Park, New Jersey: Crypton Press, 1965), p. 910.

The data were then analyzed by computer with the mean and standard deviation for each variable calculated for each sample. Next, all possible correlations were calculated. An analysis of variance was then performed with the Scheffe Test of Multiple Comparisons. Each of the seventh grade class groups were analyzed for each of the sex, IQ, and achievement variables.

CHAPTER IV

RESULTS

Results of this study fell into three main areas: (1) class differences in arithmetic computational achievement among the four class groups, (2) class stability in other skill areas among the four class groups, and (3) comparison by correlation of all skills within each class.

Results indicated that achievement in computation of Manhattan Junior High School Seventh Graders was significantly lower for the years 1969 and 1970 than for the years 1967 and 1968. As indicated in Fig. 1, the means for the 1967 and 1968 class were higher than the means for the 1969 and 1970 classes. The percentile mean for achievement in arithmetic computation for 1967 was 55.16; for 1968 it was 61.11; for 1969 it was 41.26; and for 1970 it was 41.80.

As reported in Table 6 of Appendix A, the 1967 class group differed significantly at the .01 level from the 1969 class group with $F(3,396) = 4.05$. The 1967 group differed significantly at the .05 level from the 1970 class group with $F(3,396) = 3.74$. The 1968 class group also differed significantly from the 1969 group at the .01 level with $F(3,396) = 8.26$, and differed significantly from the 1970 group at the .01 level with $F(3,306) = 7.81$. Groups 1967 and 1968 did not differ significantly between themselves,

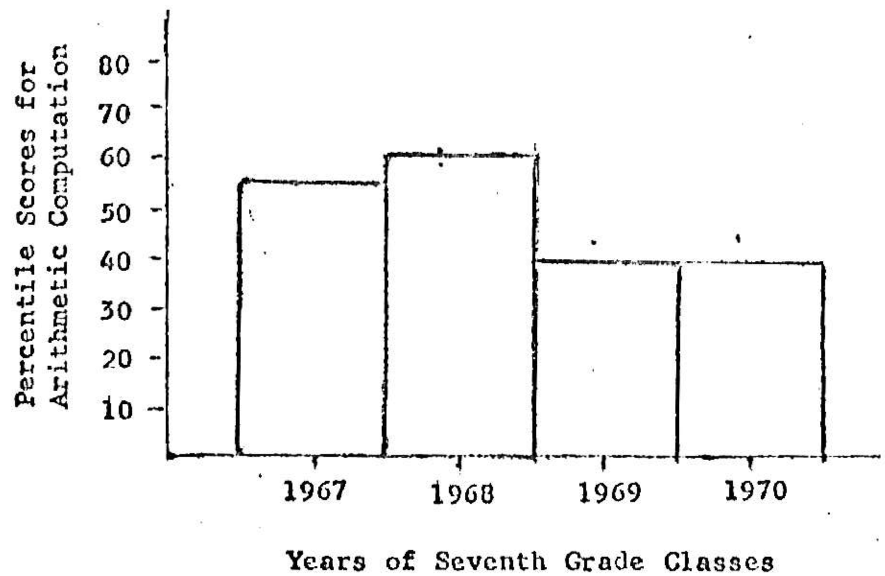

Figure 1. Percentile Scores for Arithmetic Computation on the Stanford Achievement Test for each of the Seventh Grade Classes 1967 through 1970 at Manhattan Junior High

nor did groups 1969 and 1970 differ significantly between themselves.

Tables 1-10 of Appendix A present the comparison of the four class groups for each of the variables in the study. It can be noted from the tables that only one variable, Arithmetic Computation, indicated any significant differences among the four Seventh Grade Class groups. For the other variables--IQ, Sex, and achievement skills measured on the Stanford Achievement Test for Paragraph Meaning, Spelling, Language, Arithmetic Concepts, Arithmetic Applications, Social Studies, and Science--there were no significant differences indicated between class groups.

The means for IQ presented in Table 1 were very nearly the same for each of the four groups and did not differ significantly. The variance for Sex was also non-significant as reported in Table 2.

In Table 7 on Arithmetic Concepts, it can be observed that the means for the class groups of 1967 and 1968 were higher than the means for 1969 and 1970, but these differences were not significant. Also in the skill of Arithmetic Applications it can be observed from Table 8 that the 1967 and 1968 groups had higher means than the 1969 and 1970 groups, but this difference was also non-significant. It should be noted that the differences in Arithmetic Applications between the 1968 class group and the 1969 class group was 9.11 percentile points, a large difference, but not significant.

