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THE EFFECTS OF STUDYING CERTAIN MATHEMATICS COURSES ON MATHEMATICAL COMPETENCY IN SELECTED MICHIGAN HIGH SCHOOLS

by
Richard George Rust

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in the
University of Michigan
1964

Doctoral Committee:

Professor Stanley E. Dimond, Co-Chairman
Visiting Assistant Professor William M. Fitzgerald, Co-Chairman
Professor Phillip S. Jones
Lecturer Ray E. Kehoe
Associate Professor Wilfred M. Kincaid
Associate Professor Joseph N. Payne

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To my wife and children who have shared my problems throughout these years I dedicate this work in hopes that others may derive some practical value from it while attempting to build more effective mathematical programs.

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CHAPTER I

INTRODUCTION

The Need for the Study

Mathematics educators devote a large portion of their efforts to trying a variety of course offerings, devising appropriate instructional materials, or attempting different teaching approaches, in order to increase the number of competent mathematic students being graduated from our public high schools. The administrators and the curriculum consultants are an integral part of the team which strives to assure mathematical competency. But sometimes these educators do not have an opportunity to determine what effect these efforts have on the mathematical proficiency of the students. Concomitantly, neither do these educators have an opportunity to determine the attitudes toward mathematics developed by the students. Some seek to determine a relationship between attitude and the socio-economic class. Thus Markert indicates:

> . . . the number of high school semester credits earned by a student in traditional mathematics is significantly related to the socio-economic status of his family, when measured intelligence is controlled. Little is known about these relationships.[1]

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[1] Marlow Markert, "Social Status and Enrollment in Traditional Mathematics," Journal of Educational Research, LIV (1960), 79.

The effects certain courses have on mathematical proficiency have been questioned previously as is attested by some research in this area. In 1941, Cassidy related that during the past quarter century controversy over commercial mathematics courses and their content was rampant. He stated, "the courses had fallen into disrepute . . . it was not known how closely the subject satisfies the needs of the business world."[2] Anderson and Dixson, during a study of the double track program of mathematics in the Kansas Secondary Schools, arrived at the conclusion that the mathematics competency of those students who had had algebra and those who had had general mathematics (non-fused) was not significantly different.[3] In addition, they stated:

> During World War II the armed services confronted secondary school leaders with information which indicated that our schools were not producing an adequate number of men sufficiently proficient in mathematics to successfully defend their country without extensive re-education.[4]

Overfield concluded that the basic need for every student in mathematics regardless of which track he follows is, "To develop the individual's mathematical competence."[5]

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[2]Walter F. Cassidy, "The Course Content in Commercial Mathematics," The School Review, XLIX, (1941), 436-444.

[3]Kenneth E. Anderson and Lyle J. Dixson, "A Study of the Double Track Program of Mathematics in the Secondary Schools of Kansas," School Science and Mathematics, LII, (1952), 637-640.

[4]"The Second Report of the Commission on Post-War Plans," Mathematics Teacher, XXXVIII, (1945), 195-221.

[5]Ruth W. Overfield, "Emerging Practices in Mathematics in Bethlehem, Pennsylvania," in John R. Clark, ed., Emerging Practices in Mathematics Education, Twenty-second Yearbook (Washington, D. C.: National Education Association, 1954), pp. 244ff.

Investigators, also, have been curious about the effect of attitude on mathematical competence. Donovan A. Johnson states:

> One unique aspect about teaching attitudes is that we have no choice in the matter. We have no escape--attitude will inevitably be learned by the poor as well as by the superior students. Attitudes extend beyond the range of habits; they govern widely the use of knowledge.[6]

Davis stated: "It is clear, however, in reviewing the field, that the vast majority of investigators agree that interests, attitudes, and achievement do have a close relationship."[7] Yet another view is presented by O'Donnell, who, using a Remmer's attitude scale, concluded:

> . . . attitude toward arithmetic and a liking or disliking for the subjects appear to be somewhat different concepts. Students sometimes score high on an attitude toward arithmetic scale but express a dislike for the subject. They recognize the social, academic, and economic values of arithmetic but still have a dislike for it.[8]

Statement of the Problem

In this investigation, the problem was to determine the effect upon secondary school students of studying various sequences of mathematics in grades nine to eleven.

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[6]Donovan A. Johnson, "Attitudes in the Mathematics Classroom, University of Minnesota High School," School Science and Mathematics, XLVII (1957), 113.

[7]Alfred C. Davis, "A Study of the Reported Attitudes of Two Hundred and Forty Pupils in the Sault Schools Toward the Teaching of Mathematics," (Unpublished Masters Thesis, University of Michigan, 1938), p. 9ff.

[8]John Robert O'Donnell, "Levels of Arithmetical Achievement, Attitudes Toward Arithmetic and Problem Solving Behavior Shown by Prospective Elementary Teachers," (Unpublished Ed. D. dissertation, Penn State University, 1958).

In the investigation the following relationships were examined:

I. The mathematical proficiency of students who studied:

1. One year of mathematics compared with various combinations of two-year mathematics sequences.
2. Two years of mathematics compared with three years.
3. Different sequences of two-year mathematics courses. (This applies to different combinations of courses and the years in which they were studied.)
4. Mathematics courses offered by non-mathematics departments compared with mathematics courses offered in the mathematics department.
5. Various three-year mathematics sequences.
6. Different types of one-year mathematics courses.

II. The attitudes toward mathematics of students who studied the different sequences.

III. The correlation between mathematical proficiency and attitude toward mathematics.

IV. The mathematical proficiency of students whose fathers or guardians have different occupations.

V. The correlation between attitude and the father's or guardian's occupation.

VI. The mathematical proficiency of male students compared with female students within the previously discussed groups and the total sample.

Hypotheses of the Investigation

Stated as hypotheses, this investigation sought evidence to support or refute the following:

I. There is no significant difference in the mathematical proficiency of:

1. Students who have studied one year of high school mathematics and those who have studied two years.

2. Students who have studied two years of high school mathematics and those who have studied three years.

3. Students who have studied high school mathematics in ninth-tenth sequence as compared with those of the students who have studied high school mathematics in ninth-eleventh sequence.

4. Students who have studied two years of college preparatory high school mathematics when compared with those of students who have studied two years of general mathematics.

5. Students who have studied two years of general high school mathematics when compared with those of students who have studied one year of college preparatory and one year of occupational mathematics.

6. Students who have studied one year of general high school mathematics and one year of college preparatory mathematics when compared with those of students who have studied one year of general and one year of occupational mathematics.

7. Students who have studied one year of college preparatory, one year of general, and one year occupational high school mathematics when compared with those of students who have studied two years of college preparatory and one year of general mathematics.

8. Students who have studied two years of college preparatory and one year of general high school mathematics when compared with those of students who have studied two years of general and one year of college preparatory mathematics.

9. Students who have studied two years of college preparatory and one year of occupational mathematics when compared with students who have studied three years of college preparatory high school mathematics.

10. Students who have studied three years of college preparatory mathematics when compared with those of students who have studied two years of general and one year of occupational mathematics.

11. Students who have studied two years of occupational and one year of general high school mathematics when compared with those of students who have studied three years of general mathematics.

II. There is no significant difference in the mathematical proficiency scores of:

1. Low IQ male and female students who have studied two years of general mathematics compared with low IQ male and female students who have studied one year of college preparatory and one year of general mathematics.

2. High IQ male and female students who have studied two years of college preparatory mathematics compared with high IQ male and female students who have studied three years of college preparatory mathematics.

3. Average IQ male students who have studied one year of mathematics in a mathematics department and one year of mathematics in a non-mathematics department (commercial, for example) compared with average IQ male students who have studied two years of college preparatory mathematics.

4. Average IQ male students who have studied two years of college preparatory mathematics compared with average IQ male students who have studied two years of general mathematics.

5. Average IQ male students who have had one year of college preparatory and one year of general mathematics compared with average IQ male students who have studied two years of general mathematics.

6. Average IQ male students who have studied one year of college preparatory mathematics compared with average IQ male students who have studied one year of college preparatory and one year of general mathematics.

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8. Average IQ female students who have studied two years of general mathematics compared with average IQ female students who have studied one year of college and one year of general mathematics.

9. Average IQ female students who have studied two years of college preparatory mathematics compared with average IQ female students who have studied one year of college preparatory and one year of general mathematics.

10. Average IQ female students who have studied one year of college preparatory and one year of general mathematics compared with average IQ female students who have studied two years of general mathematics.

11. Average IQ female students who have studied three years of college preparatory mathematics compared with average IQ female students who have studied two years of college preparatory mathematics.

12. Average IQ female students who have studied one year of college preparatory, one year of general, and one year of occupational mathematics compared with average IQ female students who have studied two years of general and one year of occupational mathematics.

13. Average IQ female students who have studied three years of college preparatory mathematics compared with average IQ female students who have studied two years of general and one year of occupational mathematics.

14. One-year general mathematics students compared with one-year algebra students.

15. One-year general mathematics students compared with any of the sub-categories within the two-three year classification.

16. One-year algebra students compared with any of the sub-categories within the two-three year classification.

III. There is no significant difference in the attitude toward mathematics of the students who have studied various sequences of mathematics.

IV. There is no significant correlation between mathematical proficiency and attitude toward mathematics.

V. There is no significant correlation between mathematical proficiency and the father's or guardian's occupation.

VI. There is no significant correlation between attitude and the father's or guardian's occupation.

VII. There is no significant difference between male and female students in the various groups of the total sample.

The General Plan of the Investigation

To obtain evidence concerning these hypotheses, eight Michigan public high schools were selected according to criteria which will be described in Chapter III. A mathematical proficiency test and an attitude scale were administered to each junior in these schools. A personal information form was completed by each student to ascertain the occupation of the parent or guardian, the year in which mathematics courses were studied, and the title of each mathematics course taken. After these data were obtained from 1,351 students, the information was processed with automatic computing machinery and analyzed as described in Chapter IV.

Definitions

Sequential or traditional courses are defined as courses required for the college preparatory curriculum. These are Algebra I and II and Plane Geometry.

General or Consumer Mathematics are defined as courses which are basically designed to accomplish the twenty-nine mathematics items which should be mastered according to the Second Report of the Commission on Post-War Plans.[9] The courses include, in addition to others not listed here, the following topics: arithmetic, algebra, informal geometry, and elementary business applications of mathematics. They are courses required of students who are not in the academic curriculum.

Functional competency or mathematical proficiency are defined as ability to perform the twenty-nine mathematical items of the Second Report of the Commission on Post-War Plans as measured by the Snader General Mathematics test.

Attitudes are defined as emotionalized feelings of students for or against something. Positive attitude is defined or described by examining the attitude score obtained by application of the attitude scale administered to each subject.

Organization of the Study

The balance of the dissertation is organized as follows. Chapter II consists of a review of the literature. Chapter III describes the procedure followed in collecting and organizing the data. Chapter IV contains analyses of the data. Chapter V consists of conclusions and suggested areas for further research.

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[9] Op. cit.

CHAPTER II

A REVIEW OF THE LITERATURE

Courses--Their Origins and Curriculum Influences

The secondary schools in the United States have offered, in addition to their regular sequential mathematics courses, a large variety of other courses in mathematics. Their nomenclature includes such titles as general mathematics, business mathematics, consumer mathematics, shop mathematics, basic mathematics and refresher mathematics. Each of these courses represents an attempt to meet the secondary student body's increasing need for functional competence. In the following paragraphs a brief history of these endeavors is presented.

Arithmetic--Where It's Studied

During early colonial days the term "common arithmetic"[1] was listed among the studies of the third year for Harvard College. In an era dominated by the classics, "Common Arithmetic" was not considered a classic. As a matter of fact, "what we in the English speaking world call 'Arithmetic' was

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[1] Harry E. Benz, "Arithmetic in the Senior High School," W. D. Reeve, editor, Arithmetic in General Education, Sixteenth Yearbook of National Council of Teachers of Mathematics (New York: Bureau of Publications, Teachers College, Columbia University, 1941), pp. 119-139.

practically never considered a part of mathematics until about the beginning of the seventeenth century."[2] Frequently only salesmen, navigators, merchants, and other tradesmen bothered to study arithmetic. Arithmetic was studied usually in the lower grades and in apprentice training programs and was not present in the "Latin Grammar" schools of that day. Gradually it became accepted that arithmetic was an elementary subject quite apart from other branches of mathematics such as algebra, geometry, plus other sequentials which were practically the only constituents of the secondary mathematics curriculum. This was most clearly stated by Benz.[3] The idea grew that arithmetic was properly an elementary school subject, and that it did not belong in the high school, while algebra and geometry were thought to be more suited to the mental powers of the secondary school pupils. The tide of relegating arithmetic to elementary school alone was somewhat stemmed by the twentieth century inception of the junior high school movement. The authors of The Reogranization of Mathematics in Secondary Education, referring to junior high school, said,

> . . . that the mathematics for these three years should be planned as a unit with the purpose of giving each pupil the most valuable mathematical training he is capable of receiving in these years, with little reference to courses which he may, or may not, take in succeeding year.[4]

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[2] Ibid.

[3] Ibid.

[4] John J. Kinsella, "Some Reflections on the General Mathematics Situation," School Science and Mathematics, LIV (1954), 432.

McCormick stated,

> . . . the new organization (The Junior High School) gave opportunity to introduce a new kind of mathematics in these three grades. Many educators have recommended a broad exploratory course in the junior high schools.[5]

According to Benz the 1923 Committee's report was more successful in injecting some algebra and geometry into the seventh-eighth grades than it was in injecting arithmetic into the high school curriculum.[6]

The Early Importance of Sequential Courses

As pointed out previously the sequential courses completely dominated secondary mathematics offerings in the late nineteenth century. This tendency, as will be pointed out below, was clearly accentuated by the cardinal recommendations of the Committee of Ten organized through the initiative of President Eliot of Harvard. Betz[7] and McCormick[8] plus numerous others discuss the influence of the Committee of Ten in 1892 but one finds Betz's summary[9] of its influence most complete. The Committee of Ten's contributions lie mostly in the field of administration. It presented the often debated "unit"

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[5]Clarence McCormick, The Teaching of General Mathematics in the Secondary Schools of the United States (New York: Bureau of Publications, Teachers College, Columbia University, 1929), p. 29.

[6]Benz, op. cit., pp. 119-139.

[7]William Betz, "Five Decades of Mathematical Reform--Evolution and Challenge," Mathematics Teacher, XLIII (1950), 377ff.

[8]McCormick, op. cit., p. 14.

[9]Betz, op. cit.

credit, standardized prerequisites for college entrance, time allotment for specific subjects, and other recommendations applicable primarily to the college-bound student even though the high schools accepted the recommendations as "law" for the whole student body. Possibly it never occurred to members of the Committee of Ten to consider whether or not the sequential courses should even be offered to all high school students.

Moore--A Sign of Change and What Followed

As influential as the Committee of Ten report has been, it did not seem to alter the number or types of secondary mathematics courses in the early twentieth century. A new direction was initiated when E. H. Moore, retiring president of the American Mathematical Society in 1902, presented a famous speech relevant to a long overdue modification of our secondary mathematics curriculum. Moore's address was credited as the stimulant which triggered a sustained effort to correlate topics, concepts, and units of the various heretofore completely insular subjects such as algebra, geometry, and trigonometry.[10,11] Schorling[12] goes one step

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[10]Ernest R. Breslick, A Half Century of Science and Mathematics Teaching (Chicago: Association of Science and Mathematics Teachers, 1950), p. 71.

[11]McCormick, op. cit., p. 20.

[12]Raleigh Schorling, "Suggestions for the Solution of an Important Problem That Has Arisen in the Last Quarter of a Century," in Charles M. Austin, Chairman of the Yearbook Committee, A General Survey of Progress in the Last Twenty-Five Years, First Yearbook of National Council of Teachers of Mathematics (Oak Park, Illinois: Oak Park and River Forest Township High School, 1926), p. 58ff.

further in analyzing several possible foreign influences that served as an impetus to Moore since it is well known that he was personally familiar with the European mathematics scholars such as Tropfke and Klein of Germany and Perry of England. The American mathematicians were impressed with their de-emphasis of pure manipulation and emphasis of mathematical applications in science and industry.

G. W. Myers, a student of Moore in 1906, published one of the first General Mathematics books, presenting a clear picture of the inter-relations which were attempted between topics chosen from various branches such as arithmetic, algebra, and geometry.[13] The subjects, however, were not treated separately, but were made to serve each other in the development of the subject matter of the course. The tenth-grade book was published in 1910 and was very much like the one for the ninth grade except that demonstrative geometry instead of algebra received major emphasis.

Not only new texts were produced but also a variation in the methods of teaching were instituted. Moore strongly recommended concrete constructive mathematics demanding the development of a laboratory system of instruction. (One might draw a direct comparison with Perry's movement which was reputed to be a move toward the practical side of mathematics.) The laboratory method is complicated, requires expensive equipment, excessive preparation time and incessant originality. Its major purpose is to teach the pupil by

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[13] G. W. Myers, First Year Mathematics for Secondary School (Chicago: University of Chicago Press, 1906).

doing. It was stated that the prerequisites of success were so ominous that only the most daring and ingenious mathematics educators were talented enough to experiment in the field.

Concomitantly in some schools a parallel treatment of mathematics was originated. As the name implies, it refers to an organization of mathematics courses whereby a student might study algebra one day and geometry the next, or any other combination, thus presenting the students with more opportunities to recognize the interrelationships among the subjects. An important point must be made here, however, that no effort was made to merge the two subjects which were being taught simultaneously. Nevertheless the fused, correlated, and/or parallel courses functioned as a beachhead. From this modest beginning were to develop innumerable courses.

The Influence of "The Reorganization of Mathematics in Secondary Education"

The culminating action in the early twentieth century move to reorganize secondary mathematics was somewhat a product of inertia. The leading mathematicians of this period were stimulated to the point that the Mathematical Association of America appointed a National Committee on Mathematical Requirements which in turn published the frequently quoted report, "The Reorganization of Mathematics in Secondary Education," in 1923. Unlike the Committee of Ten, this committee was not dedicated to purely administrative procedures.

Betz[14,15] and Kinsella[16] both agree that national commissions and committees have exerted more weight in curriculum matters than any other single factor. And of these, "the 1923 Committee most directly influenced curriculum organization and classroom practice."[17] One might designate the 1923 report as the necessary reenforcement to secure permanently a ninth-grade general mathematics course along with other nonsequential courses on the mathematics curriculum front. The report stated,

> The authors of this document conceived of general mathematics as a means of giving the student a 'broad view of the whole field of elementary mathematics,' and a glimpse of the use of mathematics in later vocational life. Referring to junior high school years, the course for these three years should be planned as a unit with the purpose of giving each pupil the most valuable mathematical training he is capable of receiving in those years with little reference to courses which he may or may not take in succeeding years. The mathematics of early high school years must be considered worthwhile by the students on the basis of what it does for him here and now. His experience in other school subjects and life out of school should begin to mean more to him because he is taking a course in secondary mathematics.[18]

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[14]Betz, op. cit.

[15]William Betz, "The Reorganization of Secondary Education, A Study of Present Problems and Trends With Particular Reference to Mathematics," in W. D. Reeve, editor, Mathematics in Modern Education, Eleventh Yearbook of National Council of Teachers of Mathematics (New York: Bureau of Publications, Teachers College, Columbia University, 1936), p. 60.

[16]Glenadine Gibb, et al., "Mathematics," Encyclopedia of Educational Research (New York: Macmillan, 1960), pp. 596-807.

[17]Ibid., pp. 796-807.

[18]Kinsella, op. cit.

During this same period the American high schools were rapidly becoming institutions for the great masses of high school age children whose mathematics needs varied greatly. Betz tells us,

> From 1900 to 1940 enrollment figures of the four year high school rose from 519,251 to 6,601,444; an increase of 1171 per cent while the entire population changed from seventy-six million to nearly one hundred thirty-one million; an increase of 73 per cent. The high schools could no longer be described as merely a priming area for future college scholars.[19]

Naturally this growth not only necessitated alteration of objectives but it also compelled the schools to expand their course offerings to meet the demand of increased span of ability and interests. The pressure of this increase in high school pupils coupled with the 1923 Commission report precipitated the influx of new courses.

Commercial Arithmetic--A Development of the Report

As a by-product of this trend one finds commercial arithmetic including what we call consumer mathematics material developing early in the twentieth century even though its existence was questioned by the 1923 Report.

> They expressed doubts about the value of adult consumer mathematics for young students. They wondered whether these boys and girls, in terms of interest and maturity, were ready for such items as stocks, bonds, and taxation.[20]

Nevertheless, the Report emphasized the fact that the ninth grade would be the last time a considerable portion of the

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[19]Betz, op. cit., p. 377ff.

[20]Kinsella, op. cit., p. 432.

students would have contact with mathematics and that they should receive the mathematics most likely to be useful to them in the business and industrial world. There is little doubt that the further development of commercial courses somewhat stems from an interpretation, even if a false one, of the 1923 Report. Hussey in a discussion of mathematics for commercial pupils in 1924 points out,

> We must keep in mind that most pupils drop out of high school at the end of, or during the tenth year. Investigators tell us that algebra does not help them to stay in school. Therefore, our course must contain matter as valuable as possible to these pupils who leave. . .[21]

In 1941, Cassidy related that, during the past quarter century, controversy over commercial mathematics courses and their content was rampant. He further stated that the courses had fallen into disrepute. This could be attributed to the lack of a challenging program (one swelled with repetitious review of elementary arithmetic) and the fact that it was not known how closely the subject satisfies the needs of the business world. Stimulated by the plight of this course, Cassidy attempted to validate some basic mathematics items for the curriculum in commercial mathematics. He proposed to accomplish the validation by subjecting common mathematics items to specific tests or criteria of social and vocational usefulness.

> By 'usefulness' is meant fitness for some desirable, practical purpose. Social usefulness in this investigation means the preparation of the individual through

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[21]Frederick Hussey, "Four Years of Mathematics for Commercial Pupils," Mathematics Teacher, XVII (1924), pp. 411-421.

> a course in Commercial mathematics for effective social contacts and relationships with his associates in his daily community life. Vocational usefulness in this investigation means the preparation of the pupil, through a course in commercial mathematics, for efficient business life.

Direct conclusions drawn from the study were:

> It is possible by use of the procedure and criteria used in this investigation to validate 102 basic mathematical items for the curriculum in commercial mathematics. A course in commercial mathematics can be built around the validated items with some degree of scientific accuracy. Since every item which satisfied the criterion for social utility was found to have satisfied also at least two of the five criteria for vocational utility, it would seem that final differentiation between social and vocational utility is difficult.[22]

In 1940 the Report of the Joint Commission of the National Council of Teachers of Mathematics and the Mathematical Association of America suggested that a social-economic mathematics of one semester course should be offered primarily for those in commercial courses and for those who expected to study the social sciences later. Although some schools offered business mathematics or commercial mathematics in either the tenth, eleventh, or twelfth grades many high schools encouraged their non-sequential mathematics students to take a semester consumer mathematics course during the last year of high school.[23,24]

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[22]Walter F. Cassidy, "The Course Content in Commercial Mathematics," The School Review, XLIX (1941), pp. 436-444.

[23]Kinsella, op. cit., p. 432.

[24]Howard F. Fehr, "The Administration of Mathematics Education in the United States of America," School Science and Mathematics, L (1955), pp. 340-344.

Another Course--Ninth Grade General Mathematics; Its Content and Success Questioned

Kinsella[25] in agreement with others points out that although the number and variety of courses increased profoundly between 1920 and 1940, many high school students received a mathematical education leaving much to be desired as a consequence of a deemphasis of the significance of mathematics. That is, the number of mathematics courses recommended and required was less than most mathematics educators thought advisable.

Carnahan, commenting on new courses, their titles, and their contents, stated,

> Another of the agreements corollary to the agreement on a name is what subjects belong in the ninth-year mathematics. This agreement is so universal that there is no hesitancy in naming the subjects. They are: (1) algebra, (2) arithmetic, (3) informal geometry, (4) numerical trigonometry. The above statements can be easily verified. Take up a dozen books written within the last fifteen years for ninth-year mathematics, books that are reasonably widely used, and eleven of the twelve will include treatments of the four subjects listed above. As a basis for comparison examine a dozen books in wide use twenty-five years ago; no such agreement will be found. Such present agreement on subjects marks distinct progress.[26]

Further evidence of existing problems in producing mathematically competent students is found in articles by

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[25]Kinsella, op. cit., p. 432.

[26]Walter H. Carnahan, "Ninth Year Mathematics," Mathematics Teacher, XL (1947), pp. 79-83.

Braverman,[27] Guiler,[28] Mallory,[29] Potter,[30] Jones,[31] and Tobey[32] who have written articles which fit into a general pattern best described by the following points: (1) Pupils enrolled in ninth-year mathematics exhibit wide differences in native ability, previous preparation, habits, attitudes, and intellectual interests; (2) The ninth-year mathematics will be the last for the majority of students who take it; (3) Personality problems more frequently arise in the slower groups; (4) The administrative and teaching techniques required in these courses is a science within itself; (5) The majority of the students may be low in mathematical skills; (6) A conscious effort must be made to keep the course from being classified by the pupils as a course for stupid pupils.

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[27]Benjamin Braverman, "The Problem of Ninth Year Mathematics," Mathematics Teacher, XXXIV (1941), pp. 309-316.

[28]Walter S. Guiler, "Difficulties in Fractions Encountered by Ninth Grade Students," The Elementary School Journal (1945), pp. 146-157.

[29]Virgil Mallory and Marv A. Potter, Education in Mathematics for the Slow Learner, National Council of Teachers of Mathematics Pamphlet (Washington: National Education Association, 1958), pp. 5-36.

[30]Mary A. Potter, "Mathematics for the Lower Fifty Per Cent," Bulletin of National Association of Secondary School Principals, XXXVIII (1954), pp. 96-103.

[31]Phillip S. Jones, "A Report on Progress in Mathematics Education," School Science and Mathematics, XLIX (1949), pp. 465-474.

[32]William S. Tobey, "General Mathematics," Mathematics Teacher, XXXIX (1946), pp. 59-65.

Cogan,[33] Rummell,[34] and Sobel[35] typify articles conceding the existence of numerous problems in ninth-year mathematics but are steeped in potential solutions such as: (1) Lucid explanation of the relations between mathematics and the pursuit of life facilitates a formation of a deeper understanding, appreciation, and aptitude toward mathematics; (2) Utilization of unusual approaches to the study of the common; (3) Vary the assignments, workload, within the class-ability grouping or individualization within the class; (4) Adolescents need security which can be supplied by general mathematics--something with which they are for the most part familiar, yet the course must present something new in order to point toward a challenge for the average student; (5) Don't reduce the course to a review of elementary arithmetic.

Variety in Mathematics Offerings Needed Beyond the Ninth Grade

So continue adages, methods, and paneceas relevant to the area of ninth-year general mathematics. But the problem did not stop at the ninth-grade level. As the number of secondary students became larger, more inclusive, more varied, the problems spilled over into the upper grades of high school. High schools were confronted with the problem of providing more

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[33] E. J. Cogan, "A New Approach to High School Mathematics," Mathematics Teacher, L (1957), pp. 347-350.

[34] Frances V. Rummell, "She Made Mathematics Almost Flunk-Proof," The Education Digest, XXIV (1958), pp. 32-34.

[35] Max H. Sobel, "Getting Started in a Ninth Grade Non-academic Class," Mathematics Teacher, LII (1959), pp. 143-146.

than a single ninth-grade general mathematics course for some non-academic students. Demands arose for other mathematics courses. A potent argument was that the armed services had indicated that the schools "were not producing an adequate number of men sufficiently proficient in mathematics to successfully defend their country without extensive re-education."[36] The first Report of the Commission on Post War Plans arrived at the conclusion that the schools should provide three series of courses as follows:

> Sequential Mathematics, Related Mathematics, and Social Mathematics. By sequential courses we mean the four years of work (9-12) inclusive providing rigor and continuity and to be obtained by greatly improving the traditional sequence: algebra, etc. By related courses we mean courses that will meet the needs of the large number of persons who will continue to be absorbed by industry fairly early in life--such courses are to be obtained by improving the existing general mathematics courses. But we need a third series of courses--courses that will insure mathematical competency in everyday human affairs. . .[37]

Double Track--Academic and Non-Academic Courses

Thus one might summarize that the numerous improvisations and innovations were epitomized in the First Report of the Commission of Post War Plans. Mathematicians and mathematics educators were acutely aware of the necessity of increasing functional competency in mathematics. They attempted constantly from the beginning of the twentieth century through

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[36]"The Second Report of the Commission on Post War Plans," Mathematics Teacher, XXXVIII (1945), pp. 195-221.

[37]"The First Report of the Commission on Post War Plans," Mathematics Teacher, XXXVII (1944), pp. 226-232.

1944 to devise courses which would meet the needs of the large masses. But the First Report of the Commission on Post War Plans was in reality only a beginning.

Much more significant and following not more than a year later was the Second Report of the Commission on Post War Plans, May, 1945, which highlighted a list of twenty-nine items that should, if mastered, enable any high school pupil to become mathematically competent without taking the traditional sequential courses. This report supported at least a double-track system in mathematics even in small schools. The Second Commission on Post War Plans gave wholehearted support to the desirability of having a double-track ninth-grade program. Many leaders in mathematics education followed as is evidenced by numerous articles recommending and supporting this plan.[38,39,40,41]

A large number of noted mathematicians and educators were not sincerely convinced of the wiseness of having even a double-track program. Not only is there a question of the value of a double-track system but there is the ever present moot question whether one track is more successful than

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[38]Milton W. Beckmann and Carl C. Wirth, Developing Mathematical Literacy in Nebraska's Youth (Lincoln: Teachers College, University of Nebraska, 1953), pp. 505-512.

[39]Harl R. Douglass, "The Double Track Plan of High School Mathematics," Mathematics Teacher, XXXVI (1943), pp. 57-61.

[40]F. G. Lankford, Jr., "What Next in General Mathematics?" (Ann Arbor: University of Michigan, Mathematics Education Summer Lecture Series, 1961).

[41]George Mallison, "Final Report to the Central Association of Science and Mathematics Teachers of Its Committee on the Significance of Mathematics and Science in Education," School Science and Mathematics, LIV (1954), pp. 119-143.

the other. More specifically, does one track produce pupils who are more proficient mathematically than the other? The reason for the double track appears to be based on the argument that algebra is suitable for some students and not for others, who have usually been placed in courses labeled general mathematics, consumer mathematics, or the like.

McCormick[42] enumerates at least four prominent research papers completed in the 1920's which attribute a slightly higher degree of proficiency to students who have had two years of general mathematics (remembering that general mathematics in these cases means fused or correlated mathematics) than those who had had two years of sequential mathematics. He adds that there were uncontrollable variables such as the fact that the unified courses were new, different, taught by highly motivated instructors, and quite popular in the eyes of the students of that time. Anderson,[43] during a study of the double-track program of mathematics in the Kansas Secondary Schools, arrived at the conclusion that the mathematics competency of those students who had had algebra and those who had had general mathematics (non-fused) was not significantly different. Therefore, he questioned the advisability of having a double track. Beckmann investigated a similar problem in Nebraska and concluded that although the increase in proficiency was unbelievably low, general mathematics students' proficiency scores excelled to a

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[42]McCormick, op. cit., pp. 40-69.

[43]Kenneth E. Anderson and Lyle J. Dixson, "A Study of the Double Track Program of Mathematics in the Secondary Schools of Kansas," School Science and Mathematics, LII (1952), pp. 637-640.

measurable degree.[44] Casting some light on this problem were the comments of Hartung,[45] Gager,[46] Jones et al.,[47] and Rosskopf,[48] all of whom stated that the success or failure of a course regardless of its nature is heavily dependent upon the unmeasurable uncontrollable variable, how well the subject is taught. Then too, numerous authors mentioned the status factor which algebra possesses as opposed to the average, common or even derogatory position which other non-sequential mathematics occupies in some situations. As previously mentioned, Markert showed that there was an important relationship between the socio-economic status of the family and the number of traditional mathematics courses taken by students.[49]

Paradoxically the prestige course, algebra, is on the one hand criticized as being archaic and on the other praised as the very epitome of mathematical perfection.

> The mathematics now taught in the secondary schools is at least three hundred years old and some of it is

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[44]Milton W. Beckmann, "Is General Mathematics or Algebra Providing Greater Opportunity to Attain the Recommended Competencies?" Journal of Educational Research, XLVII (1954).

[45]Maurice L. Hartung, "Modern Methods and Current Criticisms of Mathematical Education," School Science and Mathematics, LV (1955), pp. 85-90.

[46]William A. Gager, "Functional Mathematics Grades Seven Through Twelve," Mathematics Teacher, XLIV (1951), pp. 297-301.

[47]Phillip S. Jones, et al., "A Report on Progress in Mathematics Education," School Science and Mathematics, XLIX (1949), pp. 465-474.

[48]Myron F. Rosskopf, "The Place of Mathematics in General Education," School Science and Mathematics, XLIX (1949), pp. 565-570.

[49]Marlow Markert, "Social Status and Enrollment in Traditional Mathematics," Journal of Educational Research, LIV (1960), p. 79.

> more than three thousand years old. Ninth grade algebra includes problems similar to some found on the Rhind Papyrus. Geometry is essentially that which Euclid knew. Our present algorithms of arithmetic are more than five hundred years old.[50]

On the other hand, Beatley's[51] feelings about the cultural value of mathematics are equally well expressed by Breslich.

> As helpful as the study of the mathematical needs in practical life may be, the teacher should not overestimate its importance. They should not be used as the only basis for determining the objective of mathematics. Values far greater than the practical are to be attained. The continued study of mathematics should bring power to think, to appreciate, and to do. . . When leaders in mathematics state the objectives of the teaching of mathematics, they invariably speak of culture, discipline, power of reasoning, understandings, control over environment, modes of thinking, appreciations, and ability to apply, as the chief ends to be attained. However, tests to measure attainment of such objectives are lacking. We are just beginning to learn how to construct them.[52]

The Secondary Mathematics Curriculum Report, May 1959,[53] Dale Carpenter,[54] Daniel Parkinson,[55] and Developing Mathematical

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[50]Joseph Kennedy, "Administrative Practices in Secondary Mathematics Curriculum Experiments," School Science and Mathematics, LXI (1961), pp. 34-38.

[51]Ralph Beatley, "Coherence and Diversity in Secondary Mathematics. A Personal Philosophy Based on the Opinion of Many Leaders in Education," in W. D. Reeve, editor, Teaching of Mathematics, The National Council of Teachers of Mathematics Eighth Yearbook (New York: Bureau of Public Teachers College, Columbia University, 1933), p. 178.

[52]Ernest R. Breslich, The Administration of Mathematics in Secondary Schools (Chicago: The University of Chicago Press, 1935), p. 154.

[53]Secondary School Curriculum Commission of the National Council of Teachers of Mathematics, "The Secondary Mathematics Curriculum," A Report Printed in Mathematics Teacher, V (1959), pp. 389-417.

[54]Dale Carpenter, "Planning a Secondary Mathematics Curriculum to Meet the Needs of All Students," Mathematics Teacher, XLII (1949), pp. 41-48.

[55]Daniel S. Parkinson, "The Alternative Course in Secondary Mathematics," Journal of Educational Research, LIV (1960), pp. 128-132.

Literacy in Nebraska's Youth[56] point out that algebra and general mathematics should not be chosen or assigned on the basis of intelligence alone. They state that the goal of the students involved should have a decided bearing on placement in either course. Unfortunately in some instances the general mathematics courses have been courses for students who either were uninclined or unqualified to do the sequential work. The system utilized in La Grange, Illinois, is described as follows,

> Offering two courses in mathematics to ninth grade pupils creates certain administrative problems. Our procedure: The pupils are assigned to either general mathematics or algebra instead of electing one or the other. The assigning is done during the summer by two mathematics teachers who make a careful study of the data on the pupils.[57]

But Gager comments, "Moreover, because of the two-year requirement, it is believed by the end of the tenth year there will be about the same mathematical competence of an individual no matter which track is followed."[58] The Second Report of the Commission of Post War Plans foresaw such a problem and adequately provided for it.

> It should be made clear to pupils that the two parallel courses of the ninth grade are both tremendously worthwhile but that they do have very different goals and experiences for pupils with different backgrounds and levels of ability. The material can and

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[56]Beckman, op. cit.

[57]G. E. Hawkins, "Mathematics in the Modern School Program," School Science and Mathematics, XLVIII (1947), pp. 569-572.

[58]William A. Gager, "Functional Mathematics Grades Seven Through Twelve," Mathematics Teacher, XLIV (1951), pp. 297-301.

> should be offered in such a way to challenge the pupil to his best effort. Pupils should be told that general mathematics is organized differently, that it offers a greater variety of topics, and that it is related more directly with immediate applications. They may well be told that good work in general mathematics demands as much time and exertion as algebra.[59]

Hartung concludes,

> Whether a school subject is more or less intellectual depends upon what happens in the minds of the pupils. This in turn, clearly depends upon their abilities and interests. It also depends upon the objectives deemed important by the teacher, and the teacher's skill in selecting and organizing learning experiences. It is therefore not very fruitful to try to prove in general that one subject is better than another.[60]

Multi-Track System Becomes More Prominent

The extensive discussions of a dual-track system in actuality precipitated the exact converse of what its critics might have anticipated. In numerous instances the dual-track system has been or is being replaced by a multi-track system. To many mathematics educators this did not come as a complete surprise since intonations of such a move were inherent within the Report of the Joint Commission of the National Council of Teachers of Mathematics and the Mathematics Association of America, even though the later Second Report of the Commission on Post War Plans decisively supported the dual track. Rather than accepting the multi-track system as a negation of or contrary to The Second Report of Commission for Post War Plans,

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[59]Second Report of the Commission on Post War Plans, Mathematics Teacher, XXXVIII (1945), pp. 195-221.

[60]Maurice L. Hartung, "Modern Methods and Current Criticisms of Mathematical Education," School Science and Mathematics, LV (1955), pp. 85-90.

Irvin observed, "It seems that the majority of the cooperating specialists evidently believe that the recommendations of the Commission of Post War Planning furnish a 'point of departure' from which to begin."[61] As was discussed earlier, the critics of the dual track pointed out the lack of definite improvement in mathematical competence as a major argument against wide adoption of a double-track program. As a result of evidence and counter evidence, this has become practically a moot question. Nevertheless seeds of unsteadiness were inherent within the very structure and composition of the general mathematics classes as has been pointed out by numerous authors including Irvin,[62] Carpenter,[63] and Jones[64] who summarized,

> The program noted above implies that one current difficulty in many general mathematics courses is a confusion or consolidation in one class of persons of very low competency needing remedial work with competent persons needing to make substantial progress in new mathematical areas which will help them to be effective individuals and citizens.[65]

W. D. Reeve is much more outspoken,

> THE GENERAL MATHEMATICS PROGRAMS ARE USUALLY GEARED TO THE SLOWER STUDENTS, LEAVING THE BETTER STUDENTS

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[61] Lee Irvin, "The Organization of Instruction in Arithmetic and Basic Mathematics in Selected Secondary Schools," Mathematics Teacher, XLVI (1953), pp. 235-240.

[62] Ibid., p. 43.

[63] Dale Carpenter, "Planning a Secondary Mathematics Curriculum to Meet the Needs of All Students," Mathematics Teacher, XLII (1949), pp. 41-48.

[64] Phillip S. Jones, et al., "A Report on Progress in Mathematics Education," School Science and Mathematics, XLIX (1949), pp. 465-474.

[65] Phillip S. Jones, "Experiments and Trends in General Mathematics," The University of Michigan School of Education Bulletin, XXIV (1952), pp. 33-36.

> UNCHALLENGED. (The italics are directly from the quote.) Textbooks for these general mathematics courses are usually written for those students with more general interests. This situation arises from the desire to satisfy the need of a majority of the students. . . . a two track mathematics program has some merits. It has the disadvantage of requiring the student to make an early decision as to his or her life work. Too often the choice between the college preparatory and the general mathematics is made on a superficial basis. Indeed, there does not appear to exist a scientific basis for such a decision.[66]

Reeve proposed to inject in the high school schedule an experimental program (one on which he had worked since the 1920's) entitled--An Integrated Mathematics Program.

More frequently the multi-track programs consisted of refresher, industrial, drafting, business, and shop mathematics. Numerous schools after exhaustive curriculum experimentation have inaugurated various forms of multi-track programs. Reports of these experimental programs are as numerous as any other single mathematics topic: i.e., Carpenter's,[67] Gallant's,[68] Mayor's,[69] Ostrander's,[70] and Hogenmiller's.[71] The last

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[66]W. D. Reeve, "The Need for a New National Policy and Program in Secondary Mathematics," Mathematics Teacher, XLVIII (1955), pp. 2-9.

[67]Carpenter, op. cit., p. 45.

[68]Howard L. Gallant, "A Look at a Multiple Track Mathematics Program," The Bulletin of the National Association of Secondary School Principals, XLIII (1959), pp. 55-56.

[69]John R. Mayor, "A Suggested Course of Study in Mathematics," The Bulletin of the National Association of Secondary School Principals, XXXVIII (1954), pp. 80-87.

[70]Ida A. Ostrander, "A General Mathematics Program for a Large High School," The Bulletin of the National Association of Secondary School Principals, XLIII (1959), pp. 46-50.

[71]R. E. Hogenmiller, "A Science and Mathematics Program for Terminal Students in High School," The Bulletin of the National Association of Secondary School Principals, XLII (1958), pp. 109-117.

writer described minutely a diverse program for terminal students in the following categories:

> (A) Vocational--usually a boy will train for a trade; (B) General--frequently has no particular drive, simply wants to be graduated; (C) Mentally retarded is usually a group formed on basis of I.Q. between 50 and 75; (D) Commercial--student plans to enter the business world; (E) Emotionally disturbed--this student, like the mentally retarded, has a special counselor. Especially designed for one or two groups of these students is a series of semester courses entitled, "Basic Mathematics," A second category of courses entitled "Industrial Mathematics" is for another group. A third section of courses is for sophmores who need a basic knowledge of mathematics and included therein is an advanced course for those who find the beginning sophmore course beneficial. Another feature similar to that of numerous high schools is the existence of a mathematics proficiency test at the end of the junior year.

Functional Competence

A purpose of curriculum experimentation is to assist pupils in achieving their goal of becoming more competent, happy, successful citizens. Mathematics educators are convinced that one must possess a certain degree of mathematical competency in order to be a successful citizen. Although the term functional competence is not of recent origin, it appears more frequently in the literature since the publication of the Second Report of the Commission on Post War Plans. Included among its numerous provisions is a list of twenty-nine essentials for functional competence in mathematics, all very similar to the earlier Schorling's work.[72] Also included was the following statement:

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[72]Schorling, in addition to being influential in the field of mathematics and education, was chairman of the Commission.

> A good student may become functionally competent in mathematics without taking any of the traditional sequential courses in high school and he certainly can achieve the needed competence, as defined in the check list in less than four years, as for example, by taking one or two years of general mathematics. Although ability to compute effectively with whole numbers, common fractions, decimals, and per cents is still the crux of functional competence, this ability is achieved by only a fraction of the school's total population during the first eight grades, and is more likely to deteriorate than to improve in later grades unless something definite is done about it.[73]

Innumerable articles have appeared and still are appearing on functional competence. Overfield,[74] Wren,[75] Zant,[76] and Schorling[77] (as early as 1927) described in detail the predicament of general mathematics, made recommendations for the teaching of functional competence within such courses and suggested goals, objectives, and skills prerequisite to success for all pupils who have passed through these courses. Authors writing over a period of at least thirty years did not concur but one reviewing the articles sees a strand of

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[73] Second Report of the Commission on Post War Plans, Mathematics Teacher, XXXVIII (1945), pp. 195-221.

[74] Ruth W. Overfield, "Emerging Practices in Mathematics in Bethlehem, Pennsylvania," in John R. Clark, editor, Emerging Practices in Mathematics Education, The National Council of Teachers of Mathematics, Twenty-second Yearbook (Washington, D.C.: National Education Association, 1954), p. 244ff.

[75] Lynwood F. Wren, "Learning for Functional Competence in Arithmetic," Reprint from the Spring 1958 Packet (Boston: D. C. Heath & Co.), p. 4.

[76] James H. Zant, "What Are the Mathematical Needs of the High School Student?" Mathematics Teacher, XLII (1949), pp. 75-78.

[77] Raleigh Schorling, "General Mathematics," Mathematics Teacher, XX (1927), pp. 65-81.

similarity. Schorling's general description of the proposed contents of a ninth grade course which will insure mathematical competency is all inclusive.

> General Mathematics is an introductory basic, exploratory course in which the simple and significant principles of arithmetic, algebra, intuitive geometry, statistics, and numerical trigonometry are taught so as to emphasize their natural and numerous interrelations.[78]

Overfield concludes the basic need for every student in mathematics regardless of which track he follows is, "To develop the individual's mathematical competence."[79] Wren tackled an elusive question,

> What does it mean for a person to be functionally competent in mathematics? Any intelligent answer to this question will, perforce, be relative. It can only have significance when it is framed in the context of: (1) basic student needs as defined by the demands of cultural environment; (2) essential instructional responsibilities as implied by the potential of student development; (3) accepted curriculum patterns as prescribed by the dictates of educational philosophy.[80]

Nebulous as this may appear to be, it is of necessity so, since rigidity would nullify its application to the hundreds of various situations. The essence of his report, is that one can not possibly define mathematical competency without thoroughly pondering the aforementioned three points in the light of his own school system.

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[78] Ibid., p. 65.

[79] Overfield, op. cit., p. 244ff.

[80] Wren, op. cit., p. 4.

General Education For All

The Progressive Education Association advocated a general education for all in order to increase this functional competence.[81] They quoted the Second Report of Commission on Post War Plans as follows:

> It is also clear that every pupil is potentially both citizen and consumer; hence all pupils should be given some understanding of the persistent problems that confront most of our families; viz., social security, taxation, insurance against the numerous hazards of life, and ways and means of stretching the dollar in order to buy the maximum of material comforts and values with a given income.[82]

Marino[83] and Rosskopf[84] most nearly typify the attitude of the proponents of mathematics in general education.

> The primary aim of general or social mathematics is to teach students the skills, abilities, attitudes, appreciation, and habits that will be of value to them in every day life situations thus making them more efficient and intelligent members of society.[85]

These articles continue with an explanation that general education is not just for those who cannot handle the sequential courses but it benefits all students. Schorling was also a staunch supporter of General Education. He wrote,

> We need to reject the fallacy that there is a conflict between general education and the rigorous

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[81] Some pertinent facts about this movement are expertly recorded in General Education in a Free Society (Cambridge, Massachusetts: Harvard University Press, 1945).

[82] Second Report of the Commission on Post War Plans, Mathematics Teacher, XXXVIII (1945), pp. 195-221.

[83] Anthony Marino, "Mathematics for the Non-Academic Student," Mathematics Teacher, XXXIX (1946), pp. 229-235.

[84] Rosskopf, op. cit., pp. 565-570.

[85] Marino, op. cit., pp. 229-235.

> training of the future scientist. We are not dealing with an either/or proposition. Both tasks must be done, and done extremely well in the high school years.[86]

Meanings and Concepts Lead to Understanding

Advocates of General Education weren't alone in their support of meanings or concepts. Mathematics educators were quick to point out in the Second Report of Commission on Post War Plans, "The main purpose of a general mathematics course in the ninth grade is to provide such experiences as will insure growth in understanding of the basic concepts and improvement in the necessary skills."[87] References to this part of the report continue to evoke articles relevant to concepts. Charles Henry Butler's thorough coverage of concepts in 1935 supports the contention that concepts are not new, "The important role of mathematical concepts in the development of mathematical ability can hardly be doubted. This would seem to be particularly true with respect to those abilities above the level of mere computation."[88] . . . Thus the development of ability to do functional thinking is one of the great aims of mathematical instruction, and that mastery of concepts is indispensible to the achievement of this aim."[89] Reuben S.

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[86]Raleigh Schorling, "Mathematics in General Education," School Science and Mathematics, XLIX (1949), p. 298ff.

[87]Second Report of the Commission on Post War Plans, Mathematics Teacher, XXXVIII (1945), pp. 195-221.

[88]Charles Henry Butler, "Mastery of Certain Mathematical Concepts by Pupils at the Junior High School Level," Mathematics Teacher, XXV (1932), pp. 117-165.

[89]Ibid.

Ebert[90] discusses the cultivation of one's ability to generalize which definitely depends upon excellent conceptual background. He summarized his investigations by compiling a list of fifty-four bona fide generalizations that adept mathematics pupils exhibited. Mathematicians' concern about concepts is well expressed by the Association for Supervision and Curriculum Development,

> Attention to concept formation makes for economy and permanency in learning. . . The identification of certain basic concepts which give meaning to modern living or which define the basic ideas comprising a field of knowledge. (Previous to this explanation the subject was what determines the significance of certain portions of a field of knowledge.) The point being that such concepts are basic ideas, an understanding of which enables one to grasp effectively an entire field of knowledge. These ideas form the basis on which individual items of knowledge within a field can be rightly interpreted and chosen for study. . . True understanding of central organizing concepts is less subject to forgetting than is the accumulation of a mass of meaningless detail.[91]

Spaced or Spiral Learning Leads to Better Concept Formation

While striving to perfect a method of teaching that would help attain basic mathematical concepts psychologists and mathematics educators experimented extensively with "spaced learning" or "spiral learning."

> Modern psychology has proved the effectiveness of "spaced learning." That is, "bunched learning" is not so productive of lasting values as "spaced learning"

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[90] Reuben S. Ebert, "Generalization Abilities in Mathematics," Journal of Educational Research, XXXIX (1946), pp. 671-681.

[91] Association for Supervision and Curriculum Development, A Look at Continuity in the School Program (Washington: National Education Association, 1958), p. 132.

> . . . The practice of specifying a certain year as terminal has encouraged the tendency to crowd into our courses a long list of somewhat unrelated topics that must then be studied in a single and difficult year of adolescence, on the ground that it was the pupil's "last chance" of obtaining some glimpse of secondary mathematics.[92]

Phillip S. Jones concluded,

> . . . meanings and understandings are not all-or-none affairs achieved or not achieved at first contact with a concept or problem, but meaning is really a continuum which develops and expands as children see the same concepts and processes from a variety of different situations.[93]

Hartung[94] and Jones[95] concurred with the last quotation with relation to a continuum of learning.

A View of the Academic Course Developments

More recently, within the past ten to twelve years, there has been extensive experimentation and consideration given to the sequential courses. Though some new content is introduced in these courses, the result of these improvisions to be enumerated below also stems from a change in method of presentation with an eye toward improving the attitude of sequential (college bound) students.

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[92] Commission on the Place of Mathematics in the Secondary School, The Mathematical Association of America, Inc., and National Council for Teachers of Mathematics (1938), p. 77.

[93] Phillip S. Jones, "The Role of Continuity in a Mathematics Program," The University of Michigan School of Education Bulletin, XXVIII (1957), p. 86.

[94] Maurice L. Hartung, "Mathematics in the Total School Program," Mathematics Teacher, XLI (1958), pp. 336-343.

[95] Phillip S. Jones, "The Importance of Articulation," The Bulletin of the National Association of Secondary School Principals, XLIII (1959), pp. 107-111.

One of the National Council of Teachers of Mathematics latest publications, Revolution in School Mathematics, A Challenge for Administrators and Teachers,[96] most adequately summarizes the development, functionings, and affects of recent mathematics course innovations. Leading the experimental groups has been School Mathematics Study Group (SMSG) which aims to improve mathematics teaching in secondary schools, to persuade more students to study mathematics, and in turn to insure them that the mathematics that they study is appropriate to the world of today. SMGS began by preparing sample text books for junior high school and the college preparatory programs in grades nine through twelve. They have extended their efforts to the elementary level and to courses not designated as college preparatory.

Another important study is the University of Illinois Committee on Secondary School Mathematics Project which "emphasizes cognizance of the nonverbal awareness stage in inductive learning that converts the classroom experience into that of actual discovery..."[97] With reference to this study Babb states,

> The University of Illinois Committee on Secondary School Mathematics is seeking to develop a mathematics program such that the first year or preferably the first

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[96] National Council of Teachers of Mathematics, in Frank B. Allen, Director, The Revolution in School Mathematics, A Challenge for Administrators and Teachers, A Report of Regional Orientation Conferences in Mathematics (Washington, D.C.: National Education Association, 1961), p. 90.

[97] Gertrude Hendrix, "Learning by Discovery," Mathematics Teacher, LIV (1961), pp. 290-299.

> two years may be taken as a terminal course in mathematics. In this sense, we are seeking a one track program for all students who reach the ninth year with normal competence in arithmetic through percentage and intuitive geometry. We are not claiming to meet the needs of students who arrive in the ninth year with a fourth grade or even a sixth grade mathematical maturity.[98]

Still another program, "The Ball State Teachers College Experimental Programs, initiated under the direction of Charles Brumfiel is planned for pupils in grades seven through twelve. The program emphasizes the axiomatic structure of mathematics and precision of language. The texts are characterized by careful attention to logical development."[99]

The University of Maryland has a modern mathematics project which has focused on the development of experimental courses for grades seven and eight. The courses include some of the conventional seventh and eighth grade materials, a new approach to the introduction of elements of algebra and geometry, and a direct emphasis on the precise use of mathematical language.

These new programs are generally characterized by an increased emphasis on rigor and more cognizance of the

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[98]D. S. Babb, "An Experimental High School Mathematics Program," A Report by Professor Babb, Department of Electrical Engineering, University of Illinois. Excerpts quoted in Mathematics for the Secondary School, by W. D. Reeve (New York: Henry Holt Co., 1954), p. 437.

[99]National Council of Teachers of Mathematics, in Frank B. Allen, Director, The Revolution in School Mathematics, A Challenge for Administrators and Teachers, A Report of Regional Orientation Conferences in Mathematics (Washington, D.C.: National Education Association, 1961), p. 20.

aesthetic qualities of mathematics. The originators of the program who are usually optimistic as well as those who are pessimistic might gain a more healthy perspective by heeding Phillip S. Jones, ". . . significantly different content and pedagogical approaches as well as important old concepts are to be found in many of the 'new' programs, and will, properly used, improve the outcome of mathematics."[100]

Within this first section of the literature review, the writer has briefly pointed to the development of various mathematics courses beginning with the early concept of arithmetic and continuing through the present day innovations in sequential courses. As explained earlier, the increase in the number of secondary school students necessitated mathematics curriculum innovations. The mathematics curriculum was greatly influenced by innumerable curriculum reforms at the local and national level. These forces precipitated the increase of courses, past and present, with the objective of increasing the functional competence of secondary mathematics students.