Tables 11-14 of Appendix B yielded some interesting correlational comparisons. It can be observed that IQ correlated highly with all of the skills measured on the Stanford Achievement Test for the Seventh Grade classes of 1967, 1968, 1969, and 1970. However, in the skills of Arithmetic Computation and Arithmetic Applications for the class group of 1970 there was a low correlation with IQ.

Focusing on the mathematical skills, it can be observed that all three skills of arithmetic, computation, concepts, and applications, correlated highly with each other for all four class groups. Figures 2, 3, and 4 demonstrate these high correlations.

Three other skills on the Stanford Achievement Test correlate highly with arithmetic computation. These skills were Language, Paragraph Meaning, and Social Studies. As can be observed from Fig. 5, Language had the highest correlation of the three to Arithmetic Computation.

Sex as a factor did not correlate highly with any other variables for all of the four groups represented in Tables 11-14. It was only in the correlation between Sex and Spelling and between Sex and Language that a somewhat consistent coefficient of .15 was maintained for all four class groups.

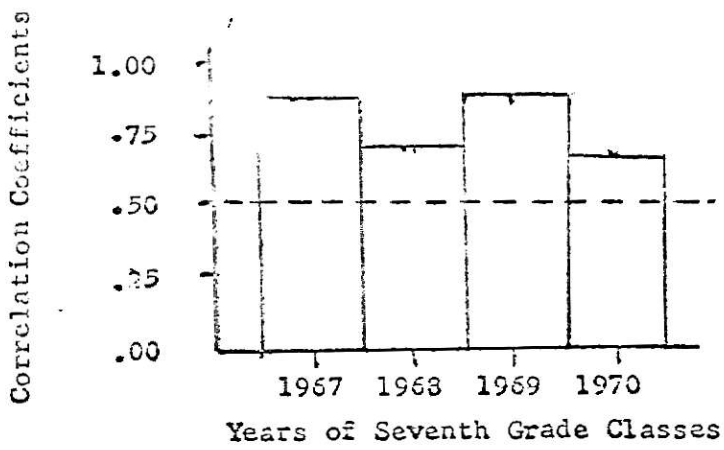

Figure 2. A Comparison by Correlation of Arithmetic Computation and Arithmetic Concepts for Manhattan Junior High Seventh Graders for the Years 1967 through 1970

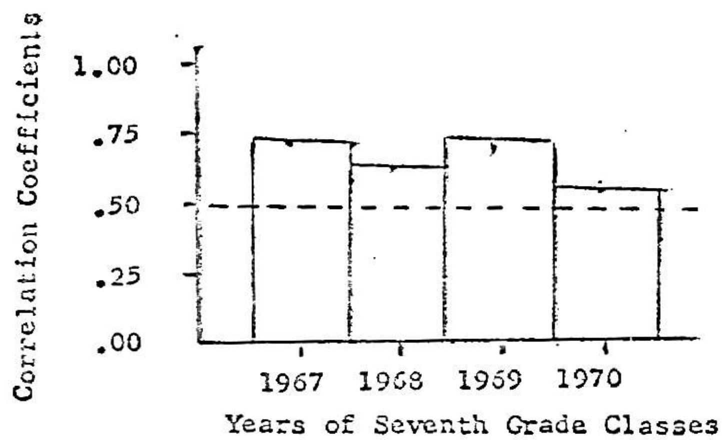

Figure 3. A Comparison by Correlation of Arithmetic Computation and Arithmetic Applications for Manhattan Junior High Seventh Graders for the Years 1967 through 1970

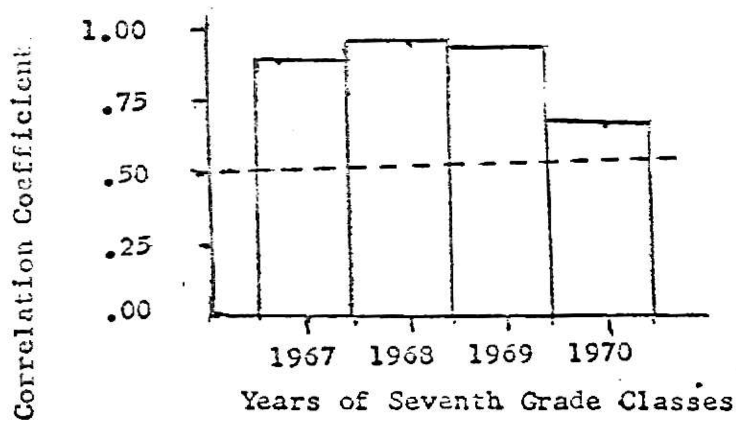

Figure 4. A Comparison by Correlation of Arithmetic Concepts and Arithmetic Applications for Manhattan Junior High Seventh Graders for the Years 1967 through 1970