Psychological Approaches Relevant to Mathematics

Introduction

In an effort to ascertain the effect of certain courses on functional competency in mathematics, the preceding section

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[100]Phillip S. Jones,"'Modernizing' The Mathematics Curriculum," The University of Michigan School of Education Bulletin, XXXIII (1962), pp. 71-77.

has traced briefly the general development of the variety of mathematics courses found in the curriculum today. In this section are reviewed articles relevant to the psychological approach to the teaching of secondary mathematics.

While reviewing the literature, it is not unusual to find articles defending one teaching approach or the other as a panacea. When one considers the gamut of articles in this vein, it appears that the apostles of certain methods can be placed in one of the three well-known psychological approaches to the teaching of mathematics. Therefore, the writer has attempted to describe and define each of the three: Mental Discipline; Incidental Approach; and the Meaning Theory. Each school of thought is convinced that its approach not only increases competency simply from an overt routine scientific approach, but also directly affects the intangible area of attitudes toward mathematics. Reviews of articles and research are included which present the multi-facet approach to attitude, what they are, and their effect on mathematics competency.

The Mental Discipline Approach

The mathematics curriculum was based upon the mental discipline approach to teaching and learning. This definitely is related to the drill concept of learning. Brownell outlines this theory as follows:

> Arithmetic consists of a vast host of unrelated facts and relatively independent skills. The pupil acquires facts by repeating them over and over again until he is able to recall them immediately and correctly. He develops the skills by going through the

> processes in question until he can perform the required operations automatically and accurately. The teacher need give little time to instructing the pupil in the meaning of what he is learning, the ideas and skills involved are either so simple as to be obvious even to the beginner, or else they are so abstruse as to suggest postponement of explanations until the child is older and is better able to grasp their meanings. The main points in the theory are (1) arithmetic, for the purposes of learning and teaching, may be analyzed into a great many units or elements of knowledge and skill which are comparatively separate and unconnected, (2) the pupil is to master these almost innumerable elements whether he understands them or not, (3) the pupil is to learn them in the form in which he will subsequently use them, and (4) the pupils will attain these ends most economically and most completely through formal repetition.[101]

Although this description of one of the popular systems of teaching is vividly described by Brownell, he is not alone in his description, interpretation, and evaluation. Betz,[102] McCormick,[103] Schorling,[104] Hussey,[105] and Reeve,[106] generally coincide in their statements which may be summarized by a quotation from the Second Report of Commission on Post War Plans, "It is possible to expect from drill both too much and too little. Drill--having children do essentially the same thing over and over again--cannot develop understanding."

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[101] W. A. Brownell, "Psychological Considerations in the Learning and the Teaching of Arithmetic," in W. D. Reeve, editor, Teaching of Arithmetic, The Tenth Yearbook of the National Council of Teachers of Mathematics (New York: Bureau of Publications, Teachers College, Columbia University, 1935), pp. 1-31.

[102] Betz, op. cit., pp. 1-255.

[103] McCormick, op. cit., p. 1.

[104] Schorling, op. cit., p. 58ff.

[105] Hussey, op. cit., p. 412.

[106] William David Reeve, Mathematics for the Secondary School (New York: Henry Holt Co., 1956), p. 547.

The Incidental Approach

Constructive criticism demanded something better than drill. Thus, the incidental approach developed partly as a reaction to the drill theory and as a result of extensive research in the area of everyday utilization of mathematics by the general public. The theory is that children, while studying in social situations, will learn arithmetic concommitantly, through natural behavior. Because they learn as they see a need for the knowledge, it was believed that the vitality of the situation would provide adequate impetus to afford thorough understanding and efficient retention. Brownell points out that this theory developed partly from the emergence of the child-centered school. He further states,

> Some years ago the more radical leaders in this reform movement did not hesitate to insist that all education must be derived from, and must be organized and directed with respect to, children's self-determined interests and needs. This extreme position, which is held less widely now than formerly, rested upon a faulty psychological basis. Interests and needs were supposed to arise spontaneously, as the product of some kind of inner compulsion which made their appearance more or less automatic at a predictable time.[107]

Since the period when incidental learning was considered by some to be a near **panacea**, continued research has succeeded in establishing the fact that interests are basically socially determined, that is, they are precipitated by the child's experiences. Mallinson[108] and Foust[109] both emphasize the

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[107]Brownell, op. cit., p. 13.

[108]Mallinson, op. cit., p. 139.

[109]Judson W. Foust, "The Responsibility of the Mathematics Teacher in Curriculum Building," Mathematics Teacher, III (1943), pp. 102-105.

facts that interests tend to be transient and that children's experiences must be planned and guided by something more than their own temporary and evanescent interests. Upon reviewing these articles, one notes that none of the quoted writers was ignoring the learners' interests since naturally a high degree of the learner's interest is prerequisite to a positive attitude.

Complementary to incidental learning but a phase of it is social utility which presently one would liberally find in texts such as Useful Mathematics, Mathematics for Modern Life, Mathematics for Everday Use, Living Mathematics, and Mathematics and Life.[110] Today just as in earlier days the supporters of this idea are convinced that the functional competence of students who have participated in a socially-oriented mathematics curriculum will be higher than had they not had this series of courses. Even though the above listed titles are modern ones, the move toward social utility is not a recent one. Schorling[111] in 1926 listed nine studies dealing with the social and business activities of adults as related to the use of mathematics facts taught in the schools. The early social utility investigations are summarized well by a final statement from Woody's research, "The schools are emphasizing much arithmetic that is unessential."[112]

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[110]Breslich, op. cit., p.111ff.

[111]Schorling, op. cit., p. 58ff.

[112]Clifford Woody, "Types of Arithmetic Needed in Certain Types of Salesmanship," Elementary School Journal, XXII (1922), pp. 505-520.

To the early investigations should be added Wilson and Dalrymple's "Useful Fractions,"[113] Russell's,[114] Carmany's,[115] and Wilson's.[116] All arrived at a conclusion similar to Woody's opinion quoted in the previous paragraph.

Criticisms of this research questioned whether it really was research at all and even if it were, of what value was it?[117] Nevertheless, within a decade social arithmetic courses began to appear. Many of the fundamental areas which the research had indicated needed emphasis and likewise those that research indicated should be de-emphasized originally were increased. Paradoxically though, as the courses continued to develop, the literature points to an influx of social topics which were as far removed from the students' needs and interests as were the so-called superfluous materials found in the sequential courses. Brownell deftly pinpointed this tendency when he stated that many texts and courses of study still contain long sections on insurance, investments, and banking which are taught because this study is supposed to

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[113]E. O. Dalrymple and Guy M. Wilson, "Useful Fractions," Journal of Educational Research, XXX (1937), pp. 341-347.

[114]Garland B. Russell, "Decimal Usage in the Occupational World," Journal of Educational Research, XXXVIII (1945),

[115]Burton R. Carmany, "A Survey of the Mathematical Requirements for High School Graduates to Hold Certain Jobs and the Use of Arithmetic by Teachers Outside of the Classroom," (Unpublished Master's Thesis, School of Education, University of Michigan, 1941).

[116]Guy M. Wilson, "Why Do Pupils Avoid Mathematics in High School?" The Arithmetic Teacher, VIII (1961), pp. 168-171.

[117]Schorling, op. cit., p. 58ff.

prepare for life. "But children aged fourteen or fifteen do not themselves take out insurance policies or seek to obtain mortgages."[118] Infiltration of social arithmetic courses by superfluous (according to critics) material has been the basis of much criticism of the movement as will be discussed shortly.

Wilson, in January, 1948, contributed an enlightening article relevant to functional competence and social theory,

> The proper basis for functional arithmetic is the social utility theory. This theory posits (1) that the chief purpose of school is to equip the child for life, life as a child, life as an adult, and (2) that skills, knowledges, and appreciations should receive attention in school somewhat proportional to usefulness in life, limited and guided, of course, by the laws of psychology and the principles of good teaching.[119]

Buswell does not question the value or necessity of the term "social utility" but he opposes adamantly the narrow definition of the term stating, "It is not a problem of computation versus social arithmetic but of the relative emphasis to be given the two."[120]

Breslich supports the social utility theory as follows,

> The most pressing problem before the teachers of mathematics is to formulate a second curriculum which

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[118] William A. Brownell, "Arithmetic in 1970," The National Elementary Principal, XXXIV (1959), pp. 42-45.

[119] Guy M. Wilson, "The Social Utility Theory as Applied to Arithmetic, Its Research Basis and Some of Its Implications," Journal of Educational Research (1948), p. 321.

[120] G. T. Buswell, "The Relation of Social Arithmetic to Computational Arithmetic," The Tenth Yearbook of the National Council of Teachers of Mathematics (New York: Bureau of Publications, Teachers College, Columbia University, 1935), p. 74ff.

> will attract and be profitable for, the large group of pupils now going through high school without taking courses in mathematics. . . courses will be organized in social units from a social point of view. To the learner the mathematics work will seem incidental; actually it will have been planned with great care, so that mathematical objectives are not slighted. Much of the traditional mathematics will be omitted, but the type of mathematics that people, in general should know and be able to use will be retained.[121]

Some of the earliest criticisms of the social utility theory were written by Schorling. After having examined the early studies, he stated,

> It ought to be unnecessary to point out that any one of the so-called scientific studies now available cannot serve as the basis for the selection of subject matter.

He elaborated further, posing the question, "What uses do people make of mathematics?"[122] It is perhaps even more important to inquire, "What use could they make with great economy and profit?"[123] Wilson, after listing reasons why the social units in commercial mathematics are not really constructive mathematically, surmised, "We cannot possibly predict the social needs of twenty, ten, or even five years hence; consequently, it is extremely hazardous to organize a program on the basis of usefulness in everyday life."[124] Along the same line, Moser, Kinney, and Purdy published a

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[121] Breslich, op. cit., p. 111.

[122] Schorling's elaboration was a direct quotation from Thorndike, both of whom were critical of the social utility theory.

[123] Schorling, op. cit., p. 84.

[124] Jack D. Wilson, "What Mathematics for the Terminal Student," Mathematics Teacher, LIII (1960), pp. 518-523.

concise summary of social theory criticism excerpted from the writings of Brownell, Johnson, Wheat, and others,

> (A) To split up and spread out the topics of arithmetic on the basis of frequency in adult usage is to ignore the principles of relationship and continuity within the topics; (B) A survey of the computational needs of adults is an inadequate basis for determining the mathematical content in curriculum because the number responses of adults are so intimately intertwined with personal and social situations that they rarely separate one from another. Results of the social survey is geared to a low level of competence.[125]

Proponents of the social utility theory advocate adoption of their theories pointing out that the competency of many high school mathematics students would be improved. Opponents do not subscribe to such a theory or have faith in its claims of increasing mathematical proficiency.

The Meaning Theory

In their search to improve mathematical competency, mathematics educators and curriculum experts have written profusely about a third theory of learning which has been labeled in various manners but here will be entitled the "Meaning Theory." A review of the literature suggests that this theory is far reaching and relevant to the degree of competency and the attitudes of secondary mathematics students.

In contrast to the social utility theory, meaning theory is reputed to be neither created nor practiced as a compromise of the logical versus social approaches. One is

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[125]Harry E. Moser, Lucien Kinney, and Charles Purdy, "Aims and Purposes in the Teaching of Mathematics," Review of Educational Research, XVIII (1948), p. 315ff.

not at a loss to find proponents such as Fehr,[126] Association for Supervision and Curriculum,[127] Brown,[128] Carlton,[129] Glennon,[130] Jones,[131,132,133] Schaaf,[134] and Van Engen[135,136] in favor of this theory.

Although it is said that the meaning theory is not a compromise, the meaning theory's multi-facet nature of necessity exhibits traits of both earlier theories. Possibly one

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[126]Fehr, op. cit., pp. 340-344.

[127]Association for Supervision and Curriculum Development, op. cit., p. 136.

[128]Brown, op. cit., pp. 85-89.

[129]Charlotte Carlton, "Providing a Differentiated Curriculum Through a New Organization of Content--An Emerging Mathematics Curriculum," in John R. Clark, editor, Emerging Practices in Mathematics Education, Twenty-second Yearbook of National Council of Teachers of Mathematics (Washington, D.C.: National Education Association, 1954), pp. 2-9.

[130]Vincent J. Glennon, "Balanced Progress in School Mathematics," Educational Leadership, XIX (1962), pp. 354-358.

[131]Phillip S. Jones, "The Role of Continuity in a Mathematics Program," The University of Michigan School of Education Bulletin, XXVIII (1957), p. 86.

[132]Phillip S. Jones, "Experiment and Trends in General Mathematics," The University of Michigan School of Education Bulletin, XXIV (1952), pp. 33-36.

[133]Phillip S. Jones, "The Importance of Articulation," The Bulletin of the National Association of Secondary School Principals, XLIII (1959), pp. 107-111.

[134]William L. Schaaf, "New Emphasis in Mathematical Education With References to Recent Literature," School Science and Mathematics, XLIX (1949), pp. 639-649.

[135]Van Engen, op. cit.

[136]H. Van Engen, "Some Psychological Principles Underlying Mathematics Instruction," School Science and Mathematics, LXI (1961), pp. 242-250.

can attribute its development to the advances in psychological research but one must not stop there. Mathematicians and mathematics educators have long been aware of deficiencies in the secondary school mathematics programs. This awareness must be credited with having promoted the theory, once it developed. Here, too, Brownell was adept in summarizing his concept of meaning theory,

> This name [referring to "Meaning Theory"--the parenthetical statement in brackets is that of this author] is selected for the reason that, more than any other, this theory makes meaning, the fact that children shall see sense in what they learn, the central issue in the arithmetical instruction. Within the meaning theory the virtues of drill are frankly recognized. This theory conceives of arithmetic as a closely knit system of understandable ideas, principles, and processes. According to this theory, the test of learning is not mere mechanical facility in "figuring." The true test is an intelligent grasp of number relations and the ability to deal with arithmetical situations with proper comprehension of their mathematical as well as their practical significance.[137]

Towards further elucidation of this theory Schaaf in 1949 explains, "Teaching arithmetic for understanding is no longer a battle cry but rather an established practice thanks to the excellent work of Brownell, Johnson, Morton, Van Engen, Wheat, and many others." He continues, "Relational thinking involves abstraction, generalization, symbolism, and quantitative thinking. It is basic to human behavior, but it requires cultivation."[138]

Close scrutiny of the literature does not indicate that the third theory, even though highly praised and rated by the

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[137]Brownell, op. cit., pp. 1-31.

[138]Schaaf, op. cit., pp. 639-649.

majority of mathematics educators, prompted a wholesale invasion of the secondary curriculum by new courses. It appears that the widespread support of this theory has instigated reform in the manner in which courses are taught as opposed to creating new courses. This is distinctly expressed by Kline,

> It seems to the writer that the present difficulties in putting mathematics across are not due to a poor curriculum. The trouble with the present curriculum lies rather in the way we approach the material we teach. Mathematics is commonly presented as a series of techniques, processes, and theorems.[139]

All three psychological approaches to mathematics teaching can be found in schools today. The formal discipline, the incidental, and the meaning approach were all developed in order to improve student mathematical competency as has been stated but experts disagree as to the effectiveness of any single one or combination. Regardless, the existence of these three basic theories stimulated the mathematics teachers and curriculum workers to respond by creating the variety of courses which one finds today. Mathematics educators constantly are inquiring,--are the schools producing functionally competent students?

Attitude Toward Mathematics

In addition to the endeavor to improve the functional competency of the secondary mathematics students one notes one other complementary ever-present factor--attitude. For many years psychologists and educators have been convinced that

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[139]Morris Kline, "Reform in the Mathematics Curriculum," The Education Digest, XXIV (1959), pp. 36-38.

positive attitudes are part and parcel of a successful learn-experience. The problem is to determine how and to what degree this factor is related to functional competence in mathematics.

Attitude--Defined

While reviewing the literature past and present for related work, one is confronted with the question, are interests, likes, dislikes, and attitudes related? The reason for broaching this question is clearly depicted by reading articles by Breslich,[140] C. H. Brown,[141] D. Brown,[142] Davis,[143] Kinney and Purdy,[144] O'Donnell,[145] Poffenberger,[146] Torrance,[147] and

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[140]Breslich, op. cit., pp. 189-212.

[141]Claude H. Brown, The Teaching of Secondary Mathematics (New York: Harper and Brothers, 1953), p. 226.

[142]Douglass Brown, "The Mathematics Teacher's Part in Effective Guidance for Optimum Use of Differentiated Curriculums," Twenty-second Yearbook of the National Council of Teachers of Mathematics (Washington, D.C.: National Education Association, 1954), pp. 95-99.

[143]David R. Davis, "The Teaching of Mathematics," (Cambridge, Massachusetts: Addison Wesley Prentice, Inc., 1951), p. 415.

[144]Lucien Blair Kinney and Richard C. Purdy, Teaching Mathematics in the Secondary School (New York: Rinehart & Co., Inc., 1956), p. 51.

[145]John Robert O'Donnell, "Levels of Arithmetical Achievement, Attitudes Toward Arithmetic and Problem Solving Behavior Shown by Prospective Elementary Teachers," (Unpublished Ed. D. dissertation, Penn State University, 1958).

[146]Thomas Poffenberger and Donald A. Norton, "Factors Determining Attitudes Toward Arithmetic and Mathematics," Arithmetic Teacher, L (1956), pp. 113-116.

[147]Paul Torrance, "Mathematics Interest--Fundamental or Not?" Mathematics Teacher, XXXIX (1946), pp. 24-26.

Tulock.[148] Each one uses one, two, three or all of the terms. Frequently they are interchanged as if they were synonyms. Billig quotes Newcombe as he summarizes attitude as "primarily a way of being 'set' toward or against certain things. Both the response and the situations are in most cases of verbal nature--almost exclusively so in so far as attitudes lend themselves to measurement."[149] Continuing, Billig quotes Stagner,

> The attitude is characterized always by (1) an object, (2) a direction, and (3) intensity. The object may be considered the intellectual or cognitive aspect of the experience; the direction is given by the predominantly pleasant or unpleasant feeling-tone bound up with this intellectual understanding. Intensity may be thought of as related to excitement, or degree of activity which will be released by situations involving the attitude.[150]

Dutton, author and designer of numerous attitude scales, utilizes the following definition of attitudes as a basis of his work,

> Attitudes are emotionalized feelings of students for or against something. The term attitudes includes not only bias, and the like but also positive attitude (sometimes called sentiments) which include our attachments and loyalties to persons, objects, and ideals.[151]

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[148]Mary K. Tulock, "Emotional Blocks in Mathematics," Mathematics Teacher, L (1957), pp. 572-576.

[149]Alberg L. Billig, "Student Attitude As a Factor in the Mastery of Commerical Arithmetic," Mathematics Teacher, XXXVII (1944), pp. 170-173.

[150]Ibid.

[151]Wilbur H. Dutton, "Attitudes of Prospective Teachers Toward Arithmetic," The Elementary School Journal, (1951) pp. 84-90.

The connotations given these terms as specifically stated by Benz,[152] Davis,[153] Jersild and Tasch,[154] and Johnson[155] are so interrelated that they are used practically synomymously.

Attitudes, Good or Bad, Exist

Both the twenty-fifth and the twenty-sixth yearbooks of the National Council of Teachers of Mathematics contain articles relevant to attitudes. In the twenty-fifth yearbook, Dickey draws the following conclusions, "Attitudes must be considered in a successful arithmetic program. Attitudes are learned, and they can be found on any level of maturity."[156] Evaluation in Mathematics, defines mathematics attitude quite concisely, "A student's attitude toward mathematics is, for example, a

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[152]H. E. Benz, "A Summary of Some Scientific Investigations of the Teaching of High School Mathematics," in W. D. Reeve, editor, Teaching of Mathematics, The Eighth Yearbook of the National Council of Teachers of Mathematics (New York: Bureau of Publications, Teachers College, Columbia University, 1933).

[153]Alfred C. Davis, "A Study of the Reported Attitudes of Two Hundred and Forty Pupils in the Sault Schools Toward the Teaching of Mathematics," (Unpublished Master's Thesis, University of Michigan, 1938).

[154]Arthur T. Jersild and Ruth J. Tasch, Children's Interests and What They Suggest for Education (New York: Bureau of Publications, Teachers College, Columbia University, 1949), p. 173.

[155]Donovan A. Johnson, "Attitudes in the Mathematics Classroom, University of Minnesota High School," School Science and Mathematics, XLVII (1957), pp. 113-120.

[156]John W. Dickey and Edna B. Taylor, "Mental Hygiene and Arithmetic," in Foster E. Grossnickle, chairman, Instruction in Arithmetic, Twenty-fifth Yearbook of National Council of Teachers of Mathematics (Washington, D.C.: National Education Association, 1960), pp. 179-201.

composite of intellectual appreciation of the subject and emotional reaction to it."[157] A portion of the report is devoted to a discourse on evaluation of attitudes. Methods of observing and recording manifestations of attitudes are discussed including ways to produce an attitude-measuring instrument. Donovan A. Johnson advises,

> One unique aspect about teaching attitudes is that we have no choice in the matter. We have no escape--attitude will inevitably be learned by the poor as well as (by) the superior students. Attitudes extend beyond the range of habits; they govern widely the use of knowledge. Attitudes differ from ideals in that conscious purpose or foresight of the goal has dropped out.[158]

Since authors have not been hesitant about stating their opinions and quoting research concerning attitudes, it is necessary to classify the writings which seem to fall logically into three groups: (1) Mathematical Interest Inventories and Attitude Measuring Instruments; (2) Relationship of Attitude to Learning; (3) Scales to Measure Attitude.

Inventories and Measuring Instruments

One of the earliest surveys of pupil interest in mathematics according to Benz[159] was carried out by Downey under the auspices of The Mathematical Association of America. In 1923 he sent out a questionnaire to 7,000 pupils in fifteen high schools. Eighty-four per cent applied affirmatively to

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[157]National Council of Teachers, in Donovan A. Johnson, chairman, Evaluation in Mathematics, Twenty-sixth Yearbook of the National Council of Mathematics (Washington, D.C.: National Education Association, 1961), pp. 1-216.

[158]Johnson, op. cit., p. 113.

[159]Benz, op. cit., p. 19.

question, "Do you like mathematics?" Liking was based mainly on the interest, usefulness, and mental training involved.

Jersild and Tasch investigated pupil reactions from elementary school through high school but there is some mathematical data which are worthy of consideration. They concluded,

> Favorable remarks concerning work in the category of arithmetic or mathematics outnumbered complaints with one single exception in all grade levels in all schools. In grades one through three arithmetic was mentioned unfavorably. In grades four through six favorable comments predominated in a ratio of a little more than two to one. At the junior high school level the difference between the favorable and unfavorable comment was small but still on the favorable side. In the high schools, mathematics received favorable mention in a ratio of about two to one. This came as a surprise to many teachers.[160]

Dutton[161,162] leaves little doubt as to the feasibility of measuring objectively attitudes toward arithmetic. "The main findings of this study show that attitude toward arithmetic may be measured objectively . . ."[163] The strength of Dutton's work lies in a thorough development of a relatively precise instrument for measuring attitude. A summary of the results of one of his investigations included the following,

> Girls showed a little more dislike for arithmetic than boys, they also were more afraid of story problems; more boys than girls like the challenge presented by arithmetic; about a third of the pupils recognized changes in attitude toward arithmetic in junior high

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[160] Jersild and Tasch, op. cit.

[161] Wilbur H. D. Dutton, "Measuring Attitudes Toward Arithmetic," The Elementary School Journal, LV (1954), pp. 24-31.

[162] Wilbur H. Dutton, "Attitude of Junior High Pupils Toward Arithmetic," The School Review, LXIV (1956), pp. 18-22.

[163] Dutton, op. cit., p.30.

school (the increased work load of homework caused additional concern about marks and influenced general attitudes toward arithmetic.)[164]

Aiken and Dreger[165] devised a mathematics attitude scale in order to study the relations between selected intellectual and non-intellectual variables and mathematics attitudes and additionally the contribution of these attitudes to the prediction of achievement in mathematics. They were not able to substantiate that mathematics attitude scores made a significant prediction of final grades in mathematics courses or that the attitude scores predicted gains in scores from initial to final administration of a mathematics achievement test when training has intervened. They were successful in determining--that mathematics attitudes are positively correlated with numerical ability and ratings of former mathematics teachers.

Billig[166] through a process of having commercial arithmetic students submit essays expressing their feelings about arithmetic in answer to questions such as, "What I think of commercial arithmetic, How I feel about arithmetic," produced an attitude scale with which he successfully supported his hypothesis that student interest is a determinant in the mastery of commercial arithmetic.

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[164]Wilbur H. Dutton, "Attitude of Junior High Pupils Toward Arithmetic," The School Review, LXIV (1956), pp. 18-22.

[165]Lewis R. Aiken and Ralph Mason Dreger, "The Effects of Attitudes on Performance in Mathematics," Journal of Educational Psychology, LII, (1961), pp. 19-24.

[166]Billig, op. cit.

Relationship of Attitude to Learning

Davis at the secondary school level and Stright at the elementary school level developed attitude scales without any intention of correlating the academic grades with the attitude. Before proceeding with his project, Davis's review of the literature pertaining to attitudes and high school courses summarized,

> It is clear, however, in reviewing the field, that the vast majority of investigators agree with the first three studies reported that interests, attitudes, and achievement do have a close relationship. In every study it is shown that attitudes are among the most important factors in school work.[167]

In his summary, Davis reiterated that the like or dislike of a subject has a strong influence on pupils' preferences. Stokes, while conducting an experiment with control and experimental groups in ninth grade mathematics at the University of Minnesota campus reported, "A consistent relationship was found between interest and achievement and application and achievement."[168]

Stright's study[169] involved twenty teachers, 1,023 students, in ten different areas in Pennsylvania and Ohio. Among her conclusions are:

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[167] A. C. Davis, op. cit., p. 9ff.

[168] Claude Newton Stokes, Instruction in Ninth Grade Mathematics (New York: Henry Holt, 1941), p. 120ff.

[169] Virginia M. Stright, "A Study of Attitudes in the Third, Fourth, and Sixth Grades," The Arithmetic Teacher, VIII (1960).

> (1) A large percentage of elementary teachers really enjoy teaching arithmetic; (4) Contrary to popular opinion, a very large percentage of both boys and girls do like arithmetic and feel it is a very useful subject; (6) Definite attitudes in students have developed by the third grade.[170]

Contrary to the previously discussed articles, three mathematical attitudinal surveys involving college personnel, all of whom were products of our sequential high school mathematics program, are definitely not so positive in their summaries of relationships between attitude and learning. O'Donnell, using a Remmer's attitude scale, concluded,

> . . . attitude toward arithmetic and a liking or disliking for the subject appear to be somewhat different concepts. Students sometimes score high on an attitude toward arithmetic scale but express a dislike for the subject. They recognize the social, academic and economic values of arithmetic but still have a dislike for it.