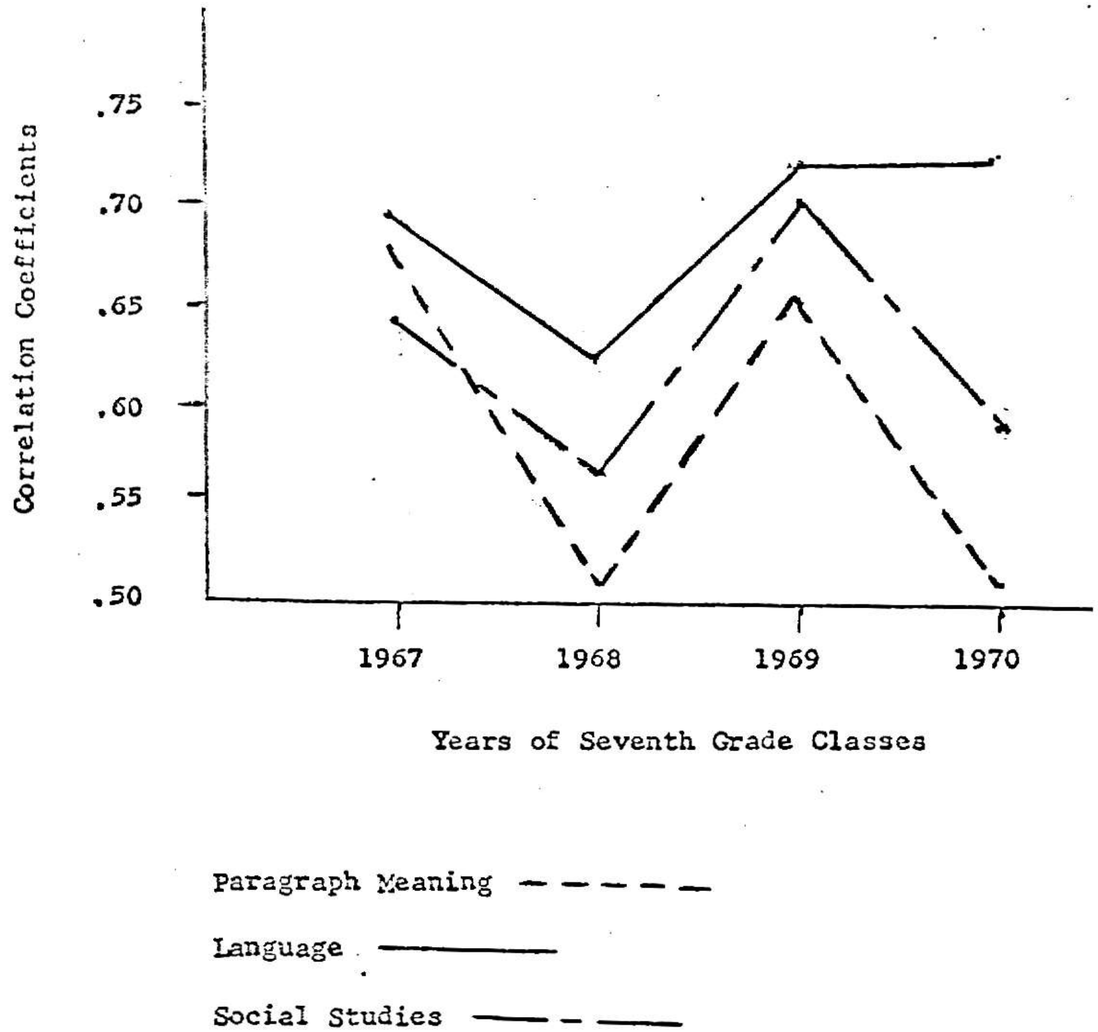

Figure 5. A Comparison by Correlation of those Skills on the Stanford Achievement Test which Correlate Highly with Arithmetic Computation for Manhattan Junior High Seventh Graders for the Years 1967 through 1970

CHAPTER V

DISCUSSION

The results of the study clearly indicate that the achievement of those students at Manhattan Junior High School who took modern mathematics in the seventh grade in the years 1969 and 1970 scored significantly lower on the computational section of the Stanford Achievement Test than those students who did not take the modern mathematics program in seventh grade in the years 1967 and 1968. The results of the study also revealed that IQ did not vary significantly over these four classes of students and that there was no significant decline in other subject skills as measured by the Stanford Achievement Test. This indicated that the modern mathematics program did reduce achievement of Junior high students in computational skills. This seems to be a plausible conclusion due to the fact that modern mathematics at this level emphasizes terminology and did not drill upon basic arithmetic skills. The modern mathematics also tends to deal in more abstractions and had few concrete applications in the computational area. It would be surprising indeed if the students had scored higher on arithmetic computational, for they would then be demonstrating achievement in a skill they had not been practicing.

One of the underlying assumptions starting the trend in modern mathematics was that mathematics needed to be more interesting and that the deficiencies of many students could be eliminated. However, it appears that those assumptions have not held true because of the abstraction of modern mathematics and the absence of fundamental learning in basic computational skills. A more successful approach may have been more concrete applications of a practical nature which would increase understanding and hopefully increase interest in turn.

The logical extention of this study should be an evaluation of the modern mathematics program and revision of curriculum so that valuable computational skills are not ignored. It is also extremely important that some acceptable and realistic objectives be defined for modern mathematics curricula so that students can achieve these objectives through proper mathematics study.

Interestingly enough there was no measured decline in arithmetic concepts and arithmetic applications with the introduction of the modern mathematics. This was probably because the area of concepts and applications is more abstract than computation and has a similar content to that of the modern mathematics courses.

Other results that were expected was the high correlation of IQ with arithmetic skills and with other skills measured by the Stanford Achievement Test. The results of this study on the relationship of IQ to Stanford Achievement Test skills seemed to indicate that the California Test of Mental Maturity and the Stanford Achievement Test measure very closely the same aspects of intelligence and that one test has some degree of predictability for the other test.

One aspect of the study that was interesting was the high relationship between arithmetic computation and language skills, between computation and paragraph meaning skills, and between computation and social studies skills. It may be that there is a great similarity between the cognitive skills and use of symbols in arithmetic computation, language, social studies, and paragraph meaning. However, the study does not give any indications as to the cause of the high correlation between computation and the skills of language, paragraph meaning, and social studies. This is an area that suggests further study through a more detailed research design and analysis.

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APPENDIX A

APPENDIX A

Table 1. Analysis of Variance for IQ of Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

	Scheffe Test for Multiple Comparisons			
Class Groups	1967	1968	1969	1970
1967	0.0	0.21	0.33	0.09
1968	0.21	0.0	1.07	0.02
1969	0.33	1.07	0.0	0.77
1970	0.09	0.02	0.77	0.0
MEAN	114.23	115.69	112.39	115.19
STDV	17.32	11.14	12.03	10.24

APPENDIX A

Table 2. Analysis of Variance for Sex* of Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

Class Groups	Scheffe Test for Multiple Comparisons 1967	1968	1969	1970
1967	0.0	0.53	0.79	0.06
1968	0.53	0.0	0.03	0.23
1969	0.79	0.03	0.0	0.42
1970	0.06	0.23	0.42	0.0
MEAN	1.45	1.54	1.56	1.48
STDV	0.52	0.50	0.50	0.50

*In this study the number 1 denotes male and 2 denotes female.

APPENDIX A

Table 3. Analysis of Variance for Paragraph Meaning on the Stanford Achievement Test by Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

	Scheffe Test for Multiple Comparisons			
Class Groups	1967	1968	1969	1970
1967	0.0	0.47	0.11	0.85
1968	0.47	0.0	0.13	0.06
1969	0.11	0.13	0.0	0.36
1970	0.85	0.06	0.36	0.0
MEAN	60.08	64.65	62.26	66.27
STDV	29.60	25.01	29.18	25.32

APPENDIX A

Table 4. Analysis of Variance for Spelling on the Stanford Achievement Test by Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