Then, too, he writes, "attitudes toward arithmetic showed only a low correlation with arithmetical achievement and arithmetical problem solving behavior."[171] This study involved 109 Penn State University senior elementary education majors. Parallel to this study is a similar one of prospective elementary teachers completed by Dutton[172] which emphasized the negative feelings toward arithmetic of the group as a whole, yet, on the other hand, the realization by this group of the importance of success and accomplishment in arithmetic. Herriott, in 1929, did his doctoral study on the problem, "Are

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[170] Ibid.

[171] O'Donnell, op. cit.

[172] Wilbur H. Dutton, "Attitudes of Prospective Teachers Toward Arithmetic," The Elementary School Journal (1951), pp. 84-90.

students' attitudes important determining factors of the marks they receive in college?" In his summary, he stated that there are five major factors of scholastic success: (a) Previous Preparation, (b) Intelligence, (c) Study habits, (d) Evaluation--non-evaluation attitude, (e) Persevering-vacillating attitude, (f) Self-confident--dependent attitude. He concludes that the first five are related to success in a positive way; the self-confident dependent appears to be related to success in a negative way. The five are so interrelated that it is difficult to separate them.[173] Herriott further summarizes that an inadequate knowledge of the nature of attitudes, a lack of an adequate measuring instrument for them, and the absence of any established statistical technique for use in manipulating the data, handicap one in arriving at pure scientific data and conclusions. The review of the literature suggests that two of these three problems have since been surmounted to some degree.

Thus, the literature contains much information relevant to the high school mathematics courses and their origins, theories of teaching, discussions of competency, and attitude. Through such a review, numerous suggestions are formed indicating that research might be useful in the fields of mathematical competence as related to specific courses and attitudes.

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[173]M. E. Herriott, "Attitudes as Factors of Scholastic Success," University of Illinois Bulletin, XXVII (1929), p. 25.

CHAPTER III

PROCEDURE

Introduction

As was pointed out in Chapter II a concerted emphasis on improvement of high school college-preparatory mathematics has to some degree, dominated secondary mathematics during the past few years. A concurrent development has been an emphasis on more mathematics for all high school students. What effect have these trends had on Michigan public high schools? How might one determine the mathematical proficiency of students from the various curricula? This chapter describes the procedures employed in this investigation.

A Survey of Mathematics Requirements for High School Graduation

At the beginning of the investigation it was necessary to determine how many public high schools in the State of Michigan required two years of mathematics in order that a student may be graduated. Upon discussing this problem with Ray E. Kehoe, Director of the Bureau of School Services, it was explained that each year all Michigan schools accredited by the University of Michigan must submit an extensive report to the Bureau of School Services by October 1. This report includes high school requirements for graduation and schedules of classes, both of which were examined by the author. In

some instances the schedules of potential course offerings did not appear to fulfill the school's graduation requirements. In these cases, letters with self-addressed stamped postcards were mailed to those Michigan public high schools whose requirements or class schedules left some doubt as to whether or not two years of mathematics for graduation were required.

A List of Michigan Public High Schools Requiring Two Years of Mathematics for Graduation

Of the 488 Michigan public high schools whose records were checked, it was possible to determine definitely only twenty schools which require two years of mathematics of all graduates.

The author listed the twenty schools; then similar information for each school was accumulated from the reports to the Bureau. The location and identification of high schools which required two years of mathematics for graduation had a two-fold purpose: a) There was the possibility of matching students of a school requiring two years of mathematics with comparable students of a school which did not; b) Within a school requiring two years of mathematics for graduation one could obtain various patterns of course combinations from which students could be matched.

A List of Schools Requiring Only One Year of Mathematics to be Graduated

Upon completion of this list of twenty schools the writer returned to the Bureau files to compile a list of

twenty to twenty-five schools which require only one year of mathematics. The objective was to choose schools which would best match the original schools in as many ways as possible. The size of the graduating class, geographic area, and length of class periods, were not difficult characteristics to match. The number of dropouts, assessed valuation per pupil, tax rate, and expenditure per pupil complicated the issue greatly.

Finally, it was decided to exclude the matching of the one-year and two-year schools. By eliminating the matching of the schools of these two lists, the influence of the variable of different instructors, courses, and school atmosphere are reduced. It was decided to determine if groups, within the same school, which had various patterns of mathematics experience, could be compared. In order to obtain some information as to the approximate number of students who might take various mathematics sequences in one of the sample schools, during the summer of 1961, all scholastic record cards of juniors from Taylor Center High School were reviewed.

An analysis of the scholastic cards of these 484 juniors produced the following:

1. Sixty students had taken general mathematics in ninth and tenth grade.
2. Forty-three had taken general mathematics in the ninth and eleventh grades.
3. Ninety-seven had taken general mathematics in the ninth grade and were scheduled for the second course of general mathematics or some other mathematics course of their choice in their senior year.
4. Forty-nine had taken general mathematics in ninth and business mathematics in tenth grades.

5. One had had ninth grade general mathematics and business mathematics in eleventh grade.
6. Twenty had had ninth grade algebra and tenth grade business mathematics.
7. Three had had ninth grade general mathematics and first year algebra in eleventh grade.
8. Sixteen had had ninth grade general mathematics, first year algebra in tenth, and geometry in the eleventh grades.
9. Nine had had ninth and tenth grade general mathematics followed by the first year of algebra in the eleventh grade.
10. Twenty had had ninth grade remedial mathematics and tenth grade practical mathematics.
11. One hundred forty-nine had had at least the regular college preparatory sequence of ninth grade algebra and tenth grade geometry.

The results of the pilot survey may be summarized in percentages as follows:

1. Approximately 20 per cent of the class would have had only one year of mathematics, if tested at the end of the eleventh year.
2. Approximately 37 per cent would have had two years of mathematics, with a one-year interim during which they had no mathematics whatsoever, if tested at the end of the eleventh grade (mathematics in ninth and tenth grades only).
3. Approximately 12 per cent of the class would have had a ninth grade course, the tenth grade free of mathematics, and a mathematics course during the eleventh grade.
4. Approximately 31 per cent of the class would have had at least ninth grade algebra and tenth grade geometry.[1]

From the pilot survey it appeared that enough students existed in each group to make possible comparisons between and among groups which had had various sequences of courses in mathematics in the same high school.

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[1] It is important to note here that no tabulation was made to determine what percentage of the 149 continued with mathematics during the twelfth grade of high school. This might be a factor worthy of consideration when viewing the data.

Selection of the Participating Schools

Careful study of the reports of the schools requiring two years of mathematics for graduation revealed that they could be divided into groups. One group required or strongly recommended that the two-year requirement be met in the ninth and tenth grade; in the other group, the two-year requirement could be met at any time during grades nine through twelve. As a result of difficulties encountered in attempting to match schools with references to several factors as explained earlier, it was decided to match the schools according to size, as illustrated in Table 1. The schools which are underlined were selected by coin-tossing.

TABLE 1

THE MICHIGAN PUBLIC HIGH SCHOOLS FROM WHICH EIGHT PARTICIPATING SCHOOLS WERE SELECTED

Schools in Which the Two-Year Requirement May be Met During Any Two Years		Schools in Which the Two-Year Requirement Is To Be Met During Ninth and Tenth	
School	Size of Junior Class	School	Size of Junior Class
Burr Oak	30	Climax	45
Onsted	73	Lyons	43
Dye Community	65	Fairview	32
Mayville	62	McBain	42
Comstock	89	Morenci	70
Harper Creek	113	Springfield	82
Kelloggsville	152	Lakeview	234
Ainsworth	135	Lapeer	214
Taylor Center	516	Battle Creek Central	536
Wayne Memorial	532	Bay City (T. L. Handy)	539

*Underlining signifies that these schools were selected for the sample.

Letters of invitation to participate in the project were sent to the chosen schools in November, 1962. In each letter the nature of the experiment was explained with a request for their cooperation in the following:

1. Allot one sixty-minute period for the testing.
   a. A standardized achievement test will be administered.
   b. An opinionnaire will be given.
2. The schools will make available their records of each testee.
3. The schools will receive in turn the standardized test scores, general opinionnaire ratings of the groups, and a summary of all the schools' data.

Choice of an Achievement Test

The testing instrument to be employed in this investigation needed to be nationally standardized, capable of measuring a wide range of functional competence, and require no longer than forty-five minutes in order to allow time for its administration within the class periods of the participating schools. In addition, the criteria for selecting a published mathematics test as listed in the Twenty-sixth Yearbook were used:

(a) The nature of the pupil population
(b) The content and objectives of the curriculum
(c) The purpose of the testing
(d) The way the test scores may be used to accomplish these purposes[2]

In addition to these points from this same reference the following questions were considered:

Are the questions in general fair for this class and course?
Are the questions mathematically sound?

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[2] Evaluation in Mathematics, in Donovan A. Johnson, chairman, Twenty-sixth Yearbook of the National Council of Teachers of Mathematics (Washington, D.C.: National Education Association, 1961), p. 98.

Are the questions mathematically interesting?
Is the vocabulary and reading in the test suitable?
Would the test be easy to administer and easy to take in terms of pupil directions and format?
Is the test likely to be speeded or unspeeded for your class and does this agree with the way it was purportedly normed?
Can the test be conveniently administered in a school period?
How good are printing and layout?[3]

A survey of the mathematics tests on file at the University of Michigan Education Library was made. A summary of data for each test which the author thought might qualify was made. Reviews of each test were then studied from one of the Mental Measurement Yearbooks.[4,5] A problem faced was that of the nature of the student population for this investigation. Many tests were either academically oriented or computationally oriented--neither of which would suffice since the population consisted of all high school juniors in the participating schools. Parallel to this problem was that of vocabulary which could not be highly academic if the test was to have a wide testing range. Although it was not possible to determine the exact contents and objectives of the curriculums of the chosen schools, it was assumed from the beginning that the participating schools' curriculums would be designed to provide stimulation for groups with low through high mental ability. Time of administration was also an

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[3] Ibid., p. 100.

[4] The Fourth Mental Measurements Yearbook, in Oscar K. Buros, editor (Highland Park, New Jersey: The Gryphon Press, 1949).

[5] The Fifth Mental Measurements Yearbook, in Oscar K. Buros, editor (Highland Park, New Jersey: The Gryphon Press, 1953).

obstacle difficult to surmount. Some of the best known tests have several parts entailing sixty-eighty minutes of testing time.

Myers'[6] pamphlet on testing in addition to conferences with J. N. Payne, a University of Michigan professor of mathematics education, and Frank Womer, University of Michigan test specialist, resulted in a selection of two potential tests: The Davis Test of Functional Competence[7] and The Snader General Mathematics Test.[8]

The Davis Test was criticized by Dressel and Lamke for not measuring specific items as stated in the manual.[9] They further state,

> No evidence is presented showing that the standardizing group resembles a defined larger population in important respects, nor is there any indication that the standardizing group is a statistically based sample of some larger population. It is, then, difficult to know just how to generalize from the norms group to a population which is of practical importance.[10]

Furthermore, the vocabulary utilized in the test is difficult. Close examination of the test by several secondary mathematics

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[6]Sheldon S. Myers, Mathetics Tests Available in the United States, National Council of Teachers of Mathematics (Washington, D.C.: National Education Association, 1959), 16 pp.

[7]David J. Davis, Davis Test of Functional Competence in Mathematics (Yonkers-on-Hudson, New York: World Book Co., 1951).

[8]Daniel W. Snader, Snader General Mathematics Test (Yonkers-on-Hudson, New York: World Book Company, 1952).

[9]Paul L. Dressel and Tom A. Lamke, "Davis Test of Functional Competence," Mental Measurements Fifth Yearbook, op. cit., pp. 563-565.

[10]Ibid.

instructors prompted them to comment that the vocabulary and degree of difficulty of the problems were not applicable to students of all curricula.

The Snader Test evaluation by Blommers[11] states that the items are too difficult.[12] He further criticizes the lack of balance due to the relatively few problems requiring some reasoning ability. The reviewer lists some other criticisms which would be more serious if the population of this experiment were purely academic in nature:

> The test is heavily loaded (42 per cent) with arithmetic items. In fact, about one-third of the items deal with arithmetic skills taught in the lower grades. Granting the maintenance of such skills to be an objective of the high school mathematics program, this degree of attention in a forty-minute test of general mathematics seems inordinately high. On the other hand, the area of numerical trigonometry as applied to indirect measurement, which is treated in every general mathematics text known to the reviewer, is allotted but a single item in each form. This item moreover, is extremely superficial.[13]

Considering the nature of the population for this investigation, both of the above criticisms could be advantageous in producing a better picture of the students in the middle to lower mental ability levels while still measuring the upper level students.

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[11]Paul J. Blommers, "Snader General Mathematics Test, Evaluation and Adjustment Series," Mental Measurements Yearbook, Fourth Edition, op. cit., pp. 489-490.

[12]The author wishes to point out that "too difficult" is relevant to the fact that this test is reputed to be for general mathematics students. This criticism may be interpreted as satisfactory within the limits of this testing situation as projected by the author since juniors will be tested.

[13]Blommers, op. cit., pp. 489-490.

Relative to the problem of undetermined curriculums and objectives one finds Blommer's critique encouraging,

> To achieve curricular validity, the content specifications were based on a study of widely used textbook and representative courses of study. Consideration was also given to the recommendations of NCTM and Commission on Post War Plans.[14]

Three other points made by Blommer were important in deciding on the measuring instrument:

> The manual is more complete and far more honest in its claims than is customary. . . . The mechanics of elementary algebra with emphasis on the solution of simple equations and the use of formulas is fairly well covered (25 per cent) and the items for the most part are well constructed. . . . it is clear that more than the usual care has been taken in the development of this test which is among the better tests of its type known to the reviewer.[15]

In the same yearbook, Fehr's review states,

> The test is designed for students studying a course that includes arithmetic, informal geometry, basic algebra, graphical representation, and numerical trigonometry. It is not designed particularly for non-mathematically inclined students.[16]

Three of the five points of content listed by Fehr are found in many general mathematics courses. Graphic representation is often covered in such a course. It has been stated that the trigonometry, found therein, is not substantial. Although not designed specifically for the non-mathematically inclined, the content is that which most high school mathematics students have studied regardless of their program.

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[14] Ibid.

[15] Ibid.

[16] Howard F. Fehr, "Snader General Mathematics Test, Evaluation and Adjustment Series," Mental Measurements Yearbook, Fifth Yearbook, op. cit., pp. 489-490.

Traxler classifies and evaluates achievement tests in mathematics as follows:

> There are three broad types of mathematics achievement tests. Two of these--tests of general achievement, such as the Cooperative Mathematics Tests for Grades seven, eight, and nine, and the earlier forms of the Cooperative General Achievement Tests in Mathematics, and tests in particular subjects, such as the Cooperative tests in algebra and in plane geometry, were mentioned in the preceeding section of this paper. The third type is sometimes called a general achievement test, but it is better termed a test of general proficiency in mathematics . . . general achievement tests consist of a combination of questions drawn from algebra, geometry, and plane trigonometry while the general proficiency tests contain questions designed to reveal a student's understanding of mathematical concepts and his ability to read typical materials in this field. General proficiency tests probably involve a larger element of aptitude than do the other kinds of achievement tests.[17]

Within the limits of this definition one would be inclined to admit that the Snader test is more general achievement than general proficiency. But, considering the purpose of the testing, this investigation is more interested in an achievement factor than the degree of aptitude. After having reviewed all the general mathematics tests available, it was apparent that a relatively appropriate instrument was the best that could be expected as is implied by Traxler, "A second reason why a uniform program of objectives tests cannot completely meet the measurement needs of the mathematics departments in all schools is that even when schools agree upon a common set of objectives, frequently they organize their units of instruction in widely different ways."[18]

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[17] Arthur E. Traxler, "A Testing Program for Mathematics at the Secondary Level," Mathematics Teacher, XXXIX (1946), p. 308.

[18] Ibid., pp. 303-307.

Based on the preceding study, an examination set of the Snader test was obtained. Each problem was worked and the test was pilot checked by administering it to various students. The criticisms as outlined above were partially verified but on the basis of its strengths as enumerated earlier, and the recommendations of Womer, it was decided to select the Snader test as the achievement measuring instrument. In justification of this decision, the following quotation from Fehr's reference to the Snader test is relevant.

> This test cannot be compared with other tests since there are no other standard tests designed to measure the same objectives. The test can be used to measure achievement but until more information is gathered its guidance prediction values are small.[19] [The underlining is that of the author.]

Choice of Attitude Measuring Instrument

One of the most important questions concerning any test is the question of its validity--that is the extent to which it measures what it is intended to measure. This issue of validity epitomized the problem relevant to constructing or selecting an attitude measuring instrument.

Records of obtaining opinions are numerous but the manner in which they are collected often precludes their use in scientific research. Some of these are anecdotal notes, drawings, oral discussions, 'what I like best' and 'what I don't like' statements, and others of a similar nature.

The author attempted to construct an attitude measuring instrument. Analyses of the pilot tests and the completed

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[19] Fehr, op. cit., pp. 489-490.

opinionnaires revealed that too much time was required for some of the slower readers, and that some could not be answered by students. Omission of these questions would have nullified the instrument's value. However, after this preliminary effort, it was decided to attempt to locate an attitude instrument which was validated.

In Chapter II it was noted that the Thurstone and Likert inventories have been successful in assessing an individual's attitude toward an academic subject. This author decided upon the selection of a Likert-type inventory for the following reasons: a) A Likert-type instrument provides more opportunities for a subject to express his opinion;[20] b) It is simpler to score; c) Its reliability is as high as that of a Thurstone instrument.[21]

From among those attitude scales reviewed, Aiken's instrument was selected because its structure approaches that of a Likert-type scale. Its reliability has been

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[20] H. H. Remmers, op. cit., p. 90, "In the Likert-type scale a subject makes some response to every item. A high score (let us suppose this means highly favorable attitude) is obtained by the subject who makes more strongly favorable responses to more of the items than the subject with less favorable reactions."

[21] Allen L. Edwards and Kathryn Claire Kenny, "A Comparison of the Thurstone and Likert Techniques of Attitude Scale Construction," Journal of Applied Psychology, XXX (1946), pp. 72-83. "This simplified method of scoring was found to correlate .99 with the more complicated sigma method first used." [page 74] "According to the evidence at hand, there is no longer any reason to doubt that scales constructed by the method of summated ratings and containing fewer items will yield reliability coefficients as high or higher than those obtained with scales constructed by the Thurstone method." [page 78].

statistically substantiated.[22] Furthermore, a test of independence suggested that attitudes specific to mathematics were being measured.[23] (See Appendix I.)

Administration and Tabulation of the Tests

Each of the principals of the eight participating schools was sent a letter which thanked him for his willingness to cooperate in the investigation. Enclosed was a self-addressed stamped postcard listing the potential testing dates from April 1, 1963, through May 4, 1963. The administrator of each school was to circle three potential testing dates. He also was requested to signify the desirable times for testing, size of the testing groups, the number of the groups, the room in which the testing would be done, and any additional information relevant to the testing procedure adaptable to each individual school.

When the testing schedule was complete, another letter informing each of the impending test date was forwarded. Included in this letter was a brief description of a generalized information form which each student would be requested to complete. (See Appendix II.) It was further explained that this form would vary from school to school since the course offerings, titles, and requirements are similar but not identical in each school. Further, a request was made to have a list of all juniors and their I.Q.'s.

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[22] Lewis R. Aiken, Jr., and Ralph Mason Dreger, "The Effect of Attitudes on Performance in Mathematics," Journal of Educational Psychology, LII (1961), pp. 19-24.

[23] Ibid., pp. 19-24.

Before each group was tested, test answer sheets, opinionnaires, and personal information sheets were numbered and inserted in the 335 available test booklets. For those schools which had more than 335 juniors, it was necessary to insert pre-numbered answer sheets and opinionnaires in the test booklets between testing sessions. After testing at Taylor Center High School, it was determined that the completion of the achievement test, opinionnaire, and the general information forms all within a fifty-five minute session was impractical. Thereafter, with the exception of Lapeer, where a period and a half was allotted to testing, the general information forms were left at each school on the testing date, completed later at the convenience of the school, and mailed to the author. This created a problem of missing general information forms which in turn necessitated vigilant follow-up.

The author attempted to expedite the pretest instructional period in Bay City Handy High School where the class periods were the shortest and the tests would be administered to partial groups all in the same study hall. An orientation sheet for each junior was sent to Bay City the week before the testing date. It was agreed that each junior would receive and read the sheet during homeroom one or two days before the test administration. (See Appendix III.) As a result, although the periods were shorter, it appeared that the testing proceeded smoothly.

Collection of Data in
Preparation for Punching

Preliminary to punching the data on IBM cards, all facts were recorded on a master form. (See Appendix IV.) The first column provided for a four digit school-testee identification number.

In anticipation that some might forget to write their names or record them illegibly, it was decided to utilize a four digit number for each testee. The thousands digit represented the school for each testee and the other digits identify the individual:

1000	Taylor Center	5000	Harper Creek
2000	Lapeer	6000	Kelloggsville
3000	Mayville	7000	Bay City Handy
4000	Springfield	8000	Fairview

Then follows the name of testee, the age in months, the I.Q., and the sex.

The attitude score recorded consists of a positive score, a negative score, and a total. The twenty questions can be classified into ten positive questions. (See Appendix I.) The positive questions were scored one, two, three, four, five for SD, D, U, A, SA, respectively. The negative questions were scored conversely, that is: five, four, three, two, one for SD, D, U, A, SA, respectively. Scored in such a manner, the maximum accumulated positive score is 100, the minimum is twenty. This type of scoring facilitates an internal check on the consistency of the testee's answers.

Since the author was interested in obtaining an objective measure of the student's achievement level, raw scores

from the Snader General Mathematics tests were recorded in the column entitled achievement.

Occupational Status

Each student was asked to state who was the major wage earner in the family and exactly what was his occupation. The author utilized a system of classifying occupations as established by Warner.[24] The Dictionary of Occupational Titles enabled the author to place unfamiliar jobs in the correct group.[25] In this system of classification there are seven categories. The author added an eighth category in order to have a symbol for occupations that were omitted or inadequately described.

Students' Mathematical Experience--
Courses They Have Had in High School

In preparation for testing and collecting data in each school the author had requested a list of mathematics courses offered. These courses were listed on each school's personal information sheet which was completed by all testees. (See Appendix II.) The total number of courses, with different titles, offered in all eight schools was seventeen. They are as follows: (The letters preceding each will be explained later.)

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[24]Lloyd W. Warner, Marchie Meeker, and Kenneth Eels, Social Class in America (New York: Harper & Brothers, 1960) pp. 128-140.

[25]Dictionary of Occupational Titles, Definitions of Titles I (Washington, D.C.: Department of Labor, 1949).

G	1.	General Mathematics or Basic Mathematics 9th grade level
C	2.	Algebra I (First Course)
C	3.	Geometry
G or O	4.	Business Mathematics
O	5.	Bookkeeping
G	6.	Remedial or Refresher Mathematics
O	7.	General Business
G	8.	Practical Mathematics
O or G	9.	Junior Business or Consumer Mathematics
C	10.	Advanced Algebra
G	11.	General Mathematics II
G	12.	Commercial Mathematics
G	13.	Applied Mathematics
C	14.	Solid Geometry
C	15.	Trigonometry
O or G	16.	Shop Mathematics
O	17.	Record Keeping

During the testing visit to each school, the author, through conversation with administrators, heads of mathematics departments, mathematics teachers and students, obtained the names of various texts utilized in each mathematics course, the general nature of some of the courses,[26] and the departments, other than mathematics, in which they were taught. The purpose was two-fold: a) It assisted the author in determining how similar, if at all, the curriculums of the sample schools were; b) It facilitated classification and grouping of courses with various nomenclature but similar course content. A survey of the tests used in each course

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[26]Very little attention was devoted to discussions of the content of the academic courses in each school since it did not appear that the courses varied greatly from school to school. The exception to this was Bay City Handy which has regular honors sections in algebra and geometry. Since this existed in only one school and it did not encompass a significant fraction of the total sample, no special group was designed for these students. That is, they were classified as college preparatory along with other college preparatory students not in an honors course.

revealed that many of the courses were similar in content, although not in title. On the basis of the material covered in the textbook and course guides, where available, the courses were classified as College (C), General (G), or Occupational (O). Here also one finds some variation in schools: e.g., business arithmetic is considered general mathematics in one school while in another, using the same text, it is classified as occupational and is taught by the business department. Therefore, it was determined that the occupational title would be utilized only when a course was taught in a non-mathematics department. Essentially, this was the business or commercial departments.

Upon receiving the general information forms from each school, the numbers of the courses (one-seventeen) were recorded under the appropriate years in which each student had studied them. This completed the collection of data. These data were summarized on sheets for punching on IBM cards in preparation for employing an already existing program on the 7090 computer.

The analysis of these data is described in Chapter IV.

CHAPTER IV

ANALYSIS OF DATA

This chapter presents the analysis of the data collected by the procedures discussed in Chapter III. Scores of mathematical proficiency, attitude, and I.Q. and parental occupational status are organized and recorded from large groups to smaller ones. The scores of females are compared with males, the scores of students who have studied one mathematical sequence are compared with those who have studied another, and then those groupings are further refined by comparing the scores of low, average, and high IQ students in one sequence with low, average, and high IQ students in another.

To facilitate the programming, a maximum number of categories were formed before the programming was initiated. (Table 1 in Appendix V summarizes the categories established.) In preparing this table, all students with at least two years of mathematics were classified as either male or female. These two classifications were further subdivided into low, average, or high IQ on the basis of a frequency distribution chart of the complete sample.[1]

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[1] After compiling the frequency chart, it was discovered that a division of the sample into three equal parts produced an unusually low limit for the high IQ category. To avert this irregular classification, the author divided the total sample into sixths. One-sixth was considered high; four-sixths, average; and one-sixth, low. The numerical points of division by IQ were: High - 115 and above; Average - 91-114; Low - 60-90.

Additionally, thirteen categories based upon students' mathematical experience were established. The first category consisted of students who had studied two years of college preparatory mathematics. Those who had studied the two years of general mathematics formed the second category, and those who had studied one year of college preparatory mathematics and one year of occupational mathematics the third category. Finally, the three-year mathematics students were also classified according to the courses taken. In summary, these categories are:

1. College preparatory - two years
2. General mathematics - two years
3. College preparatory - occupational - two years
4. College preparatory - general - three years
5. General - occupational - three years
6. College preparatory - general - occupational - three years
7. Two years college preparatory - one year general
8. Two years general - one year college preparatory
9. Two years college preparatory - one year occupational
10. Three years college preparatory
11. Two years general - one year occupational
12. Two years occupational - one year general
13. Three years general

By means of these categories, one is able to compare students who studied mathematics in one category with the students of any one of the other categories. These comparisons ignore male or female divisions and more precise comparisons by controlled IQ.