Class Groups	Scheffe Test for Multiple Comparisons			
	1967	1968	1969	1970
1967	0.0	0.40	0.07	0.05
1968	0.40	0.0	0.13	0.75
1969	0.07	0.13	0.0	0.25
1970	0.05	0.75	0.25	0.0
MEAN	55.88	59.72	57.54	54.48
STDV	27.66	23.22	24.59	23.32

APPENDIX A

Table 5. Analysis of Variance for Language on the Stanford Achievement Test by Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

	Scheffe Test for Multiple Comparisons			
Class Groups	1967	1968	1969	1970
1967	0.0	0.00	0.58	1.19
1968	0.00	0.0	0.52	1.11
1969	0.58	0.52	0.0	0.11
1970	1.19	1.11	0.11	0.0
MEAN	60.85	60.60	55.88	53.73
STDV	28.04	25.31	28.29	24.64

APPENDIX A

Table 6. Analysis of Variance for Arithmetic Computation on the Stanford Achievement Test by Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

	Scheffe Test for Multiple Comparisons			
Class Groups	1967	1968	1969	1970
1967	0.0	0.74	4.05[a]	3.74[b]
1968	0.74	0.0	8.26[a]	7.81[a]
1969	4.05[a]	8.26[a]	0.0	0.01
1970	3.74[b]	7.81[a]	0.01	0.0
MEAN	55.16	61.11	41.26	41.80
STDV	30.80	26.38	29.51	25.82

[a]Group difference is significant at the .01 level.

[b]Group difference is significant at the .05 level.

APPENDIX A

Table 7. Analysis of Variance for Arithmetic Concepts on the Stanford Achievement Test by Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

	Scheffe Test for Multiple Comparisons			
Class Groups	1967	1968	1969	1970
1967	0.0	0.01	0.38	0.18
1968	0.01	0.0	0.48	0.26
1969	0.38	0.48	0.0	0.03
1970	0.18	0.26	0.03	0.0
MEAN	63.27	63.86	58.87	60.21
STDV	31.07	26.63	31.41	27.88

APPENDIX A

Table 8. Analysis of Variance for Arithmetic Applications on the Stanford Achievement Test by Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

Class Groups	1967	1968	1969	1970
	Scheffe Test for Multiple Comparisons			
1967	0.0	0.03	1.54	0.80
1968	0.03	0.0	2.03	1.16
1969	1.54	2.03	0.0	0.12
1970	0.80	1.16	0.12	0.0
MEAN	60.87	62.04	52.93	55.15
STDV	26.91	27.47	25.41	24.45

APPENDIX A

Table 9. Analysis of Variance for Social Studies on the Stanford Achievement Test by Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

Class Groups	1967	1968	1969	1970
	Scheffe Test for Multiple Comparisons			
1967	0.0	0.05	0.36	0.14
1968	0.05	0.0	0.14	0.02
1969	0.36	0.14	0.0	0.05
1970	0.14	0.02	0.05	0.0
MEAN	61.83	60.40	57.98	59.45
STDV	28.13	24.17	27.79	24.53

APPENDIX A

Table 10. Analysis of Variance for Science on the Stanford Achievement Test by Manhattan Junior High School Seventh Grade Classes from 1967 through 1970

	Scheffe Test for Multiple Comparisons			
Class Groups	1967	1968	1969	1970
1967	0.0	0.04	0.30	0.18
1968	0.04	0.0	0.13	0.05
1969	0.30	0.13	0.0	0.02
1970	0.18	0.05	0.02	0.0
MEAN	61.21	59.81	57.20	58.10
STDV	31.66	28.75	31.15	27.60

APPENDIX B

APPENDIX B

Table 11. A Comparison with Correlation Coefficients of IQ, Sex, and Test Areas on the Stanford Achievement Test for Manhattan Junior High School's Seventh Grade Class of 1967