In preparation for the more precise comparisons of sub-categories, each horizontal category was subdivided into low, average, and high IQ males and low, average, and high IQ females. Instead of writing the complete descriptive

phrase as, for example, college-college low IQ males, abbreviations are utilized. A numeral represents the mathematics sequence studied (one of the thirteen horizontal categories), M. or F. symbolizes gender, and the last letter represents the IQ classification. In the above example, the groups would be abbreviated to 1 M.L. Other examples are: One Year Male, Low IQ (1 M.L.); One Year Male, Average IQ (1 M. A.); One Year Male, High IQ (1 M. H.); One Year Female, Low IQ (1 F. L.); One Year Female, Average IQ (1 F. A.); and One Year Female, High IQ (1 F. H.).

After classifying the sample as described above, the analyses revealed very few measurable results of the effect, if any, of parents' occupation on proficiency scores. This necessitated a completely different type of sample division. Although this phase of my investigation is not major, the description of the study is made easier by placing these results plus the results of the division of the sample by sex at the beginning of this chapter.

Comparisons of Students by Parent's Occupation

After devising the system of classification by males, females, low, average, and high IQ, and the thirteen horizontal categories, the analysis indicated that no conclusions could be drawn as to the relationship of parental occupational status, attitude, and mathematics proficiency since the number of cases was not adequate. In order to facilitate such analysis, the total sample was once more divided first into males and females

and then into the eight occupational groups described in Chapter III, page 78. These occupational groups are:

1. Professionals
2. Semi-professionals
3. Clerks and kindred workers
4. Skilled workers
5. Moderately skilled workers and proprietors of small businesses
6. Semi-skilled workers
7. Unskilled workers
8. Unclassified

In Chapter I, it was hypothesized, with respect to occupational status, that:

There is no significant correlation between mathematical proficiency and the father's or guardian's occupation.

There is no significant correlation between attitude and the father's or guardian's occupation.

To test these hypotheses, comparisons were made of the IQ, attitude, and proficiency scores of each successive group of males with occupational group one, then each group with occupational group two, until each group had been compared with the others. (For example, see Table 2 for a comparison of each male occupational group with group one.)

Groups two and three when compared with group one did not exhibit any significantly different means in any of the three variables, although the F scores indicated that differences in the variance of the distributions among the three groups were great. T scores produced by the comparisons of mean intelligent quotients of group one with groups five, six, seven, and eight were significant. Significantly different mean proficiency scores accompanied significant differences in mean IQ scores among the groups. The differences in

attitude were not significant.[2] (See Table 2). It is apparent that the intelligence and proficiency scores of male students from the professional occupational group (group one) were significantly higher than the scores of moderately skilled workers (group five), semi-skilled workers (group six), non-skilled (group seven), and unclassified (group eight).

Comparisons of all the other male occupational groups through similar tables produced a few significant differences in means but no distinguishable patterns appears. There were many significant differences in variance. See Tables 2, 3, 4, 5, 6, and 7 in Appendix V.

For females, (see Table 3) the means of intelligent quotients for groups 4-8 when compared with group 1 were significantly higher than the proficiency scores with the exception of group one compared with group seven, which was not significant. No difference in female attitude scores between group one and the other groups was evidenced as in the analysis of the male attitude scores.

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[2]Initially it occurred to the investigator that significant differences between the negative attitude and positive attitude scores might exist and yet not be reflected in the final attitude score. If this were true, it would certainly pose serious questions as to the validity and reliability of the instrument. It would also necessitate the reporting of more than the final attitude score. In an effort to determine if this were true, all three scores--negative, positive, and final--were punched on each individual card representing a pupil. Examination of the output revealed no significant differences between the positive-negative, and final attitude scores. Therefore, only the final attitude scores are reported within this work.

TABLE 2

SCORES OF ALL MALE OCCUPATIONAL GROUPS
COMPARED WITH THOSE OF GROUP ONE*

		IQ				Attitude				Mathematical Proficiency			
Group	N	X	SD	T	F	X	SD	T	F	X	SD	T	F
1.	26	110.3	12.54			66.	21.58			40.73	12.41		
2.	25	104.6	11.79	1.66	2.76	59.84	18.52	1.09	1.19	33.36	12.01	2.15	4.64
3.	34	106.4	13.23	1.14	1.29	63.15	19.44	.17	.29	33.85	13.44	2.03	4.12
4.	152	104.1	12.00	2.42	5.87	68.99	17.02	.79	.63	33.38	11.41	3.00	9.00
5.	132	100.6	12.27	3.65	13.33	64.76	16.90	.33	.11	29.95	11.74	4.24	18.00
6.	181	100.9	14.29	3.17	10.07	68.44	14.60	.75	.56	30.18	11.92	4.19	17.62
7.	39	102.4	11.00	2.68	7.21	69.21	15.44	.7	.49	30.05	10.64	3.70	13.76
8.	38	95.80	14.72	4.09	16.74	64.68	18.29	.26	.07	25.45	11.32	5.09	26.02

*Underlined items indicate T scores are significant at the 1% level.

TABLE 3

SCORES OF ALL FEMALE OCCUPATIONAL GROUPS COMPARED WITH THOSE OF GROUP ONE*

		IQ				Attitude				Mathematical Proficiency			
Group	N	X	SD	T	F	X	SD	T	F	X	SD	T	F
1. ____	35	111.8	10.36			64.31	19.87			31.17	12.71		
2. ____	25	109.8	9.96	.76	.58	63.12	17.29	.24	.06	33.08	9.07	.64	.41
3. ____	54	108.4	9.19	1.64	2.68	61.85	19.09	.58	.34	30.78	10.25	.17	.03
4. ____	175	104.5	11.80	3.41	11.63	64.37	19.41	0	0	29.74	11.32	.67	.45
5. ____	139	102.0	12.35	4.33	18.79	63.16	18.72	.32	.10	26.90	10.52	2.06	4.23
6. ____	223	101.6	12.79	4.48	20.16	64.27	18.84	0	0	26.16	10.10	2.47	6.91
7. ____	43	98.6	12.02	5.13	26.38	59.23	17.27	1.21	1.46	23.23	8.30	3.32	11.03
8. ____	30	102.6	12.86	3.19	10.2	65.93	21.64	.32	.10	29.17	11.92	.65	.43

*Underlined items indicate T scores are significant at the 1% level.

When group two females are compared with each successive female occupational group, the group has significantly higher IQ and proficiency scores than groups five, six, and seven; but again, no significant difference in attitude. As was the case in analysis of male scores by occupational groups, no significant difference in attitude was found among all the female group comparisons. The tables summarizing the female data are to be found in Appendix V, Tables 8-11.

Group three females compared with each successive female occupational group exhibited significantly higher IQ and proficiency scores than groups six and seven. See Table 9 in Appendix V.

Comparisons among the other female occupational groups resulted in no pattern of significant difference among the three variables. As a result of a computer-administrative problem female groups six and seven were not compared completely. But since these groups fall into the same general area toward the lower end of the occupational ladder, it was decided to exclude them.

Correlations Between and Among IQ, Attitude, and Mathematical Proficiency

In an effort to establish whether or not there is any correlation between and among IQ, age, attitude, mathematical proficiency, and parrent occupation, the Product-Moment correlations formula was utilized.

Table 12, Appendix V, lists the five variables with the figures for the totals of the raw data for all males.

Table 4 presents the results of the applications of the Product-Moment correlations formula to the raw data from Table 12, Appendix V. The correlations between IQ and age; IQ and attitude; IQ and mathematical proficiency; and IQ and occupational index can be determined by scanning the vertical column of figures under the column heading IQ. The IQ-proficiency and the proficiency-attitude correlations are significant at the 1% level. The IQ-attitude correlation, while not significant, is positive.

TABLE 4

MALE OCCUPATIONAL GROUP CORRELATION COEFFICIENTS*

	IQ	Age	Attitude	Mathematical Proficiency	Occupational Index
Column =	1	2	3	4	5
Row = 1	1.00				
Row = 2	-.36	1.00			
Row = 3	.34	-.14	1.00		
Row = 4	<u>.72</u>	-.29	<u>.50</u>	1.00	
Row = 5	-.19	.06	.05	-.21	1.00

*Underlined items indicate correlations are significant at the 1% level.

Table 13, Appendix V, presents the same type of raw data on females.

Table 5 indicates that a significant correlation exists among IQ-proficiency and attitude-proficiency. Although the correlation between IQ and attitude was low it was positive.

TABLE 5

FEMALE OCCUPATIONAL GROUP CORRELATIONS COEFFICIENTS*

Column =	IQ 1	Age 2	Attitude 3	Mathematical Proficiency 4	Occupational Index 5
Row = 1	1.00				
Row = 2	-.39	1.00			
Row = 3	.20	-.07	1.00		
Row = 4	.66	-.18	.42	1.00	
Row = 5	-.24	.04	-.01	-.19	1.00

*Underlined items indicate correlations are significant at the 1% level.

Comparisons by Sex

A hypothesis of this investigation was:

There is no significant difference in the mathematical proficiency and attitude scores of male and female students.

An analysis of the total group, divided into 724 females and 627 males was made. The results are presented in Table 6. This table shows that the males exhibited significantly higher attitude and proficiency scores. One notes also that the IQ of the females was not significantly higher.

Comparisons by Number of Years of Mathematics

Another hypothesis of this investigation was:

There is no significant difference in either the mathematical proficiency and/or the attitude scores of:

(a) students who have studied one year of high school mathematics and those who have studied two years.
(b) students who have studied two years of high school mathematics and those who have studied three years.
(c) students who have studied high school mathematics in ninth-tenth sequence as compared with those of the students who studied high school mathematics in ninth-eleventh sequence.

TABLE 6

MALE STUDENTS COMPARED WITH FEMALE STUDENTS*

Variables Intelligence Quotient	N = 627 Males	N = 724 Females
Mean--X	102.2	103.5
Standard Deviation--SD	13.19	12.0
T Score--T	-1.72	
F Score--F	1.2	
Age in Months		
X	203.5	202.7
SD	6.24	5.79
T	2.28	
F	1.16	
Attitude		
X	66.9	63.6
SD	16.82	18.98
T	<u>3.33</u>	
F	1.27	
Mathematical Proficiency		
X	31.4	27.9
SD	12.04	10.78
T	<u>5.56</u>	
F	1.25	
Occupational Index		
X	4.95	4.85
SD	1.60	1.60
T	1.24	
F	1.00	

*Underlined items indicate T scores significant at the 1% level.

(b) Students who have studied two years of general when compared with those of students who have studied one year of college preparatory and one year of occupational mathematics.

(c) Students who have studied one year of general high school mathematics and one year of college preparatory mathematics when compared with those of students who have studied one year of general and one year of occupational mathematics.

(d) Students who have studied one year of college preparatory, one year of general, and one year of occupational high school mathematics when compared with those of students who have studied two years of college preparatory and one year of general mathematics.

(e) Students who have studied two years of college preparatory and one year of general high school mathematics when compared with those of students who have studied two years of general and one year of college preparatory mathematics.

(f) Students who have studied two years of college preparatory and one year of occupational mathematics when compared with students who have studied three years of college preparatory high school mathematics.

(g) Students who have studied three years of college preparatory mathematics when compared with those of students who have studied two years of general and one year of occupational mathematics.

(h) Students who have studied two years of occupational and one year of general high school mathematics when compared with those of students who have studied three years of general mathematics.

The total sample was divided into (a) males and females; (b) one-year mathematics categories; (c) low, average, and high IQ; (d) two-year or three-year categories corresponding to the established thirteen course classifications which were previously described, e.g., the first category consisted of all students who had studied two years of college preparatory mathematics; the second category consisted of all students

Comparisons of the scores of students who had had one year of high school mathematics with those who had had two years (See Table 7) plus a comparison of those who had had two years in ninth and tenth as opposed to those who had studied two years in ninth and eleventh (See Table 14 in Appendix V) produced no significant differences. But a comparison of two-year mathematics students with those of three-year mathematics students did produce significantly different scores in attitude and proficiency. It is extremely important, though, to note that these significant scores in the two variables are accompanied by a significant difference in the IQ of the two groups being compared. (See Table 7.) In order to control this difference, another approach to analysis had to be sought. An attempt statistically to equalize the native ability of the two groups through an analysis of covariance was made. The mean mathematical proficiency scores of the three-year groups were significantly different from those of the two-year groups but the slopes of the two groups were also significantly different; therefore, one questions the accuracy and adequacy of analysis of covariance to control the IQ in this particular situation. (See Tables 15 and 16 in Appendix V.)

Comparisons Based Upon
Mathematics Sequences Studied

It was hypothesized that there were no significant differences in the mathematical proficiency and/or the attitude scores of:

(a) Students who have studied two years of college preparatory high school mathematics when compared with those of students who have studied two years of general mathematics.

TABLE 7

TWO-YEAR MATHEMATICS STUDENTS COMPARED WITH ONE-YEAR AND THREE-YEAR MATHEMATICS STUDENTS*

Variables	Two-Year	One-Year	Three-Year
Intelligent Quotient	N = 624	N = 49	N = 687
Mean--X	99.1	99.5	106.7
Standard Deviation--SD	12.27	1.08	12.34
T Score--T		.136	-10.6
F Score--F		128.67	1.01
Age in Months			
X	203.7	199.6	202.2
SD	9.24	24.59	5.03
T		1.5	3.67
F		7.08	3.37
Final Attitude			
X	59.8	60.4	70.4
SD	17.37	16.30	17.30
T		.14	-10.99
F		1.14	1.01
Mathematical Proficiency			
X	24.2	22.7	34.9
SD	7.85	12.24	12.04
T		.73	-18.8
F		2.45	2.18
Occupational Index			
X	4.94	5.60	4.81
SD	16.19	113.7	1.58
T		.17	1.44
F		1.4	1.05

*Underlined items indicate T scores significant at the 1% level.

(b) Students who have studied two years of general when compared with those of students who have studied one year of college preparatory and one year of occupational mathematics.

(c) Students who have studied one year of general high school mathematics and one year of college preparatory mathematics when compared with those of students who have studied one year of general and one year of occupational mathematics.

(d) Students who have studied one year of college preparatory, one year of general, and one year of occupational high school mathematics when compared with those of students who have studied two years of college preparatory and one year of general mathematics.

(e) Students who have studied two years of college preparatory and one year of general high school mathematics when compared with those of students who have studied two years of general and one year of college preparatory mathematics.

(f) Students who have studied two years of college preparatory and one year of occupational mathematics when compared with students who have studied three years of college preparatory high school mathematics.

(g) Students who have studied three years of college preparatory mathematics when compared with those of students who have studied two years of general and one year of occupational mathematics.

(h) Students who have studied two years of occupational and one year of general high school mathematics when compared with those of students who have studied three years of general mathematics.

The total sample was divided into (a) males and females; (b) one-year mathematics categories; (c) low, average, and high IQ; (d) two-year or three-year categories corresponding to the established thirteen course classifications which were previously described, e.g., the first category consisted of all students who had studied two years of college preparatory mathematics; the second category consisted of all students

who had studied two years of general mathematics. (These large course classification categories grouped three IQ levels and combined males and females thus temporarily destroying the designed sex-IQ control necessary for later analyses.)

Three groups exhibited significant differences in proficiency. They were as follows: The college-general students' proficiency scores (group four) were significantly higher than the general-occupational students (group five), (see Table 8), the college-general-occupational students' proficiency scores (group six) were significantly higher than those of students who had studied two college preparatory courses and one general (group seven), (see Table 9); three years of college preparatory (group ten) proficiency scores were significantly higher than those of the two college preparatory-one occupational (group nine) scores (see Table 10).

The attitude scores of those students who had studied three years of college preparatory mathematics (group ten) were significantly higher than those of two-year college--one-year occupational (group nine) and two-year general--one-year occupational (group eleven). (See Tables 10 and 11.) It is also noteworthy that the occupational index of college-college students is significantly higher than those of the general-general classification. The occupational index of college-college-college students is significantly higher than that of two-year general--one-year occupational group.

Groups eight-nine (two general-one college preparatory compared with two college-one occupational) reflected a

TABLE 8

STUDENTS WHO STUDIED ONE YEAR OF COLLEGE PREPARATORY AND ONE YEAR GENERAL MATHEMATICS COMPARED WITH THOSE STUDENTS WHO STUDIED ONE YEAR OF GENERAL AND ONE YEAR OF OCCUPATIONAL MATHEMATICS*

Variables	Groups Being Compared	
Intelligent Quotient	College-General N = 152	General-Occupational N = 48
Mean--X	99.7	96.2
Standard Deviation--SD	9.49	8.77
T Score--T		2.31
F Score--F		
Age in Months		
X	203.9	203.4
SD	6.72	6.43
T		.46
F		
Attitude		
X	62.64	62.21
SD	16.72	17.87
T		.15
F		
Mathematical Proficiency		
X	23.68	19.92
SD	6.79	5.00
T		<u>3.54</u>
F		
Occupational Index		
X	4.87	5.42
SD	1.64	1.14
T		-2.15
F		

*Underlined items indicate T scores significant at the 1% level.

TABLE 9

STUDENTS WHO STUDIED ONE YEAR OF COLLEGE-GENERAL-OCCUPATIONAL MATHEMATICS COMPARED WITH THOSE STUDENTS WHO STUDIED TWO YEARS OF COLLEGE PREPARATORY AND ONE YEAR OF GENERAL MATHEMATICS*

Variables	Groups Being Compared	
Intelligent Quotient	College-General-Occupational N = 49	2 College-1 General N = 78
Mean--$\bar{X}$	102.	104.9
Standard Deviation--SD	10.68	9.92
T Score--T		-1.54
F Score--F		
Age in Months		
X	202.6	202.0
SD	4.18	5.41
T		.73
F		
Attitude		
X	66.70	63.21
SD	15.85	16.26
T		1.19
F		
Mathematical Proficiency		
X	25.44	30.95
SD	8.01	7.81
T		<u>-3.85</u>
F		
Occupational Index		
X	5.44	5.17
SD	1.32	1.55
T		1.02
F		

*Underlined items indicate T scores significant at the 1% level.

TABLE 10

STUDENTS WHO STUDIED TWO YEARS OF COLLEGE PREPARATORY AND ONE YEAR OCCUPATIONAL MATHEMATICS COMPARED WITH THOSE STUDENTS WHO STUDIED THREE YEARS OF COLLEGE PREPARATORY MATHEMATICS*

Variables	Groups Being Compared	
Intelligent Quotient	2 College- 1 Occupational N = 23	3 College N = 346
Mean--X	107.7	112.5
Standard Deviation--SD	8.34	10.76
T Score--T		-2.14
F Score--F		
Age in Months		
X	202.7	201.6
SD	4.55	4.54
T		1.14
F		
Attitude		
X	66.09	76.12
SD	15.38	15.62
T		<u>-2.99</u>
F		
Mathematical Proficiency		
X	29.91	43.27
SD	8.34	8.85
T		<u>-7.04</u>
F		
Occupational Index		
X	5.22	4.41
SD	1.02	1.69
T		2.27
F		

*Underlined items indicate T scores significant at the 1% level.

TABLE 11

STUDENTS WHO STUDIED THREE YEARS COLLEGE PREPARATORY MATHEMATICS COMPARED WITH THOSE STUDENTS WHO STUDIED TWO YEARS GENERAL AND ONE YEAR OCCUPATIONAL MATHEMATICS*

Variables	Groups Being Compared	
Intelligent Quotient	3 College N = 346	2 General-1 Occupational N = 64
Mean--X	112.5	95.4
Standard Deviation--SD	10.76	8.92
T Score--T		12.03
F Score--F		
Age in Months		
X	201.6	204.4
SD	4.54	5.76
T		-3.81
F		
Attitude		
X	76.12	63.34
SD	15.62	18.90
T		5.81
F		
Mathematical Proficiency		
X	43.27	23.44
SD	8.85	6.86
T		17.0
F		
Occupational Index		
X	4.41	5.27
SD	1.69	1.25
T		-3.88
F		

*Underlined items indicate T scores significant at the 1% level.

significant difference in IQ, but no significant difference in any other of the other variables. (See Table 17 in Appendix V.)

In contrast, groups ten-eleven (three years college preparatory compared with two years general-one year occupational) yielded such significant differences in all variables that an analysis of covariance was not considered necessary. The great variation in the means scores of the two categories preclude any possibilities of a successful covariance test. (See Table 11.)

Comparisons of Scores Based Upon Mathematical Sequences Studied, While Controlling IQ

As a result of sacrificing some controls in favor of obtaining large groups, analysis of covariance was required in the comparison of groups one-two, two-three, seven-eight, and nine-ten. (See Tables 12 and 13, 14 and 15, 16 and 17, and 18 and 19.)

The analysis of covariance of groups one-two (two-year college preparatory compared with two-year general) yielded a significant difference in proficiency when controlled for intelligence. Worthy of comment also is the fact that the original T tests (with intelligence not controlled) indicated that the occupational index of the two-year college preparatory was significantly higher than the occupational index of the two-year general group. (See Tables 12 and 13.)

The covariance analysis of groups two-three (all two-year generals compared with one-year college preparatory and

TABLE 12

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF STUDENTS WHO HAVE STUDIED TWO YEARS OF COLLEGE PREPARATORY MATHEMATICS COMPARED WITH STUDENTS WHO STUDIED TWO YEARS OF GENERAL MATHEMATICS*

Groups	x^2	xy	y^2	df	y'^2	r	b
Group 1	17378.6	6895.9	12031.9			.3399	.3015
Group 2	25230.8	7245.3	7551.0			.5249	.2872
Within Groups	42609.4	14141.2	19582.9		14889.7		

*Underlined items indicate T scores significant at the 1% level.

TABLE 13

ANALYSIS OF COVARIANCE FOR IQ AND PROFICIENCY SCORES OF STUDENTS WHO HAVE STUDIED TWO YEARS OF COLLEGE PREPARATORY MATHEMATICS COMPARED WITH STUDENTS WHO STUDIED TWO YEARS OF GENERAL MATHEMATICS*

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		24635.2	13767.9	7694.1	1	803.93	803.93
Within	396	42609.4	14141.2	19583.9	395	14889.72	37.7
Totals		67244.6	27909.1	27277.0		15693.65	<u>21.6</u>

*Underlined items indicate T scores significant at the 1% level.

TABLE 14

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF STUDENTS WHO HAVE STUDIED TWO YEARS OF GENERAL MATHEMATICS COMPARED WITH STUDENTS WHO STUDIED ONE YEAR OF COLLEGE PREPARATORY AND ONE YEAR OF OCCUPATIONAL MATHEMATICS

Groups	x^2	xy	y^2	df	y'^2	r	b
Group 2	25230.8	7245.3	7550.7		5470.13	.5249	.2872
Group 3	1868.4	-216.8	1315.9		1290.74	.1383	-.1161
Within Groups	27099.2	8028.5	8866.6		6760.87		

TABLE 15

ANALYSIS OF COVARIANCE FOR IQ AND PROFICIENCY OF STUDENTS WHO HAVE STUDIED TWO YEARS OF GENERAL MATHEMATICS COMPARED WITH STUDENTS WHO STUDIED ONE YEAR OF COLLEGE PREPARATORY AND ONE YEAR OF OCCUPATIONAL MATHEMATICS

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		1449.4	833.4	479.1	1	36.9	36.9
Within	227	27099.2	7028.5	8866.6	226	7043.7	31.2
Totals		28548.6	7861.9	9345.7		7180.6	1.18

TABLE 16

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF STUDENTS WHO HAVE STUDIED TWO YEARS OF COLLEGE PREPARATORY AND ONE YEAR OF GENERAL MATHEMATICS COMPARED WITH STUDENTS WHO STUDIED TWO YEARS OF GENERAL AND ONE YEAR OF COLLEGE PREPARATORY MATHEMATICS

Groups	x^2	xy	y^2	df	Y'^2	r	b
Group 7	7731.00	2095.55	4797.30			.3441	.2711
Group 8	6228.92	2329.49	2892.95			.5488	.3740
Within Groups	13959.92	4425.04	7690.25		6287.59		

TABLE 17

ANALYSIS OF COVARIANCE FOR IQ AND PROFICIENCY SCORES OF STUDENTS WHO HAVE STUDIED TWO YEARS OF COLLEGE PREPARATORY AND ONE YEAR OF GENERAL MATHEMATICS COMPARED WITH STUDENTS WHO STUDIED TWO YEARS OF GENERAL AND ONE YEAR OF COLLEGE PREPARATORY MATHEMATICS*

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		693.6	605.74	529.02	1	204.53	204.53
Within	135	13959.9	4425.04	7690.25	134	6287.59	46.92
Totals		14653.5	5030.78	8219.27		6492.12	<u>4.1</u>

*Underlined items indicate T scores significant at the 1% level.

TABLE 18

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF STUDENTS WHO HAVE STUDIED TWO YEARS OF COLLEGE PREPARATORY AND ONE YEAR OF OCCUPATIONAL MATHEMATICS COMPARED WITH STUDENTS WHO STUDIED THREE YEARS OF COLLEGE PREPARATORY MATHEMATICS

Groups	x^2	xy	y^2	df	y'^2	r	b
Group 9	6684.96	1570.5	1722.0			.4629	.2349
Group 10	39495.9	17508.1	26434.4			.5419	.4433
Within Groups	49180.86	19078.6	28156.4		20274.5		

TABLE 19

ANALYSIS OF COVARIANCE FOR IQ AND PROFICIENCY SCORES OF STUDENTS WHO HAVE STUDIED TWO YEARS OF COLLEGE PREPARATORY AND ONE YEAR OF OCCUPATIONAL MATHEMATICS COMPARED WITH STUDENTS WHO STUDIED THREE YEARS OF COLLEGE PREPARATORY MATHEMATICS*

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among	368	81.6	549.9	3704.0	1	3257.8	3257.8
Within		46180.9	19078.6	28156.4	367	20274.5	55.2
Totals		46262.5	19628.5	31860.4		23532.3	<u>59.0</u>

*Underlined items indicate T scores significant at the 1% level.

one-year occupational) produced no significant difference. Yet, upon checking the slope of the two regression lines, it was found that they are significantly different. This leads one to question the reliability of covariance with these two groups. (See Tables 14 and 15.)

The analysis of covariance of groups seven-eight (all two-year college preparatory--one-year general students compared with all two-year general--one-year college resulted in a significantly higher proficiency score for the two-year college--one-year general students when controlled for intelligence. No other variables reflected any significant differences. (See Tables 16 and 17.)

Tables 18 and 19 present significantly higher proficiency scores for the three-year college preparatory students when compared with two years of college--one-year occupational (groups nine and ten).

Comparisons of Scores of Low, Average, and High IQ Groups

The presentation now turns to a more precise scrutiny of the subcategories within the sample.

The following hypotheses were being tested.

When low IQ male and female students who have studied two years of general mathematics are compared with low IQ male and female students who have studied one year of college preparatory and one year of general mathematics:

(a) There is no significant difference in the mathematical proficiency scores.
(b) There is no significant difference in the attitude scores.
(c) There is no significant difference in the parents' occupational indexes.

As a result of the manner in which the IQ groups were determined, the number of potential matching groups in low and high IQ ranges in both male and female groups was small. (Table 1, Appendix V, presents the thirteen course classifications, with sex-IQ divisions, and the number of cases in each category.) No comparisons of any group with ten or fewer members will be reported in the main body of this paper.

A comparison of fifty-one low IQ males who had two years of general mathematics with eighteen low IQ males who had one year of college preparatory and one year of general mathematics produced no significant differences in any of the variables except occupational index as is shown in Table 20. While examining Table 20, it is interesting to note that the occupational indexes of the general-general students was significantly higher than that of the students who had studied one year of college preparatory and one year of general mathematics. There is no significant difference between the attitude scores.

A comparison of the proficiency and attitude scores of forty low IQ general-general females with twelve low IQ college-general females revealed no significant differences in proficiency or attitude. (See Table 18 in Appendix V.)

Another hypothesis was:

When high IQ male and female students who have studied two years of college preparatory mathematics are compared with high IQ male and female students who have studied three years of college preparatory mathematics:

(a) There is no significant difference between the mathematical proficiency scores.

TABLE 20

FIFTY-ONE GENERAL-GENERAL LOW IQ MALE STUDENTS COMPARED WITH EIGHTEEN COLLEGE-GENERAL LOW IQ MALE STUDENTS

Variables	Groups Being Compared	
Intelligent Quotient	General-General N = 51	College-General N = 18
Mean--X	81.4	85.3
Standard Deviation--Sd	7.53	4.82
T Score--T		-2.06
F Score--F		2.43
Age in Months		
X	207.8	205.4
SD	8.87	5.75
T		1.09
F		2.38
Final Attitude		
X	62.1	59.3
SD	17.1	13.9
T		- .50
F		1.51
Mathematical Proficiency		
X	22.	18.2
SD	5.66	6.29
T		2.15
F		1.24
Occupational Index		
X	4.7	5.4
SD	1.70	1.50
T		<u>4.04</u>
F		1.28

*Underlined items indicate T scores significant at the 1% level.

(b) There is no significant difference between the attitude scores.
(c) There is no significant difference between the parents' occupational indexes.

The matching of thirty-one high IQ girls who had studied two years of college preparatory mathematics with sixty-six girls of the same IQ bracket but who had had three years of college preparatory mathematics produced significant differences in both attitude and proficiency as can be seen in the tabulated figures in Table 21. The three-year students obtained the higher scores. A significant difference in the F ratio of the age implies that although the means of the two groups are not significantly different the significant difference in their variances leads one to believe that their distributions are quite different.

Comparisons of Average IQ Male Groups

It was hypothesized that,

When average IQ male students who have studied one year of mathematics in a mathematics department and one year of mathematics in a non-mathematics department (commercial, for example) are compared with average IQ male students who have studied two years of college preparatory mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

Since the sample included only four average IQ male students who had taken a year of college preparatory mathematics and a year of occupational mathematics, it was impossible to compare that group alone with the group of average

TABLE 21

THIRTY-ONE COLLEGE-COLLEGE HIGH IQ FEMALE STUDENTS COMPARED WITH SIXTY-SIX THREE-YEAR HIGH IQ COLLEGE PREPARATORY STUDENTS*

Variables	Groups Being Compared	
Intelligent Quotient	College-College N = 32	College-College-College N = 66
Mean--X	111.9	121.7
Standard Deviation--SD	4.14	5.56
T Score--T		-1.62
F Score--F		1.80
Age in Months		
X	201.5	200.3
SD	4.02	2.05
T		1.96
F		5.16
Final Attitude		
X	55.1	80.0
SD	20.5	14.7
T		<u>-6.86</u>
F		1.94
Mathematical Proficiency		
X	32.8	47.0
SD	8.10	6.79
T		<u>9.1</u>
F		~~1.94~~ 1.42
Occupational Index		
X	3.4	4.3
SD	1.79	1.89
T		-2.24
F		1.12

*Underlined items indicate T scores significant at the 1% level.

IQ males who had studied two years of college preparatory mathematics. But, within the average IQ male category, there was a sub-group of eighteen males who had taken one year of general mathematics and one year of occupational mathematics. By combining these two groups it was possible to compare one sufficiently large group that had studied one year of college preparatory mathematics and one year of either general or occupational mathematics with a group that had had two years of college preparatory mathematics. While the variability among the scores of the college-college (students who had had two years of college preparatory mathematics) was much greater than that among the college-occupational--general-occupational grouping as may be seen in Table 19, Appendix V, the results showed no significant difference.

Another hypothesis stated:

When average IQ male students who have studied two years of college preparatory mathematics are compared with average IQ male students who have studied two years of general mathematics, there is no significant difference between:

(a) The attitude scores.
(b) The parents' occupational indexes.
(c) The mathematical proficiency scores.

Of the four other comparisons made within this classification, a significant difference exists between the groups of average IQ males who have studied two years of college preparatory mathematics and those who have studied two years of general mathematics. (See Table 20, Appendix V.) Even though these two groups are from the same IQ classification, there is a significant difference in their mean IQ's. Not

only is there a significant difference in the mean of the ages, but also the variability among the scores of each group is significantly different.

It is possible that the significant differences in mathematical proficiency are a direct reflection of the significant differences in the IQ means. This will be discussed later.

An additional hypothesis stated:

When average IQ male students who have had one year of college preparatory and one year of general mathematics are compared with average IQ male students who have studied two years of general mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

The difference resulting from a comparison of average IQ males who have had one year of college preparatory and one year of general mathematics with a group of the same IQ classification, which had had two years of general mathematics, were not significant in any of the variables presented in Table 21, Appendix V.

It was hypothesized that:

When average IQ male students who have studied one year of college preparatory mathematics are compared with average IQ male students who have studied one year of college preparatory and one year of general mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

The mathematical proficiency of sixty college-college average IQ males was significantly higher than that of forty-

one college-general average IQ males. (See Table 22.) There were other significant differences. A final hypothesis in this category stated:

When average IQ male students who studied three years of college preparatory mathematics are compared with average IQ male students who studied two years of college preparatory mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

Both the attitude and proficiency scores of average IQ males with three years of college preparatory mathematics were significantly higher than those of the average IQ males with two years of college preparatory mathematics as tabulated in Table 23.

Comparisons of Average IQ Female Groups

It was hypothesized that:

When average IQ female students who studied two years of college preparatory mathematics are compared with average IQ female students who studied two years of general mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

The presence of more girls in several different groups facilitated the comparison of more combinations within the average female classification than was possible within the male classification.

The IQ, mathematical proficiency, and occupational index scores of average IQ females with two years of college preparatory mathematics are significantly higher than those

TABLE 22

SIXTY COLLEGE-COLLEGE AVERAGE IQ MALE STUDENTS COMPARED WITH FORTY-ONE COLLEGE-GENERAL AVERAGE IQ MALE STUDENTS

Variables	Groups Being Compared	
Intelligent Quotient	College-College N = 60	College-General N = 41
Mean--X	103.5	101.1
Standard Deviation--SD	6.21	6.24
T Score--T		1.86
F Score--F		1.01
Age in Months		
X	202.3	206.1
SD	19.5	7.66
T		1.19
F		6.48
Final Attitude		
X	60.0	64.3
SD	15.1	13.8
T		-1.45
F		1.20
Mathematical Proficiency		
X	28.4	24.5
SD	6.70	7.51
T		2.74
F		1.26
Occupational Index		
X	4.72	4.98
SD	1.61	1.53
T		-.08
F		1.17

Underlined items indicate T scores significant at the 1% level.

TABLE 23

THREE-YEAR COLLEGE PREPARATORY AVERAGE IQ MALE STUDENTS COMPARED WITH TWO-YEAR COLLEGE PREPARATORY AVERAGE IQ MALE STUDENTS

Variables	Groups Being Compared	
Intelligent Quotient	College-College N = 60	College-College-College N = 116
Mean--X	103.5	105.7
Standard Deviation--SD	6.21	5.87
T Score--T		2.32
F Score--F		1.12
Age in Months		
X	202.3	202.3
SD	4.5	3.98
T		0
F		1.28
Final Attitude		
X	60.0	74.0
SD	15.1	13.7
T		-6.2
F		1.21
Mathematical Proficiency		
X	28.4	39.9
SD	6.70	8.10
T		-9.43
F		1.46
Occupational Index		
X	4.72	4.56
SD	1.61	1.67
T		.06
F		1.08

Underlined items indicate T scores significant at the 1% level.

of average IQ females who have studied two years of general mathematics. (See Table 22, Appendix V.)

Another hypothesis was:

When average IQ female students who have studied two years of general mathematics are compared with average IQ female students who have studied one year of college and one year of general mathematics, there is no significant difference between the:

(a) Mathematical proficiency scores.
(b) The attitude scores.
(c) Parents' occupational indexes.

When IQ is controlled, the mathematical proficiency scores of average IQ females who have studied one year of college preparatory and one year of general mathematics is significantly higher than those of average IQ females who have studied two years of general mathematics. (See Tables 24 and 25.)

Another hypothesis was:

When average IQ female students who have studied two years of college preparatory mathematics are compared with average IQ female students who have studied one year of college preparatory and one year of general mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

A comparison of eighty-two average IQ females, having had two years of college preparatory mathematics, with seventy-four average IQ females, having had one year of college preparatory and one year of general mathematics, resulted in significantly different IQ's and proficiency scores. (See Table 23, Appendix V.)

Another hypothesis was:

TABLE 24

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF ONE-YEAR COLLEGE PREPARATORY AND ONE-YEAR GENERAL MATHEMATICS FEMALE STUDENTS AND TWO-YEAR GENERAL MATHEMATICS STUDENTS

Groups	x^2	xy	y^2	df	y'^2	r	b
College-General	2144	952	1981			.4619	.4439
General-General	2226	956	1835			.2135	.1821
Within	4370	1908	3816		2983		

TABLE 25

ANALYSIS OF COVARIANCE FOR IQ AND PROFICIENCY SCORES OF ONE-YEAR COLLEGE PREPARATORY AND ONE-YEAR GENERAL MATHEMATICS STUDENTS AND TWO-YEAR GENERAL MATHEMATICS STUDENTS*

Groups	df	y^2	xy	y^2	df	y'^2	M.S.
Among		517	412	329	1	61	61
Within	143	4370	1908	3816	142	2983	21
Total		4887	2320	4145		3044	<u>2.9</u>

*Underlined items indicate T scores significant at the 1% level.

When average IQ female students who have studied one year of college preparatory and one year of general mathematics are compared with average IQ female students who have studied two years of general mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

The seventy-four average IQ female students with one year of college preparatory mathematics and one year of general mathematics obtained IQ, proficiency and occupational scores significantly higher than a comparable group which had studied two years of general mathematics. (See Table 24, Appendix V.)

Another hypothesis was:

When average IQ female students who have studied three years of college preparatory mathematics are compared with average IQ female students who have studied two years of college preparatory mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

The attitude and mathematical proficiency scores of average IQ female students who had had three years of college preparatory mathematics were significantly higher than those of a comparable group which had studied only two years of college preparatory mathematics. (See Table 26.)

Another hypothesis was:

When average IQ female students who have studied one year of college preparatory, one year of general, and one year of occupational mathematics was compared with average IQ female students who have studied two years of general and one year of occupational mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

TABLE 26

THREE-YEAR COLLEGE PREPARATORY AVERAGE IQ FEMALE STUDENTS COMPARED WITH TWO-YEAR COLLEGE PREPARATORY AVERAGE IQ FEMALE STUDENTS*

Variables	Groups Being Compared	
Intelligent Quotient	College-College N = 82	College-College-College N = 66
Mean--X	105.8	107.2
Standard Deviation--SD	5.43	5.46
T Score--T		-1.56
F Score--F		1.01
Age in Months		
X	202.5	201.8
SD	4.72	4.88
T		.33
F		1.07
Final Attitude		
X	56.2	74.3
SD	18.6	18.6
T		-5.90
F		1.00
Mathematical Proficiency		
X	28.4	40.0
SD	7.56	8.37
T		-8.85
F		1.23
Occupational Index		
X	4.49	4.18
SD	1.60	1.51
T		.98
F		1.20

*Underlined items indicate T scores significant at the 1% level.

In spite of the fact that the mean IQ score of average IQ female students with a year each of college preparatory, general, and occupational mathematics, was significantly higher than that of the comparable group, with two years of general mathematics and one year of occupational mathematics, there were no significant differences in any of the variables. (See Table 25, Appendix V.)

Another hypothesis was:

When average IQ female students who have studied three years of college preparatory mathematics are compared with average IQ female students who have studied two years of general and one year of occupational mathematics, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

Significant differences existed among the IQ, attitude, mathematical proficiency, and occupational index of the average IQ females with three years of college preparatory mathematics when matched with a group of average IQ females who had had two years of general and one year of occupational mathematics. The college-college-college group scores were higher in each variable. (See Table 26, Appendix V.)

Comparisons of One-Year Groups With Two- and Three-Year Groups

Since the total number of students who had had one year of mathematics was only forty-nine, it was decided to divide this group into two sections, twenty-nine who had studied one year of algebra and twenty who had had one year

of general mathematics in an effort to determine whether there were any significant differences between the scores of each of these when compared with the scores of the two- and three-year groups, T tests were run successively.

It was hypothesized that:

When one-year general mathematics students are compared with one-year algebra students, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

The scores of the one-year general mathematics students when compared with twenty-nine one-year algebra students exhibited no significant difference in attitude, proficiency, or occupational index although there were significant differences in IQ. (See Table 27, Appendix V.)

Another hypothesis was:

When one-year general mathematics students are compared with any of the sub-categories within the two-three-year classification, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

The scores of the one-year general mathematics students when compared with fifty-one male general-general mathematics students, eighteen male college-general students, and forty female general-general students exhibited significant differences in IQ but not in attitude, proficiency, or occupational index. (See Table 27, Appendix V.)

When the scores of the one-year general mathematics students were compared with sixty male college-college students,

eighty-two female college-college students, and seventy-four female college-general students, it was determined that in each case a significant difference in the IQ was accompanied by a significant difference in mathematical proficiency. (See Table 28, Appendix V.)

Another hypothesis was:

When one-year algebra students are compared with any of the sub-categories within the two-three year classification, there is no significant difference between:

(a) The mathematical proficiency scores.
(b) The attitude scores.
(c) The parents' occupational indexes.

When the one-year algebra scores are compared with the scores of fifty-one male general-general students, eighteen male college-general students, forty female general-general students significant differences were found in both the IQ and proficiency. (See Table 29, Appendix V.)

Analysis of Covariance of Sub-Groups

Earlier it was noted that significant differences in mathematical proficiency might be the result of differences in IQ means. To determine if this is true, analysis of covariance was made.

The slopes of the average IQ male two-year college preparatory and the two-year general students were so dissimilar that analysis of covariance was not successful. See Tables 30 and 31 in Appendix V.

The analysis of covariance of the scores of forty-one average college-general males when compared with 116 average IQ males who had studied three years of mathematics resulted in a significant difference in the proficiency scores even though IQ was controlled. (See Tables 27 and 28.)

TABLE 27

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF FORTY-ONE AVERAGE COLLEGE GENERAL MALE STUDENTS COMPARED WITH 116 AVERAGE THREE-YEAR MATHEMATICS MALE STUDENTS

Groups	N	x^2	xy	y^2	df	y'^2	r	b
College-General	41	1560.39	870.17	2243.51	1		.4651	.5577
Three-Year Academic	116	3964.72	1550.46	7590.51	115		.2826	.3911
Within Groups		5525.11	2420.53	9834.01		8773.58		

TABLE 28

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF FORTY-ONE AVERAGE COLLEGE-GENERAL MALE STUDENTS COMPARED WITH 116 AVERAGE THREE-YEAR MATHEMATICS MALE STUDENTS *

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		655.03	2163.34	7266.29	1	4918.54	4918.54
Within	155	5525.11	2420.53	9834.01	154	8773.58	56.97
Total		6169.14	4583.87	17100.3		13694.34	<u>86.00</u>

*Underlined items indicate T scores significant at the 1% level.

TABLE 29

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF EIGHTY-TWO AVERAGE COLLEGE-COLLEGE FEMALE STUDENTS AND SEVENTY-ONE GENERAL-GENERAL FEMALE STUDENTS

Groups	N	x^2	xy	xy^2	df	y'^2	r	b
College-College	82	2388.60	1338.88	4627.90			.4027	.5605
General-General	71	2144.31	951.93	1980.79			.4619	.4439
Within Groups		4532.91	2290.81	6608.69		5450.98		

TABLE 30

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF EIGHTY-TWO AVERAGE COLLEGE-COLLEGE FEMALE STUDENTS AND SEVENTY-ONE GENERAL-GENERAL FEMALE STUDENTS *

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		1794.34	1753.44	1713.48	1	286.19	386.19
Within	151	4532.91	2290.81	6608.69	150	5450.98	36.34
Total		6327.25	4044.25	8322.17		5737.17	<u>71</u>

* Underlined items indicate T scores significant at the 1% level.

TABLE 31

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF SIXTY-SIX AVERAGE IQ COLLEGE-COLLEGE-COLLEGE FEMALE STUDENTS AND THIRTY-THREE AVERAGE IQ FEMALE STUDENTS WITH TWO YEARS GENERAL AND ONE YEAR OCCUPATIONAL MATHEMATICS

Groups	x^2	xy	y^2	df	y'^2	r	b
College-College-College	1940.45	273.20	4556.99		4518.53	.09187	.1408
General-Occupational	1440.62	950.24	1162.47		535.69	.7343	.6596
Within Groups	3381.07	1223.44	5719.46		5276.76		

TABLE 32

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF SIXTY-SIX AVERAGE IQ COLLEGE-COLLEGE-COLLEGE FEMALE STUDENTS AND THIRTY-FOUR AVERAGE IQ FEMALE STUDENTS WITH TWO YEARS GENERAL AND ONE YEAR OCCUPATIONAL MATHEMATICS*

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		1249.38	2597.70	5401.14	1	2690.56	2690.56
Within	98	3381.07	1223.44	5719.46	97	5276.76	54.40
Total		4630.45	3821.14	11120.6		7967.32	<u>49.</u>

*Underlined items indicate T scores significant at the 1% level.

TABLE 33

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF SIXTY COLLEGE-COLLEGE AVERAGE IQ MALE STUDENTS AND TWENTY ONE-YEAR GENERAL MATHEMATICS STUDENTS

Groups	N	x^2	xy	y^2	df	y'^2	r	b
College-College	14	2276.9	1132.8	2652.4			.4610	.4975
One-Year General		2431.2	896.8	1322.9			.5001	.3689
Within Groups		4708.1	2029.6	3975.3		3100.3		

TABLE 34

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF SIXTY COLLEGE-COLLEGE AVERAGE IQ MALE STUDENTS AND TWENTY ONE-YEAR GENERAL MATHEMATICS STUDENTS*

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		1126.7	1098.5	1071.1	1	279.0	279
Within	78	4708.1	2029.6	3975.3	77	3100.3	40.3
Totals		5834.8	3128.1	5046.4		3379.3	<u>6.9</u>

*Underlined items indicate T scores significant at the 1% level.

A significant difference was obtained when the same procedure was applied to eighty-two average college-college female students and seventy-one general-general female students. (See Tables 29 and 30.)

The proficiency scores of sixty-six average IQ college-college-college females matched with thirty-three average IQ females who had had two years of general mathematics and one year of occupational mathematics were significantly higher. (See Tables 31 and 32.) In spite of the fact that this difference is significant as one would surmise, one must also be aware of the great difference in slope which creates a question as to the validity of analysis of covariance in this case.

Analysis of covariance of the scores of seventy-four college-general average IQ female students and twenty-five average IQ female students who had studied one year each of college preparatory, general, and occupational mathematics produced no significant difference in the proficiency of the two groups. (See Tables 32 and 33 in Appendix V.)

Due to the fact that the two groups, general mathematics and algebra, had only one year of mathematics, they were not subdivided into IQ ranges. Thus, it was necessary to utilize analysis of covariance when comparing them with any of the two-year--three-year groups.

A significant difference between the proficiency scores of sixty college-college average IQ males and twenty one-year general mathematics students was present. (See Tables 33 and 34.)

Eighteen general-occupational average IQ male students had significantly higher proficiency scores than twenty-nine one-year algebra students. (See Tables 34 and 35, Appendix V.)

Analysis of covariance of the following pairs revealed no significant differences when IQ was controlled:

(a) Fifty-one low IQ general-general males and twenty-nine one-year algebra students. (See Tables 36 and 37, Appendix V.)

(b) Thirty-nine general-general average IQ males and twenty one-year general mathematics students. (See Tables 38 and 39, Appendix V.)

(c) Twenty-nine one-year algebra students and twenty one-year general mathematics students. (See Tables 40 and 41, Appendix V.)

(d) Forty-one college-general average IQ males and twenty one-year general mathematics students. (See Tables 42 and 43, Appendix V.)

(e) Eighteen general-occupational average IQ males and twenty one-year general mathematics students. (See Tables 44 and 45, Appendix V.)

(f) Thirty-nine general-general average IQ males and twenty-nine one-year algebra students. (See Tables 46 and 47, Appendix V.)

(g) Seventy-one general-general average IQ females and twenty-nine one-year algebra students. (See Tables 48 and 49, Appendix V.)

Throughout this chapter, the results of each basic comparison were presented in tables and the significant differences were pointed out. In the next chapter the conclusions from these data will be presented.

CHAPTER V

CONCLUSIONS

Before proceeding to the summary of the analyzed data and to the conclusions, a review of the investigation may help center attention on the more important features.

The Purpose of the Study

The purpose of this study was to determine the effect upon secondary school students of studying various sequences of mathematics in grades nine to eleven.

The Relationships Studied

In the investigation the following relationships were examined:

I. The mathematical proficiency of students who studied:

1. One year of mathematics compared with various combinations of two-year mathematics sequences.
2. Two years of mathematics compared with three years.
3. Different sequences of two-year mathematics courses. (This applies to different combinations of courses and the years in which they were studied.)
4. Mathematics courses offered by non-mathematics departments compared with mathematics courses offered in the mathematics department.
5. Various three-year mathematics sequences.
6. Different types of one-year mathematics courses.

II. The attitudes toward mathematics of students who studied the different sequences.

III. The correlation between mathematical proficiency and attitude toward mathematics.

IV. The mathematical proficiency of students whose fathers or guardians have different occupations.

V. The correlation between attitude and the father's or guardian's occupation.

VI. The mathematical proficiency of male students compared with female students within the previously discussed groups and the total sample.

The General Plan of the Investigation

In the conduct of this investigation, these relationships were restated as hypotheses. To obtain evidence of these hypotheses eight Michigan public high schools were selected according to criteria which were described in Chapter III. The Snader General Mathematics Test, and an attitude scale, developed by Lewis R. Aiken Jr., were administered to each junior in these schools. A personal information form was completed by each student to ascertain the occupation of the parent or guardian, the year in which mathematics courses were studied, and the title of each mathematics course taken. A total of 1,351 students were involved in the investigation. After the data were obtained, the information was processed with automatic computing machinery and analyzed as was described in Chapter IV.

Evidence to Refute or Confirm Hypotheses

Chapter IV presented the data in the form of tables and charts. When the means of variances were significantly different, the data from the tests were included in the text. Those which were not significant appear in the appendix. The function of the following section is to summarize or generalize from these results in terms of the hypotheses.

Comparisons of One-Year Groups With Two-Year Groups

There is no significant difference in the mathematical proficiency of students who studied:

1. One year of algebra compared with students who studied sequences of two years of non-college preparatory mathematics. (Chapter I, hypotheses I-I, II-16).

The comparisons of first-year algebra students with low and average IQ male students and female students with comparable students who had studied two years of non-college preparatory mathematics, revealed that there were no significant differences in mathematical proficiency. The hypothesis, therefore, is confirmed.

2. One year of algebra when compared with students who have had one year of general mathematics. (Chapter I, hypothesis II-14).

There were no significant differences in the mathematical proficiency of general mathematics when compared with those who had studied one year of algebra. The hypothesis again is confirmed.

3. One year of general mathematics when compared with students who have studied various sequences of two years of non-college preparatory mathematics. (Chapter I, hypotheses I-1, II-15)

There were no significant differences in the mathematical proficiency of those students who had studied one year of general mathematics when compared successively with low IQ male students who had studied two years of general mathematics, average IQ male students who had studied one year of general and one year of occupational mathematics, low IQ female students who had studied two years of general mathematics. But analysis of covariance was not possible when comparing one year general mathematics students with selected groups of average IQ and high IQ female students. Therefore, the hypothesis is only partially proven.

4. One year of algebra compared with students who studied various sequences of two years of mathematics. (Chapter I, hypotheses I-1, II-16)

There was a significant difference in the mathematical proficiency of one-year algebra students when compared with eighteen male college-general students. A comparison of one-year algebra students with various college preparatory sequences of two years of mathematics was not possible because of the variance between the IQ of the one-year algebra group when compared with the two-year college preparatory students. The hypothesis is partially refuted.

5. One year of general mathematics when compared with students who studied various sequences of two years of mathematics. (Chapter I, hypotheses I-1, II-15)

There were significant differences in the mathematical proficiency when one year general mathematics was compared

with eighty-two college-college average IQ female students who had studied one year of college-preparatory mathematics and one year of general. The hypothesis is only partially refuted.

The essence of the data relevant to the first five hypotheses is contained in the following summary. The comparisons of one-year mathematics students with students who studied two years of non-college mathematics revealed no significant differences in mathematical proficiency. The comparisons of one-year mathematics students with students who studied two years of mathematics including one or two years of college preparatory mathematics revealed that part of the two-year students' mathematical proficiency scores were higher than the one-year. But as discussed in Chapter IV, it should be noted that the number of one-year mathematics students was so limited that the above conclusions warrant further investigations.

Comparison of Scores of
Various Two-Year Sequences

There is no significant difference in the mathematical proficiency of students who studied:

6. Various two-year mathematics sequences, regardless of the order, kind, or time of taking the two years of mathematics. (Chapter I, hypotheses I-3, 4, 5; II-1, 4, 5, 6, 7, 8, 9, 10)

Regardless of the sequence of courses, types of mathematics courses taken, and the time of taking the two years of mathematics, there were no significant differences among the

proficiency scores of sub-categories of low IQ male and female students. The hypothesis is confirmed.

The mathematical proficiency scores of average IQ male students who have studied one year of general and one year of college preparatory mathematics are not significantly different from those who have studied two years of general mathematics. The hypothesis is confirmed.

With IQ controlled the mathematical proficiency scores of average IQ female students who have studied one year of college preparatory mathematics and one year of general mathematics were significantly higher than the scores of average IQ female students who studied two years of general mathematics. The hypothesis is refuted.

When controlled for intelligence, the mathematical proficiency scores of two-year college preparatory students were significantly higher than that of the two-year general students. The hypothesis is refuted.

When the proficiency scores of two-year students who studied mathematics in ninth and eleventh grades were compared with the scores of those who took their mathematics in ninth and tenth grades, there were no significant differences in attitude or proficiency. The hypothesis is confirmed.

To summarize, the data do not permit a clear confirmation or refutation of the hypotheses. The comparison of subcategories in which the IQ was more precisely defined and the sample size reduced, produced no significant differences.

When all of the sub-categories were combined into one large category which was compared with another, significant differences appeared. Although the data revealed no significant differences in the scores of students who studied mathematics in ninth-tenth grades when compared with students who studied mathematics in ninth-eleventh, the sample was limited. Therefore, this facet warrants investigation with larger numbers of students.