Variables	I Q	Sex	Paragraph Meaning	Spell-ing	Lang-uage	Arith. Computa-tion	Arith. Concepts	Arith. Appli-cations	Social Studies	Science
I Q	1.0000	0.1579	0.7081	0.5956	0.6916	0.5800	0.6538	0.6216	0.6723	0.6447
Sex	0.1579	1.0000	-0.0293	0.1562	0.1433	0.0485	-0.1070	-0.0810	-0.0258	-0.2047
Paragraph Meaning	0.7031	-0.0293	1.0000	0.7250	0.8762	0.6722	0.8109	0.7296	0.8989	0.8181
Spelling	0.5956	0.1562	0.7250	1.0000	0.7428	0.5886	0.5865	0.5038	0.6371	0.6045
Language	0.6916	0.1433	0.8762	0.7428	1.0000	0.6921	0.7976	0.6951	0.8283	0.7677
Arithmetic Computation	0.5800	0.0485	0.6722	0.5886	0.6921	1.0000	0.7649	0.7451	0.6388	0.5790
Arithmetic Concepts	0.6538	-0.1070	0.8109	0.5865	0.7976	0.7649	1.0000	0.7938	0.7827	0.6864
Arithmetic Applications	0.6216	-0.0810	0.7296	0.5038	0.6951	0.7451	0.7938	1.0000	0.7081	0.6735
Social Studies	0.6723	-0.0258	0.8989	0.6371	0.8283	0.6388	0.7827	0.7081	1.0000	0.8400
Science	0.6447	-0.2047	0.8181	0.6045	0.7677	0.5790	0.6864	0.6735	0.8400	1.0000
MEANS	114.230	1.450	60.080	55.680	60.850	55.160	63.270	60.870	61.830	61.210
STDV.	17.343	0.517	29.447	27.523	27.897	30.645	30.917	26.773	27.994	31.502

APPENDIX B

Table 12. A Comparison with Correlation Coefficients of IQ, Sex, and Test Areas on the Stanford Achievement Test for Manhattan Junior High School's Seventh Grade Class of 1968

Variables	I Q	Sex	Paragraph Meaning	Spell-ing	Lang-uage	Arith. Computa-tion	Arith. Concepts	Arith. Appli-cations	Social Studies	Science
I Q	1.0000	-0.1054	0.5395	0.4011	0.5734	0.5045	0.6117	0.6187	0.5725	0.6064
Sex	-0.1054	1.0000	0.0733	0.2884	0.1805	-0.0137	-0.1677	-0.0596	-0.0355	-0.1871
Paragraph Meaning	0.5395	0.0733	1.0000	0.5378	0.7306	0.5152	0.6162	0.6136	0.7800	0.7375
Spelling	0.4011	0.2884	0.5378	1.0000	0.5886	0.3710	0.2942	0.4223	0.4495	0.3756
Language	0.5734	0.1805	0.7306	0.5886	1.0000	0.6152	0.6474	0.6807	0.6703	0.5930
Arithmetic Computation	0.5045	-0.0137	0.5152	0.3710	0.6152	1.0000	0.6827	0.5964	0.5525	0.4322
Arithmetic Concepts	0.6117	-0.1677	0.6162	0.2942	0.6474	0.6827	1.0000	0.7428	0.7150	0.6966
Arithmetic Applications	0.6187	-0.0596	0.6136	0.4223	0.6807	0.5964	0.7428	1.0000	0.6540	0.6210
Social Studies	0.5725	-0.0355	0.7800	0.4495	0.6703	0.5525	0.7150	0.6540	1.0000	0.7959
Science	0.6064	-0.1871	0.7375	0.3756	0.5930	0.4322	0.6966	0.6210	0.7959	1.0000
MEANS	115.690	1.540	64.650	59.720	60.600	61.110	63.860	62.040	60.400	59.810
STDV.	11.087	0.498	24.884	23.106	25.187	26.244	26.496	27.337	24.053	28.609

APPENDIX B

Table 13. A Comparison with Correlation Coefficients of IQ, Sex, and Test Areas on the Stanford Achievement Test for Manhattan Junior High School's Seventh Grade Class of 1969