Comparisons of Various Three-Year Sequence Scores and Two-Year Scores

There is no significant difference in the mathematical proficiency of students who studied:

7. Various sequences of three-year mathematics courses. (Chapter I, hypotheses I-2, 7, 8, 9, 10, 11; II-2, 11, 13)

The IQ and proficiency scores of three-year college preparatory students were significantly higher than each of the other sequences of mathematics. The hypothesis is refuted.

8. Mathematics two years and those who studied three years.

The mathematical proficiency scores of the high IQ female students who studied three years of college preparatory mathematics were significantly higher than those who studied two years of college preparatory mathematics. The hypothesis is refuted.

Those students who had studied three years had significantly higher mathematical proficiency scores than those who had studied two years of mathematics. But when analysis of

covariance was attempted in order to control statistically the IQ variation between the two sample sections, it was not possible since the slopes of the two samples varied so greatly. The hypothesis is partially confirmed.

In summary, the data revealed that proficiency scores of three-year mathematics students were significantly higher than those of two-year mathematics students. One might ask if it is possible that this is true as a result of the fact that the largest percentage of students who take three years of mathematics are in the college preparatory fields. This is certainly implied when one examines the results of comparisons of scores of three-year college preparatory students with other three-year mathematics sequences. Still, the three-year college preparatory category, in every instance where it was possible to control intelligence statistically, had much higher proficiency scores than each mathematical sequence with which it was compared.

Comparisons of Scores of Students Who Studied Mathematics in Non-Mathematics Departments With Students Who Studied Only in Mathematics Departments

There is no significant difference in the mathematical proficiency of students who studied:

9. Mathematics courses in departments other than mathematics and students who have studied all their mathematics in the mathematics department. (Chapter I, hypothesis I-5, 6, 7, 9, 10, 11; II-3, 12, 13)

The mathematical proficiency of average IQ male students to whom mathematics was taught in non-mathematics departments

(such as business, vocational, or commercial) were not significantly different from the scores of students who had studied mathematics within the mathematics department. The hypothesis is confirmed.

The mathematics proficiency scores of students who had studied one year of college preparatory and one year of general mathematics were significantly higher than those of students who had studied one year of general and one year of occupational mathematics in other than the mathematics department. The hypothesis is refuted.

Adding a year of mathematics taught in a department other than mathematics had no effect on the mathematical proficiency of the average IQ female student. The hypothesis is confirmed.

The mathematical proficiency scores of students who had studied one year of college preparatory and one year of general mathematics were significantly higher than those of students who had studied one year of general and one year of occupational mathematics. The hypothesis is refuted.

The mathematical proficiency scores of students who had studied one year of college preparatory, one year of general, and one year of occupational mathematics were significantly higher than those of students who had studied two college preparatory courses and one general course. The hypothesis is refuted.

The mathematical proficiency scores of students who had studied three years of college preparatory were significantly

higher than those of students who had studied two college preparatory courses in the mathematics department and one occupational course not in the mathematics department. The hypothesis is refuted.

In view of the above conclusions, it is difficult to assess the effect of teaching one year of mathematics (labeled occupational throughout this dissertation) in a department other than mathematics upon mathematical proficiency since different combinations of courses produced inconsistent results. That is, the presence of occupational mathematics courses in a few instances appeared to improve proficiency, while in others it did not.

Comparisons of Attitude Scores of Students Who Studied Various Mathematics Sequences

There is no significant difference in the attitude toward mathematics of the students who have studied various sequences of mathematics. (Chapter I, hypothesis III)

The variations in attitude scores of low IQ male and female students were so small that the differences were not significant. The hypothesis is confirmed.

There were no significant differences in the attitude scores of students who had studied two years of mathematics when compared with students who had studied one year of mathematics. The hypothesis is confirmed.

Only the average IQ male and female students who have studied two years of college preparatory mathematics have significantly higher attitude scores than those of the same

sub-category who have studied two years of general mathematics. The hypothesis is refuted.

The attitude scores of female three-year mathematics students were superior to those of all sub-categories within the female categories even when the differences in IQ were statistically equalized. The hypothesis is refuted.

The attitude scores of the three-year college preparatory students were significantly higher than those of either two-year college preparatory, one-year occupational, or two-year general students. The hypothesis is refuted.

With the exception of average IQ male and female students in the two-year mathematics section, no significant differences in attitude appeared in either the one- or two-year mathematics sequences. The attitude scores of the three-year college preparatory students is much higher than that of any other sub-category or category within the sample. The hypothesis is, therefore, only partially confirmed.

In summary, when attitude scores of students who had studied various sequences of one- and two-year non-college mathematics were compared there were no significant differences. As stated above, the comparison of attitude scores of two-year college preparatory mathematics students with others in this group revealed some significant differences. When the three-year college preparatory student attitude scores were compared with any other sequences, their scores were found to be significantly higher.

Correlation Between Mathematical Proficiency and Attitude

There is no positive correlation between mathematical proficiency and attitude toward mathematics. (Chapter I, hypothesis IV)

For all male students in the sample, there was a statistically significant correlation between IQ-attitude, IQ-proficiency, and proficiency-attitude. The hypothesis is refuted.

For all female students in the sample, there was a statistically significant correlation between IQ-proficiency, and attitude-proficiency. Yet the IQ-attitude correlation factor, although significant, is low. The hypothesis is refuted.

It is interesting to note that a significant correlation between IQ and attitude exists for both male and female students but that it is lower for the female students. The hypothesis is not proven.

Correlation Between Mathematical Proficiency and the Father's Occupation

There is no positive correlation between mathematical proficiency and the father's occupation. (Chapter I, hypothesis V)

As was explained in Chapter IV, the sample was first divided into male students, female students, low, average, and high IQ groups. Then these groups were divided into groups relative to the number and sequence of mathematics courses studied. As the IQ, proficiency, and attitude scores of these groups were being compared, so were the occupational indices. Only a few of these groups produced significant differences in occupational indices. When they did, it was

important to observe if there was a corresponding significant proficiency score. The following statements summarize the results.

There appeared to be no positive correlation between the father's occupation and mathematical proficiency among any small group comparisons. The hypothesis is confirmed.

There was no positive correlation between the occupational index of parents and the mathematical proficiency of the low IQ male and female students. The hypothesis is confirmed.

The occupational index scores of the parents of female two-year college preparatory mathematics students are significantly higher than those of the parents of general mathematics students. In other words, the parents of college preparatory students had occupations higher in social class status than did those of the parents of general mathematics students.

The occupational index scores of the parents of female three-year college preparatory mathematics students were significantly higher than those parents of female students who had studied two years of general and one year of occupational mathematics.

The occupational index of those who studied two years of college preparatory mathematics is significantly higher than those of the general-general classification.

The occupational index and proficiency of those who studied three years of college preparatory mathematics is significantly higher than those of the two-year general and one-year occupational group.

Since the division of the sample by the number and sequences of mathematics courses was not as effective as was hoped in the identification of the relationship between occupation and proficiency, the sample was divided into male students and female students and then into eight occupational groups as discussed in Chapter IV. Below will be found the results of these explorations.

The mathematical proficiency scores of male students whose parents are of the highest occupational group (Group I, professional) are significantly higher than those of the other occupational groups. The hypothesis is refuted.

The mathematical proficiency scores of female students whose parents are of the highest occupational group were so varied that there were no significant differences. The hypothesis is confirmed.

The mathematical proficiency scores of female students whose parents are of the second highest occupational group were significantly higher than those of the semi-skilled and laboring class. The hypothesis is refuted.

As might be expected, the IQ of both male students and female students whose parents were in the highest occupational group were significantly higher than those of each of the remaining six occupational groups. Although the female students of this group varied more than the male students, both sexes had consistently higher proficiency scores than members of the other occupational groups. There was a statistically significant correlation between proficiency-attitude

and IQ-proficiency of all students whose parents' occupations were classified as higher occupational groups.

The variation, as to mathematical proficiency, is as great or greater between individuals than between occupational groups. This variation prohibits one from predicting any degree of proficiency for individuals. But taking an occupational group as a whole permits a higher degree of prediction as to proficiency.

In summary, it may be concluded that the occupational indices and mathematical proficiency scores of only two- and three-year college preparatory students when compared with students of other mathematical sequences appeared to be positively related. That is, a significant difference in mathematical proficiency was accompanied by a significant difference in occupational indices. Among all the other groups there was no positive correlation between the proficiency and occupational indices although this was not as clear when the sample was divided into eight occupational groups. The highest occupational group, male and female students, exhibited a significant correlation between mathematical proficiency and the father's occupation. The other groups varied so greatly that a significant relationship was not exhibited.

Correlation Between Attitude and the Father's Occupation

There is no positive correlation between attitude and the father's or guardian's occupation. (Chapter I, hypothesis VI)

There was a positive correlation between the occupational indices of parents of three-year mathematics students and their proficiency scores.

There was a positive correlation between the attitude scores and occupational indices of the highest occupational group.

In conclusion, the data revealed no positive correlation between attitude and occupational status except those described above.

There is no significant difference between male students and female students in the various groups in the total samples. (Chapter I, hypothesis VII)

Irrespective of grouping or mathematical sequences studied by both fractions of the sample, the male students exhibited significantly higher proficiency and attitude scores than the female students.

Resumé of Summaries

1. The comparisons of one-year mathematics students with students who studied two years of non-college mathematics revealed no significant differences in mathematical proficiency. The comparisons of one-year mathematics students with students who studied two years of mathematics including one or two years of college preparatory mathematics revealed that part of the two-year students' mathematical proficiency scores were higher than the one year. But as discussed in Chapter IV, it should be noted that the number of one-year mathematics students was so limited that the above conclusions warrant further investigation.

2. The data do not permit a clear confirmation or refutation of the hypotheses. The comparison of sub-categories in which the IQ was more precisely defined and the sample size reduced produced no significant differences. When all of the sub-categories were combined into one large category which was compared with another, significant differences appeared. Although the data revealed no significant differences in the scores of students who studied mathematics in ninth-tenth grades when compared with students who studied mathematics in ninth-eleventh, the sample was limited. Therefore this facet warrants further investigation with larger numbers.

3. The data revealed that proficiency scores of three-year mathematics students were significantly higher than those of two-year mathematics students. One might ask if it is possible that this is true because the largest percentage of students who take three years of mathematics are in the college preparatory fields. This is certainly implied when one examines the results of comparisons of scores of three-year college preparatory students with other three-year mathematics sequences. Still, the three-year college preparatory category, in every instance where it was possible to control intelligence statistically, had much higher proficiency scores than each mathematical sequence with which it was compared.

4. In view of the above conclusions it is difficult to assess the effect of teaching one year of mathematics (labeled occupational throughout this dissertation) in a department other than mathematics upon mathematical proficiency since

different combinations of courses produced inconsistent results. That is, the presence of occupational mathematics courses in a few instances appeared to improve proficiency while in others it did not.

5. When attitude scores of students who had studied various sequences of one- and two-year non-college mathematics were compared there were no significant differences. As stated above the comparison of attitude scores of two-year college preparatory mathematics students with others in this group revealed some significant differences. When the three-year college preparatory student attitude scores were compared with any other sequence, their scores were found to be significantly higher.

6. It is interesting to note that a significant correlation between IQ and attitude exists for both male students and female students but that it is lower for the female students.

7. It may be concluded that the occupational indices and mathematical proficiency scores of only two- and three-year college preparatory students when compared with students of other mathematical sequences appeared to be positively related. That is, a significant difference in mathematical proficiency was accompanied by a significant difference in occupational indices. Among all the other groups there was no positive correlation between proficiency and occupational indices and this relationship was not as clear when the sample was divided into eight occupational groups. The highest occupational group,

male students and female students, exhibited a significant correlation between mathematical proficiency and the father's occupation. The other groups varied so greatly that a significant relationship was not exhibited.

8. The data revealed no positive correlation between attitude and occupational status except those described earlier in this chapter.

Implications of This Research

1. Judging from the sample which was used in this research, the counselors and high school mathematics instructors who guide all apparent college preparatory students into a college preparatory mathematics program are not doing them a disservice even though some will survive only one year. The data reflected no difference in attitude and/or proficiency of one-year college preparatory and one-year general students when compared with two-year non-college preparatory students. But the tests did produce a significantly higher mathematics proficiency score for two-year college preparatory students when compared with one-year and two-year general students, thus supporting the directing of all students, thought to be capable, into the college preparatory mathematics program. This also might be interpreted as an encouraging sign for mathematics educators who maintain that college preparatory classes do produce mathematically proficient students. True, the number of variables involved is so great that it is difficult to state that this difference in degree of proficiency is a resultant of the course content.

2. There are some who believe in the magic of college preparatory mathematics and might even persist in forcing unqualified students into such situations in order to expose them to this magic. Close scrutiny of the results of testing the low IQ categories reveals that there is often no gain in mathematical proficiency under such circumstances. As a whole, the mathematical proficiency and attitude scores reflected no significant differences regardless of the mathematical sequences studied in the low IQ category.

3. Even though the size of the one-year mathematics sample was very small, one statement is necessary. Consistently, the results reflected no significant differences in the mathematical proficiency and/or attitude scores of one-year mathematics students when compared with each of the two-year mathematics sequences except the two-year college preparatory. This suggests that schools requiring two years of non-college preparatory mathematics might wish to test before and after the mathematics courses both years in an effort to ascertain the advisability of such a requirement.

4. The North Central Association for Accreditation of high schools has been criticized for not permitting certain mathematics courses to be taught by other departments in the high school unless the non-mathematics department instructor has at least a minor in mathematics. Frequently the schools involved have commented that the student attitude is better as a result of the course being taught in a non-mathematics department. This results, so some say, in a higher degree of

mathematical proficiency being obtained. Results of this research suggest that it would be wise for such schools to test for both proficiency and attitude before making such claims.

5. Although the mathematical proficiency scores of the highest occupational group (Group I, professional) are significantly higher than those of any other one of the remaining occupational groups, the fact that there is little difference in the attitude scores is worthy of note. Two practical conclusions might be drawn from this:

a. Teachers and administrators should take a more positive approach to the teaching of middle and lower economic level students, since contrary to widespread opinion, their attitude scores are just as positive as those of the upper occupational groups.

b. The utilization of NDEA funds for economically deprived students is well advised since presently these are not awarded unless there is need and academic ability. To these two pre-requisites add the positive attitude of the economically deprived and the elements of success in mathematics and progress for the country are present.

6. The correlation between IQ-proficiency-attitude indicated that schools may do some predicting as to the degree of success in mathematics that might be expected from an occupational group view. That is, if the school has a large

percentage of higher occupational group parents, it is probably wise to require and develop more mathematics courses (more, that is, compared with a district that has predominately lower occupational group families) since the group of students as a whole will be able to succeed.

7. In light of the fact that the correlation between proficiency and attitude was significantly positive, schools might be able to improve their mathematics programs by periodic surveys with attitude measuring instruments. For the most part, the attitude instrument can be administered in a very short time and, is appealing to the students, since it offers an opportunity to express their opinions.

8. School systems which are concerned about the effect on student attitude of requiring mathematics two years in succession need not be disturbed, since the time sequence of courses appeared to be unrelated to attitude or proficiency.

9. In light of the conclusions listed immediately above, it would be logical to question whether mathematical proficiency is being improved to any substantial degree by some of our curriculum improvisations. Curriculum revision is healthy but pre-tests and post-tests in both attitude and proficiency will enable a school system to evaluate the effects of change.

Further Research

The results of the correlations reflected a higher correlation between male IQ and attitude than between female

IQ and attitude. Is it possible that a more detailed examination and extension of research would contribute some explanation of this?

It would also seem worthwhile to investigate more deeply the lack of significant difference in attitude among the higher occupational groups and the lower ones. When the fact is considered that the students of the higher occupational group have higher IQ's and proficiency scores (and there is a significant correlation among them), the lack of significant differences in attitude become worthy of further investigation.

Considering the size of the one-year mathematics sample, further research with more evenly matched groups by size might produce valuable information for the mathematics educators. On the basis of what has been learned in this investigation, it would seem wise to attempt to compare only one- and two-year mathematics students. Yet, based upon the hypothesis (proven also to some degree in this study) that three-year mathematics students have significantly higher attitude scores, a more thorough scrutiny of their attitudes and reasons for them might contribute to improvement of programs and methods for the one- and two-year mathematics sequences.

If it were possible, comparing equal groups of students who had studied one year of mathematics with groups who had studied two years in the same large high school would permit control of more variables. Admittedly, the population would be selected since it would be a large school but possibly this

could be countered by selecting several large schools where the number of students studying one- and two-year mathematics sequences was somewhat equal.

Although the attitude measuring instrument used in this study was validated and statistically sound, one might produce an attitude measuring instrument that would refine the attitude scores. As the attitude data were carefully scrutinized, the question arose, would a more precise attitude score be produced if the instrument was even more simply designed and worded?

Attitude possibly doesn't have the effect on mathematics that some attribute to it even if measured accurately. The course content and manner of teaching are other factors to be considered when mathematical proficiency is to be determined. Regardless of the fact that all of these variables, frequently intangibles, do exist, continued investigation is necessary in order to continue to improve mathematics offerings.

APPENDICES

APPENDIX I

Name _____

School _____

Grade Level _____

O P I N I O N N A I R E[1]

DIRECTIONS: Please write your name in the upper right hand corner. Each of the statements on this opinionnaire expresses a feeling which a particular person has toward mathematics. You are to express on a five-point scale, the extent of agreement between the feeling expressed in each statement and your own personal feeling. The five points are: Strongly disagree (SD), Disagree (D), Undecided (U), Agree (A), Strongly agree (SA). You are to encircle the letter which best indicates how closely you agree or disagree with the feeling expressed to each statement as it concerns you.

1.	I do not like mathematics. I am always under a terrible strain in a math class.	SD	D	U	A	SA
2.	I do not like mathematics, and it scares me to have to take it.	SD	D	U	A	SA
3.	Mathematics is very interesting to me. I enjoy math courses.	SD	D	U	A	SA
4.	Mathematics is fascinating and fun.	SD	D	U	A	SA
5.	Mathematics makes me feel secure, and at the same time it is stimulating.	SD	D	U	A	SA
6.	I do not like mathematics. My mind goes blank, and I am unable to think clearly when working math.	SD	D	U	A	SA

[1]Lewis R. Aiken, Jr., and Ralph Mason Dreger, "The Effect of Attitudes on Performance in Mathematics," Journal of Educational Psychology, LII (1961), pp. 19-24.

7.	I feel a sense of insecurity when attempting mathematics.	SD	D	U	A	SA
8.	Mathematics makes me feel uncomfortable, restless, irritable, and impatient.	SD	D	U	A	SA
9.	The feeling that I have toward mathematics is a good feeling.	SD	D	U	A	SA
10.	Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out.	SD	D	U	A	SA
11.	Mathematics is something which I enjoy a great deal.	SD	D	U	A	SA
12.	When I hear the word math, I have a feeling of dislike.	SD	D	U	A	SA
13.	I approach math with a feeling of hesitation--hesitation resulting from a fear of not being able to do math.	SD	D	U	A	SA
14.	I really like mathematics.	SD	D	U	A	SA
15.	Mathematics is a course in school which I have always liked and enjoyed studying.	SD	D	U	A	SA
16.	I don't like mathematics. It makes me nervous to even think about having to do a math problem.	SD	D	U	A	SA
17.	I have never liked math, and it is my most dreaded subject.	SD	D	U	A	SA
18.	I love mathematics. I am happier in a math class than in any other class.	SD	D	U	A	SA
19.	I feel at ease in mathematics, and I like it very much.	SD	D	U	A	SA
20.	I feel a definite positive reaction to mathematics; it's enjoyable.	SD	D	U	A	SA

APPENDIX II

GENERAL INFORMATION

1. NAME _____ (Last First Middle) 2. SEX ___M ___F

3. BORN _____ (Month Day Year)

4a. What is the exact occupation of the person who is your chief means of support? (Be specific. For example, do not write factory worker; write welder or machine operator, or truck driver.)

_____

4b. Circle one. Is this person your father, mother, or another person?

Your father Your mother Another person

PLEASE CIRCLE THE MATHEMATICS COURSES YOU HAVE HAD IN THE GRADE WHICH YOU HAD THEM

9th Grade	10th Grade	11th Grade
1. Algebra I	1. Geometry	1. Algebra II
2. General Mathematics I	2. General Mathematics II	2. Bookkeeping
3. Junior Business	3. Business Mathematics	3. Trigonometry
	4. Algebra I	4. Solid Geometry

APPENDIX III

TO THE JUNIORS[2]

TEST ORIENTATION LETTER TO JUNIORS

In the near future you will be participating in a state-wide University of Michigan authorized mathematical experiment. The purpose is two fold: (1) To determine your attitude toward mathematics; (2) To determine your mathematical skills.

From the results of the information obtained, it may be possible to design mathematics courses which are both more useful and enjoyable.

On the day of the test you will first receive an opinionnaire which consists of questions designed to help you express your feelings about mathematics. The instructions will be as follows: "Each of the statements on this opinionnaire expresses a feeling which a particular person has toward mathematics. You are to express on a five-point scale, the extent of agreement between the feeling expressed in each statement and your own personal feeling. The five points are: Strongly disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly agree (SA). You are to encircle the letter which best indicates how closely you agree or disagree with the feeling expressed to each statement as it concerns you." We want to know just how you feel. Do not answer questions as you think someone would want them answered. For example, if I should state, "Coca Cola is bad for high school students; therefore no high school students should be permitted to drink cokes," most of you would circle SD, in this manner:

(SD) D U A SA

The second part of the experiment involves a 40-minute test of your skill in mathematics. Your scores will have no bearing on your academic (report card grades) marks. We are attempting to determine how well you function in mathematics. The test will have some problems which everyone can do and some which only a few can do. You are not to become discouraged if you find it difficult. Do not dwell too long on one problem since you have only 40 minutes to work 65 problems.

For each question there are five possible answers. You are to work each question (either in your head or on scratch paper) and determine which answer is correct; then record the answer on the answer sheet. You may answer a question even

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[2]Adapted from Snader. Daniel W. Snader, Snader General Mathematics Test (Yonkers-on-Hudson, New York: World Book Co., 1952).

when you are not perfectly sure that your answer is correct, but you should avoid wild guessing.

SAMPLE A. The sum of 10 and 10 is

a. 0
b. 15
c. 17
d. 20
e. 100

A. a b c d e

For Sample A the answer, of course is "20," which is answer d. Notice that a heavy mark has been made filling the space (the pair of dotted lines) marked d. Be careful to mark or fill in carefully only between the lines since the answer sheets will be machine scored and marks not between the dotted lines will be counted as incorrect answers.

SAMPLE B. If an airplane travels 1105 miles in 5 hours, what is the average number of miles it travels in one hour?

f. 201 miles
g. 205 miles
h. 221 miles
i. 225 miles
j. none of the above

For this sample you would have the same pairs of lines as above but each would be labeled in this manner:

f g h i j

The correct answer for Sample B is "221 miles," which is answer h; so you would answer Sample B by making a heavy black mark that fills the space under the letter h. If the correct answer had not been given, you would have chosen answer j, "none of the above."

There are several pages in the test. Therefore, when you finish one page you go on to the next page. YOU ARE ASKED TO WORK AS RAPIDLY AND AS ACCURATELY AS YOU CAN.

You will find that the time flies and that you can do even better than you thought.

APPENDIX IV

DATA SUMMARY SHEET

School	NAME	Age	I.Q.	Sex	Attitude	Achievement	Job Rating	9th GRADE	9th GRADE	10th GRADE	10th GRADE	11th GRADE	11th GRADE

APPENDIX V

THE RELEVANT DATA

TABLE 1

COURSE CLASSIFICATIONS OF MATHEMATICS STUDENTS WHO HAVE STUDIED TWO OR THREE YEARS OF MATHEMATICS

MALE				FEMALE			
LOW IQ	AVERAGE IQ	HIGH IQ		LOW IQ	AVERAGE IQ	HIGH IQ	
College-College (C-C)	C-C	C-C		C-C	C-C	C-C	
1-M-L 7	1-M-A 60	1-M-H 11		1-F-L 4	1-F-A 82	1-F-H 31	
General-General (G-G)	G-G	G-G		G-G	G-G	G-G	
2-M-L 51	2-M-A 39	2-M-H 28		2-F-L 40	2-F-A 71	2-F-H 1	
College Occupational (C-O)	C-O	C-O		C-O	C-O	C-O	
3-M-L 2	3-M-A 4	3-M-H 1		3-F-L 1	3-F-A 18	3-F-H 1	
College-General (C-G)	C-G	C-G		C-G	C-G	C-G	
4-M-L 18	4-M-A 41	4-M-H 2		4-F-L 12	4-F-A 74	4-F-H 5	
General-Occupational (G-O)	G-O	G-O		G-O	G-O	G-O	
5-M-L 5	5-M-A 18	5-M-H 0		5-F-L 8	5-F-A 17	5-F-H 0	
College-General-Occupational (C-G-O)	C-G-O	C-G-O		C-G-O	C-G-O	C-G-O	
6-M-L 0	6-M-A 14	6-M-H 0		6-F-L 7	6-F-A 25	6-F-H 3	
2 College-1 General (2C-1G)	2C-1G	2C-1G		2C-1G	2C-1G	2C-1G	
7-M-L 5	7-M-A 35	7-M-H 4		7-F-L 2	7-F-A 25	7-F-H 7	
2 General-1 College (2G-1C)	2G-1C	2G-1C		2G-1C	2G-1C	2G-1C	
8-M-L 8	8-M-A 25	8-M-H 2		8-F-L 5	8-F-A 17	8-F-H 2	
2 College-1 Occupational (2C-1O)	2C-1O	2C-1O		2C-1O	2C-1O	2C-1O	
9-M-L 1	9-M-A 7	9-M-H 2		9-F-L 0	9-F-A 11	9-F-H 2	
2 College-1 College (2C-1C)	2C-1C	2C-1C		2C-1C	2C-1C	2C-1C	
10-M-L 5	10-M-A 116	10-M-H 87		10-F-L 6	10-F-A 66	10-F-H 66	

TABLE 1--Continued

MALE						FEMALE					
LOW IQ		AVERAGE IQ		HIGH IQ		LOW IQ		AVERAGE IQ		HIGH IQ	
2 General-1 Occupational (2G-1O)		2G-1O		2G-1O		2G-1O		2G-1O		2G-1O	
11-M-L	9	11-M-A	10	11-M-H	0	11-F-L	11	11-F-A	33	11-F-H	1
2Occupational-1 General (2O-1G)		2O-1G		2O-1G		2O-1G		2O-1G		2O-1G	
12-M-L	2	12-M-A	1	12-M-H	0	12-F-L	4	12-F-A	9	12-F-H	0
General-General-General (G-G-G)		G-G-G		G-G-G		G-G-G		G-G-G		G-G-G	
13-M-L	7	13-M-A	9	13-M-H	0	13-F-L	12	13-F-A	12	13-F-H	0

TABLE 2

SCORES OF ALL MALE OCCUPATIONAL GROUPS FROM 3 - 8
COMPARED WITH GROUP 2*

	IQ					ATTITUDE				MATHEMATICAL PROFICIENCY			
	N	X	SD	T	F	X	SD	T	F	X	SD	T	F
2.	25	104.6	11.79			59.84	18.52			33.36	12.01		
3.	34	106.4	13.23	5.6	.31	63.15	19.44	.66	.43	33.85	13.44	.14	.02
4.	152	104.1	12.00	.2	.04	68.99	17.02	2.46	-6.05	33.38	11.41	0	0
5.	132	100.6	12.27	1.49	2.23	64.76	16.90	1.32	-1.73	29.95	11.74	1.33	1.77
6.	181	100.9	14.29	1.24	1.53	68.44	14.60	2.67	-7.12	30.18	11.92	1.25	1.56
7.	39	102.4	11.00	.77	.60	69.21	15.44	2.19	-4.79	30.05	10.64	1.15	1.33
8.	38	95.8	14.72	2.5	6.25	64.68	18.29	1.02	-1.05	25.45	11.32	2.65	7.02

*Underlined items indicate T scores are significant at the 1% level.