Variables	I Q	Sex	Paragraph Meaning	Spell-ing	Lang-uage	Arith. Computa-tion	Arith. Concepts	Arith. Appli-cations	Social Studies	Science
I Q	1.0000	-0.0283	0.7194	0.5487	0.7480	0.6578	0.6762	0.6786	0.7018	0.6633
Sex	-0.0283	1.0000	0.0329	0.1101	0.0928	0.0655	0.0002	-0.0933	-0.0349	-0.0671
Paragraph Meaning	0.7194	0.0329	1.0000	0.6863	0.8325	0.6575	0.7728	0.7407	0.8895	0.8269
Spelling	0.5487	0.1101	0.6863	1.0000	0.7700	0.6177	0.6484	0.6136	0.6716	0.5881
Language	0.7480	0.0928	0.8325	0.7700	1.0000	0.7140	0.7987	0.7607	0.8388	0.7840
Arithmetic Computation	0.6578	0.0655	0.6575	0.6177	0.7140	1.0000	0.7728	0.7272	0.6912	0.6530
Arithmetic Concepts	0.6762	0.0002	0.7728	0.6484	0.7987	0.7728	1.0000	0.8216	0.8181	0.7308
Arithmetic Applications	0.6786	-0.0933	0.7407	0.6136	0.7607	0.7272	0.8216	1.0000	0.7842	0.7171
Social Studies	0.7018	-0.0349	0.8895	0.6716	0.8388	0.6912	0.8181	0.7842	1.0000	0.8383
Science	0.6633	-0.0671	0.8269	0.5881	0.7840	0.6530	0.7308	0.7171	0.8383	1.0000
MEANS	112.390	1.560	62.260	57.540	55.880	41.260	58.870	52.930	57.980	57.200
STDV.	11.973	0.496	29.033	24.466	28.148	29.358	31.252	25.279	27.648	30.994

APPENDIX B

Table 14. A Comparison with Correlation Coefficients of IQ, Sex, and Test Areas on the Stanford Achievement Test for Manhattan Junior High School's Seventh Grade Class of 1970

Variables	I Q	Sex	Paragraph Meaning	Spell-ing	Lang-uage	Arith. Computa-tion	Arith. Concepts	Arith. Appli-cations	Social Studies	Science
I Q	1.0000	0.0351	0.6393	0.4531	0.5233	0.3747	0.5131	0.4066	0.5701	0.5006
Sex	0.0351	1.0000	0.0906	0.1475	0.1535	0.0168	-0.0838	-0.0882	0.0692	-0.1070
Paragraph Meaning	0.6393	0.0906	1.0000	0.6309	0.6545	0.5139	0.6199	0.5633	0.7853	0.6659
Spelling	0.4531	0.1475	0.6309	1.0000	0.6993	0.6086	0.5217	0.3801	0.5835	0.4506
Language	0.5233	0.1535	0.6545	0.6993	1.0000	0.7139	0.6506	0.5332	0.6705	0.5206
Arithmetic Computation	0.3747	0.0168	0.5139	0.6086	0.7139	1.0000	0.6657	0.5338	0.5777	0.4531
Arithmetic Concepts	0.5131	-0.0838	0.6199	0.5217	0.6506	0.6657	1.0000	0.6508	0.7018	0.5626
Arithmetic Applications	0.4066	-0.0882	0.5633	0.3801	0.5332	0.5338	0.6508	1.0000	0.6829	0.5736
Social Studies	0.5701	0.0692	0.7853	0.5835	0.6705	0.5777	0.7018	0.6829	1.0000	0.8075
Science	0.5006	-0.1070	0.6659	0.4506	0.5206	0.4531	0.5626	0.5736	0.8075	1.0000
MEANS	115.190	1.480	66.270	54.480	53.730	41.800	60.210	55.150	59.450	58.100
STDV.	10.187	0.500	25.189	23.265	24.514	25.687	27.739	24.328	24.407	27.461

THE EFFECT OF MODERN MATHEMATICS UPON ACHIEVEMENT IN ARITHMETIC COMPUTATION

by

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B.S., Kansas State University, 1968

AN ABSTRACT OF A MASTER'S REPORT

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Since the advent of modern mathematics in the school curriculum there have been many doubts raised by prominent educators and mathematicians as to the value of the new program. At Manhattan Junior High School in Manhattan, Kansas, the mathematics instructors, the school counselors, and school administrators have become concerned over the merits of the new program after reviewing the results of seventh grade students on the mathematics section of the Stanford Achievement Test. This study is an evaluation of the significance of modern mathematics upon the computational ability of seventh grade students by selecting a random sample of 100 students from each of the four years of seventh grade classes from the years 1967 through 1970.

Analysis by the Scheffe test of multiple comparisons revealed that the students who had taken modern mathematics did significantly poorer on the computational section of the Stanford Achievement Test than those students who had taken the traditional program. The study also revealed that intelligence as measured by the California Test of Mental Maturity did not differ significantly between the groups of students having the modern mathematics and the traditional mathematics. The other skills measured by the Stanford Achievement Test also remained stable for the two major groups showing that other skills had not changed from class to class.

Other results of the study were the high correlation between intelligence and achievement test skills. There was also a high correlation among computational, concepts, and applications skills in arithmetic.