TABLE 3

SCORES OF ALL MALE OCCUPATIONAL GROUPS FROM 4 - 8
COMPARED WITH GROUP 3

	IQ				ATTITUDE				MATHEMATICAL PROFICIENCY			
N	X	SD	T	F	X	SD	T	F	X	SD	T	F
3. 34	106.4	13.23			63.15	19.44			33.85	13.44		
4. 152	104.1	12.00	1.02	1.05	68.99	17.02	1.76	-3.10	33.38	11.41	.22	.05
5. 132	100.6	12.27	2.42	5.88	64.76	16.90	.48	- .23	29.95	11.74	1.68	2.82
6. 181	100.9	14.29	2.1	4.41	68.44	14.60	1.83	-3.36	30.18	11.92	1.61	2.60
7. 39	102.4	11.00	1.44	2.07	69.21	15.44	1.48	-2.20	30.05	10.64	1.35	1.82
8. 38	95.8	14.72	3.2	10.29	64.68	18.29	.34	- .12	25.45	11.32	2.88	8.29

TABLE 4

SCORES OF ALL MALE OCCUPATIONAL GROUPS FROM 5 - 8
COMPARED WITH GROUP 4

		IQ				ATTITUDE				MATHEMATICAL PROFICIENCY			
	N	X	SD	T	F	X	SD	T	F	X	SD	T	F
4.	152	104.1	12.00			68.99	17.02			33.38	11.41		
5.	132	100.6	12.27	2.39	5.71	64.76	16.90	2.1	4.39	29.95	11.74	2.5	6.21
6.	181	100.9	14.29	2.17	4.73	68.44	14.60	.32	.10	30.18	11.92	2.48	6.16
7.	39	102.4	11.00	.81	.66	69.21	15.44	.1	.01	30.05	10.64	1.65	2.71
8.	38	95.8	14.72	3.62	13.13	64.68	18.29	1.37	1.89	25.45	11.32	3.83	14.72

TABLE 5

SCORES OF ALL MALE OCCUPATIONAL GROUPS FROM 6 - 8
COMPARED WITH GROUP 5

	IQ				ATTITUDE				MATHEMATICAL PROFICIENCY			
	N	X	SD	T	F	X	SD	T	F	X	SD	T	F
5.	132	100.6	12.27			64.76	16.90			29.95	11.75		
6.	181	100.9	14.29	.17	.03	68.44	14.60	2.06	-4.25	30.18	11.92	.17	.03
7.	39	102.4	11.00	.79	.63	69.21	15.44	1.47	-2.17	30.05	10.64	0	0
8.	38	95.8	14.72	2.03	4.14	64.68	18.29	0	0	25.45	11.32	2.1	4.41

TABLE 6

SCORES OF ALL MALE OCCUPATIONAL GROUPS FROM 7 - 8
COMPARED WITH GROUP 6

		IQ				ATTITUDE				MATHEMATICAL PROFICIENCY			
	N	X	SD	T	F	X	SD	T	F	X	SD	T	F
6.	181	100.9	14.29			68.44	14.60			30.18	11.92		
7.	39	102.4	11.00	.6	.36	69.21	15.44	.3	- .09	30.05	10.64	0	0
8.	38	95.8	14.72	1.98	3.93	64.68	18.29	1.38	1.90	25.45	11.32	2.25	5.04

TABLE 7

SCORES OF MALE OCCUPATIONAL GROUP 8
COMPARED WITH GROUP 7

		IQ				ATTITUDE				MATHEMATICAL PROFICIENCY			
	N	X	SD	T	F	X	SD	T	F	X	SD	T	F
7.	39	102.4	11.00			69.21	15.44			30.05	10.64		
8.	38	95.8	14.72	2.21	4.90	64.68	18.29	1.17	1.38	25.45	11.32	1.84	3.38

TABLE 8

SCORES OF ALL FEMALE OCCUPATIONAL GROUPS FROM 3 - 8
COMPARED WITH GROUP 2*

	IQ				ATTITUDE				MATHEMATICAL PROFICIENCY			
	N	X	SD	T	F	X	SD	T	F	X	SD	T	F
2.	25	109.8	9.96			63.12	17.29			33.08	9.07		
3.	54	108.4	9.19	.61	.37	61.85	19.09	.32	.10	30.78	10.25	.96	.93
4.	175	104.5	11.80	2.13	4.52	64.37	19.41	.3	.09	29.74	11.32	1.41	1.99
5.	139	102.0	12.35	2.98	8.87	63.16	18.72	0	0	26.90	10.52	2.76	7.61
6.	223	101.6	12.79	3.08	9.51	64.27	18.84	.28	.08	26.16	10.10	3.27	10.76
7.	43	98.6	12.02	3.92	15.44	59.23	17.27	.89	.80	23.23	8.30	4.56	20.79
8.	30	102.6	12.86	2.27	5.16	65.93	21.64	.52	.28	29.17	11.92	1.34	1.82

*Underlined items indicate T scores are significant at the 1% level.

TABLE 9

SCORES OF ALL FEMALE OCCUPATIONAL GROUPS FROM 4 - 8
COMPARED WITH GROUP 3 *

		IQ				ATTITUDE				MATHEMATICAL PROFICIENCY			
	N	X	SD	T	F	X	SD	T	F	X	SD	T	F
3.	54	108.4	9.19			61.85	19.09			30.78	10.25		
4.	175	104.5	11.80	2.21	4.91	64.37	19.41	.83	.70	29.74	11.32	.6	.36
5.	139	102.0	12.35	3.44	11.89	63.16	18.72	.43	.19	26.90	10.52	2.31	5.36
6.	223	101.6	12.79	3.66	14.43	64.27	18.84	.84	.71	26.16	10.10	3.00	9.04
7.	43	98.6	12.02	4.54	20.67	59.23	17.27	.7	.49	23.23	8.30	3.91	15.31
8.	30	102.6	12.86	2.38	5.68	65.93	21.64	.89	.80	29.17	11.92	.64	.42

TABLE 10

SCORES OF ALL FEMALE OCCUPATIONAL GROUPS FROM 5 - 8
COMPARED WITH GROUP A

	N	IQ X	IQ SD	IQ T	IQ F	ATTITUDE X	ATTITUDE SD	ATTITUDE T	ATTITUDE F	MATHEMATICAL PROFICIENCY X	MATHEMATICAL PROFICIENCY SD	MATHEMATICAL PROFICIENCY T	MATHEMATICAL PROFICIENCY F
4.	175	104.5	11.80			64.37	19.41			29.74	11.32		
5.	139	102.0	12.35	1.93	3.73	63.16	18.72	.55	.31	26.90	10.52	2.27	5.18
6.	223	101.6	12.79	2.32	5.36	64.27	18.84	0	0	26.16	10.10	3.32	11.05
7.	43	98.6	12.02	2.93	8.60	59.23	17.27	1.59	2.52	23.23	8.30	3.54	12.52
8.	30	102.6	12.86	.8	.64	65.93	21.64	.4	.16	29.17	11.92	.24	.06

TABLE 11

SCORES OF FEMALE OCCUPATIONAL GROUPS 5 AND 6 COMPARED WITH EACH OF THE SUCCEEDING GROUPS

	N	IQ X	IQ SD	IQ T	IQ F	ATTITUDE X	ATTITUDE SD	ATTITUDE T	ATTITUDE F	MATHEMATICAL PROFICIENCY X	MATHEMATICAL PROFICIENCY SD	MATHEMATICAL PROFICIENCY T	MATHEMATICAL PROFICIENCY F
5.	139	102.0	12.35			63.11	18.72			26.90	10.52		
6.	223	101.6	12.79	.28	.08	64.27	18.84	.55	.30	26.16	10.10	.66	.44
7.	43	98.6	12.02	1.59	2.52	59.23	17.27	1.22	1.50	23.23	8.30	2.09	4.38
8.	30	102.6	12.86	.24	.06	65.93	21.64	.71	.51	29.17	11.92	1.05	1.09
6.	223	101.6	12.79			64.27	18.84			26.16	10.10		
7.	43	98.6	12.02	1.43	2.05	59.23	17.27	1.62	2.64	23.23	8.30	1.79	3.20

TABLE 12

RAW DATA FOR MALE OCCUPATIONAL GROUP CORRELATION COEFFICIENTS

Variable	Sum	Mean	Sum Squares	Standard Deviation
IQ	64098.	102.23	6661640.	13.18
Age	127568.	203.46	25979080.	6.24
Attitude	41938.	66.89	2982232.	16.81
Mathematical Proficiency	19672	31.37	707926.	12.03
Occupational Index	3109.	4.96	17023.	1.60

TABLE 13

RAW DATA FOR FEMALE OCCUPATIONAL GROUP CORRELATION COEFFICIENTS

Variable	Sum	Mean	Sum Squares	Standard Deviation
IQ	74944.	103.51	7867710.	12.32
Age	146606.	202.49	29735622.	8.20
Attitude	46069.	63.63	3191551.	18.95
Mathematical Proficiency	20231.	27.94	649441.	10.78
Occupational Index	3513.	4.85	18887.	1.59

TABLE 14

STUDENTS WHO HAD MATHEMATICS IN NINTH-TENTH COMPARED WITH THOSE OF STUDENTS WHO HAD MATHEMATICS IN NINTH-ELEVENTH*

Variables Intelligent Quotient	Math. in Ninth and Tenth N = 597	Math. in Ninth and Eleventh N = 73
Mean--X	99.4	100.1
Standard Deviation--SD	12.46	10.04
T Score--T	.52	
F Score--F	1.27	
Age in Months		
X	203.8	203.1
SD	9.35	5.69
T	.61	
F	2.7	
Final Attitude		
X	59.5	64.6
SD	1.74	1.59
T	-2.36	
F	1.71	
Mathematical Proficiency		
X	24.2	24.8
SD	7.82	7.60
T	.55	
F	1.06	
Occupational Index		
X	4.94	5.25
SD	1.61	1.44
T	-1.5	
F	1.25	

*Underlined items indicate T score significant at the 1% level.

TABLE 15

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF TWO YEAR AND THREE YEAR MATHEMATICS STUDENTS*

	X^2	xy	y^2	df	y'^2	r	b
Two-Year Group	86778.8	34494.8	37809.1			.6022	.3975
Three-Year Group	108598.0	70337.2	98040.5			.6817	.6477
Total Within Groups	195376.8	104832.0	135849.6		79600.6		

*Underlined items indicate T scores significant at the one per cent level.

TABLE 16

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY OF
TWO YEAR AND THREE YEAR MATHEMATICS STUDENTS

	df	x^2	xy	y^2	df	y'^2	M.S.
Among		18468.2	26372	37657.4	1	13406.5	13406.5
Within	1300	195376.8	104832	135849.6	1299	79600.6	61.28
Total		213845.0	131204	173507.0		93007.1	218.00

TABLE 17

STUDENTS WHO STUDIED TWO YEARS GENERAL AND ONE YEAR OF COLLEGE PREPARATORY MATHEMATICS COMPARED WITH THOSE STUDENTS WHO STUDIED TWO YEARS OF COLLEGE PREPARATORY AND ONE YEAR OCCUPATIONAL MATHEMATICS*

Variables	Groups Being Compared	
Intelligent Quotient	2 General–1 College N - 59	2 College–1 Occupational N - 23
Mean--X	100.1	107.7
Standard Deviation--SD	10.46	8.34
T Score--T		-3.08
F Score--F		
Age in Months		
X	201.6	202.7
SD	5.03	4.55
T		-.95
F		
Attitude		
X	66.17	66.09
SD	17.35	15.38
T		-.02
F		
Mathematical Proficiency		
X	26.93	29.91
SD	7.06	8.34
T		-1.63
F		
Occupational Index		
X	4.95	5.22
SD	1.23	1.02
T		-.93
F		

*Underlined items indicate T scores significant at the 1% level.

TABLE 18

FORTY GENERAL-GENERAL LOW IQ FEMALES COMPARED WITH TWELVE COLLEGE-GENERAL LOW IQ FEMALES

Variables	Groups Being Compared	
Intelligent Quotient	General-General N = 40	College-General N = 12
Mean--X	83.0	87.9
Standard Deviation--SD	9.69	5.94
T Score--T	-1.8	-1.8
F Score--F		
Age in Months		
X	208.8	205.
SD	9.98	6.06
T		1.24
F		
Final Attitude		
X	58.18	56.58
SD	17.39	21.31
T		2.64
F		
Mathematical Proficiency		
X	16.75	18.08
SD	4.94	4.47
T		
F		
Occupational Index		
X	5.58	5.33
SD	1.11	1.54
T		.61
F		

TABLE 19

THE COMBINED COLLEGE-GENERAL AND COLLEGE-OCCUPATIONAL GROUPS COMPARED WITH THE COLLEGE-COLLEGE GROUP*

Variables	Groups Being Compared	
Intelligent Quotient	College-General-College-Occupational N = 22	College-College N = 60
Mean--X	99.05	103.5
Standard Deviation--SD	1.15	6.21
T Score--T		.62
F Score--F		27.7
Age in Months		
X	203.3	202.3
SD	6.63	4.50
T		1.68
F		2.17
Final Attitude		
X	65.6	60.0
SD	16.23	15.1
T		1.46
F		1.15
Mathematical Proficiency		
X	4.5	28.4
SD	6.22	6.70
T		-2.37
F		1.16
Occupational Index		
X	4.77	4.72
SD	1.39	1.61
T		.042
F		1.02

*Underlined items indicate T scores significant at the 1% level.

The $\bar{X}$ under each variable represents the mean of the scores within the subgroup. The SD represents the Standard Deviation of the scores from $\bar{X}$. The T and F scores are measures of significant difference between the groups being compared. They appear under either the first or the second one of the two groups being compared. The t test utilized was as follows:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S_p \sqrt{(1/N_1) + (1/N_2)}}$$

where S_p^2 is the pooled mean-square estimate of sigma squared given by:

$$S_p^2 = \frac{\sum X_{1i}^2 - \frac{(\sum X_{1i})^2}{N_1} + X_{2i}^2 - \frac{(\sum X_{2i})^2}{N_2}}{N_1 + N_2 - 2}$$

$$\frac{(N_1-1)\, S_1^2 + (N_2-1)\, S_2^2}{N_1 + N_2 - 2}$$

The one per cent level was utilized in measuring if a difference in the means were significant; that is, if the difference were greater than the appropriate one found in the table. If this were found to be true, this difference would be considered to be statistically significant since it implies that in only one per cent of the time could this exist by chance.[3] In a

[3] Wilfrid J. Dixon, op. cit., p. 139. If we wish to investigate the differences among five means by performing a t test on each pair of means, there would be ten t values to compute. . . . if we use a five per cent critical value and then test a number of means in this manner, the level of significance will be much larger than five per cent for testing the hypotheses of no difference in means as a group, since, even though all samples are from the same population, five per cent of the t values will exceed the critical value of the average.

similar manner, the most sensitive measure of significance was utilized in evaluating the F ratio which enables an investigator to determine more precisely whether the difference in the variances of the two groups is significant. The F ratio was obtained by squaring the SD of each group and dividing the larger product of this operation by the smaller one, thus always producing a F ratio of at least one.

TABLE 20

COLLEGE-COLLEGE AVERAGE IQ MALES COMPARED WITH THE GENERAL-GENERAL AVERAGE IQ MALES*

Variables	Groups Being Compared	
Intelligent Quotient	College-College N = 60	General-General N = 39
Mean--X	103.5	98.7
Standard Deviation--SD	6.21	6.05
T Score--T		3.75
F Score--F		1.05
Age in Months		
X	202.3	205.6
SD	19.5	7.43
T		-10.6
F		6.89
Final Attitude		
X	60.0	63.0
SD	15.1	15.4
T		-.94
F		1.00
Mathematical Proficiency		
X	28.4	24.4
SD	6.70	6.08
T		2.98
F		1.21
Occupational Index		
X	4.72	5.44
SD	1.61	1.06
T		-2.47
F		2.31

*Underlined items represent T scores significant at the 1% level.

TABLE 21

ONE-YEAR COLLEGE PREPARATORY AND ONE-YEAR GENERAL MATHEMATICS AVERAGE IQ MALES COMPARED WITH TWO-YEAR GENERAL MATHEMATICS AVERAGE IQ MALES*

Variables	Groups Being Compared	
Intelligent Quotient	General-General N = 39	College-College N = 41
Mean--X	98.7	101.1
Standard Deviation--SD	6.05	6.24
T Score--T		-1.75
F Score--F		1.06
Age in Months		
X	205.6	206.1
SD	7.43	7.66
T		-.30
F		1.06
Final Attitude		
X	64.3	64.3
SD	15.1	13.8
T		- .02
F		1.20
Mathematical Proficiency		
X	24.4	24.5
SD	6.08	7.51
T		-.03
F		1.53
Occupational Index		
X	5.44	4.98
SD	1.06	1.53
T		1.55
F		2.09

*Underlined items indicate T scores significant at the 1% level.

TABLE 22

TWO-YEAR COLLEGE PREPARATORY AVERAGE IQ FEMALES COMPARED WITH TWO-YEAR GENERAL MATHEMATICS AVERAGE IQ FEMALES*

Variables	Groups Being Compared	
Intelligent Quotient	College-College N = 82	General-General N = 71
Mean--X	105.8	98.9
Standard Deviation--SD	5.43	5.53
T Score--T		7.73
F Score--F		1.04
Age in Months		
X	202.5	202.3
SD	4.72	4.46
T		.27
F		1.12
Final Attitude		
X	56.2	57.8
SD	18.6	18.1
T		-.53
F		1.06
Mathematical Proficiency		
X	28.4	21.7
SD	7.56	5.32
T		6.26
F		2.02
Occupational Index		
X	4.49	5.35
SD	1.60	1.33
T		-3.60
F		1.45

*Underlined items indicate T scores significant at the 1% level.

TABLE 23

EIGHTY-TWO TWO-YEAR COLLEGE AVERAGE IQ FEMALES COMPARED WITH SEVENTY-FOUR ONE-YEAR COLLEGE PREPARATORY AND ONE-YEAR GENERAL MATHEMATICS AVERAGE IQ FEMALES*

Variables	Groups Being Compared	
Intelligent Quotient	College-College N = 82	College-General N = 74
Mean--X	105.8	102.7
Standard Deviation--SD	5.43	5.52
T Score--T		3.52
F Score--F		1.03
Age in Months		
X	202.5	202.5
SD	4.72	6.18
T		0
F		1.71
Final Attitude		
X	56.2	62.4
SD	18.6	17.7
T		-2.11
F		1.10
Mathematical Proficiency		
X	28.4	24.7
SD	7.56	5.01
T		3.56
F		2.28
Occupational Index		
X	4.49	4.61
SD	1.60	1.75
T		-.04
F		1.20

*Underlined items indicate T scores significant at the 1% level.

TABLE 24

SEVENTY-FOUR ONE-YEAR COLLEGE PREPARATORY AND ONE-YEAR GENERAL MATHEMATICS AVERAGE IQ FEMALES COMPARED WITH A TWO-YEAR GENERAL MATHEMATICS GROUP*

Variables	Groups Being Compared	
Intelligent Quotient	General-General N =71	College-General N = 74
Mean--X	98.9	102.7
Standard Deviation--SD	5.53	5.52
T Score--T		-4.11
F Score--F		1.00
Age in Months		
X	202.3	202.5
SD	4.46	6.18
T		-.009
F		1.92
Final Attitude		
X	57.8	62.4
SD	18.1	17.7
T		-1.54
F		1.05
Mathematical Proficiency		
X	21.7	24.7
SD	5.32	5.01
T		-3.51
F		1.13
Occupational Index		
X	5.35	4.61
SD	1.33	1.75
T		2.87
F		1.73

*Underlined items indicate T scores significant at the 1% level.

TABLE 25

AVERAGE IQ FEMALES WITH ONE YEAR EACH OF COLLEGE PREPARATORY, GENERAL, AND OCCUPATIONAL MATHEMATICS COMPARED WITH A TWO-YEAR GENERAL AND ONE-YEAR OCCUPATIONAL MATHEMATICS GROUP*

Variables	Groups Being Compared	
Intelligent Quotient	College-General Occupational N = 25	General-General-Occupational N = 33
Mean--X	104.0	99.0
Standard Deviation--SD	6.27	5.11
T Score--T		3.27
F Score--F		1.50
Age in Months		
X	204.0	202.3
SD	3.64	4.70
T		1.47
F		1.67
Final Attitude		
X	68.3	63.4
SD	15.7	19.8
T		1.09
F		1.59
Mathematical Proficiency		
X	26.7	23.9
SD	7.92	5.02
T		1.61
F		2.50
Occupational Index		
X	5.12	5.15
SD	1.57	1.30
T		-.08
F		1.46

*Underlined items indicate T scores significant at the 1% level.

TABLE 26

THREE-YEAR COLLEGE PREPARATORY AVERAGE IQ FEMALES COMPARED WITH AVERAGE IQ FEMALES WITH TWO YEARS GENERAL AND ONE YEAR OCCUPATIONAL MATHEMATICS*

Variables	Groups Being Compared	
Intelligent Quotient	College-College-College N = 66	General-General-Occupational N = 33
Mean--X	107.2	99.0
Standard Deviation--SD	5.46	5.11
T Score--T		9.13
F Score--F		1.14
Age in Months		
X	201.8	202.3
SD	4.88	4.70
T		-.62
F		1.08
Final Attitude		
X	74.3	63.4
SD	18.6	19.8
T		2.85
F		1.13
Mathematical Proficiency		
X	40.0	23.9
SD	8.37	5.02
T		13.68
F		2.78
Occupational Index		
X	4.18	5.15
SD	1.51	1.30
T		-4.04
F		1.35

*Underlined items indicate T scores significant at the 1% level.

TABLE 27

ONE-YEAR GENERAL MATHEMATICS STUDENTS COMPARED WITH FIFTY-ONE MALE GENERAL-GENERAL STUDENTS, EIGHTEEN MALE COLLEGE-GENERAL STUDENTS, FORTY FEMALE GENERAL-GENERAL STUDENTS, AND TWENTY-NINE ONE-YEAR ALGEBRA STUDENTS*

Variables	Groups Being Compared				
Intelligent Quotient	One Year General Math. N = 20	One Year Algebra N = 29	General General (2) N = 51	College General (4) N = 18	General General (41) N = 40
Mean--X	94.8	102.7	81.4	85.3	83.0
Standard Deviation--SD	11.31	8.09	7.53	4.82	9.69
T Score--T		2.85	5.84	3.30	4.2
F Score--F		51.0	2.18	5.33	1.32
Age in Months					
X	205.7	201.1	207.8	205.4	208.8
SD	8.63	4.85	8.87	5.75	9.98
T		-2.3	.94	.11	1.19
F		3.17	1.06	2.25	1.34
Final Attitude					
X	55.4	63.4	57.08	59.3	58.18
SD	18.1	14.4	17.18	13.9	17.39
T		1.7	.38	.24	.59
F		1.58	1.11	1.70	1.08
Mathematical Proficiency					
X	20.0	24.6	18.51	18.17	16.75
SD	8.3	6.9	5.66	6.29	4.94
T		2.12	.84	.74	1.87
F		1.98	2.15	1.74	2.82
Occupational Index					
X	5.65	5.62	5.63	5.44	5.58
SD	1.4	1.3	1.71	1.50	1.11
T		-.07	.02	.43	.22
F		1.16	1.49	1.15	1.59

*Underlined items indicate T scores significant at the 1% level.

TABLE 28

TWENTY GENERAL MATHEMATICS STUDENTS COMPARED WITH SIXTY MALE COLLEGE-COLLEGE STUDENTS, EIGHTY-TWO FEMALE COLLEGE-COLLEGE STUDENTS, AND SEVENTY-FOUR FEMALE COLLEGE-GENERAL STUDENTS*

Variables	Groups Being Compared			
Intelligent Quotient	One Year General Math. N = 20	College College (14) N = 60	College College (53) N = 82	College General N = 74
Mean--X	94.8	103.5	105.8	102.7
Standard Deviation--SD	11.31	6.21	5.43	5.52
T Score--T		4.32	6.33	4.39
F Score--F		3.32	4.34	4.20
Age in Months				
X	205.7	202.3	202.5	202.5
SD	8.63	4.5	4.72	6.18
T		2.24	2.23	1.86
F		3.68	3.34	1.95
Final Attitude				
X	55.4	60.0	56.2	62.4
SD	18.09	15.13	18.6	17.67
T		1.14	.19	1.57
F		1.43	1.06	1.05
Mathematical Proficiency				
X	19.95	28.4	28.4	24.72
SD	8.34	6.71	7.56	5.01
T		4.58	4.4	3.22
F		1.55	1.22	2.77
Occupational Index				
X	5.65	4.72	4.49	4.61
SD	1.42	1.61	1.60	1.75
T		2.31	2.96	2.45
F		1.28	1.27	1.51

*Underlined items indicate T scores significant at the 1% level.

TABLE 29

FIFTY-ONE MALE GENERAL-GENERAL STUDENTS, EIGHTEEN MALE COLLEGE-GENERAL STUDENTS, FORTY FEMALE GENERAL-GENERAL STUDENTS COMPARED WITH THE ONE-YEAR ALGEBRA SCORES*

Variables		Groups Being Compared		
Intelligent Quotient	One Year Algebra N = 29	General General (2) N = 51	College General (4) N = 18	General General (41) N = 40
Mean--X	102.7	81.4	85.3	83.0
Standard Deviation--SD	8.09	7.53	4.8	9.69
T Score--T		11.9	8.25	8.91
F Score--F		1.15	2.84	1.43
Age in Months				
X	201.1	207.8	205.4	208.8
SD	4.85	8.73	5.75	9.98
T		3.76	2.65	3.81
F		3.24	1.40	4.23
Final Attitude				
X	63.4	57.08	59.33	58.2
SD	14.4	17.08	13.87	17.4
T		1.68	.9	1.32
F		1.41	1.08	1.46
Mathematical Proficiency				
X	24.6	18.5	18.17	16.8
SD	6.9	5.66	6.29	4.9
T		4.25	3.21	5.5
F		1.49	1.20	1.98
Occupational Index				
X	5.62	5.63	5.44	5.58
SD	1.35	1.71	1.5	1.11
T		.00	.4	.15
F		1.60	1.24	1.48

*Underlined items indicate T scores significant at the 1% level.

TABLE 30

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF SIXTY AVERAGE COLLEGE-COLLEGE MALES COMPARED WITH THIRTY-NINE AVERAGE IQ GENERAL-GENERAL MALES

Groups	x^2	xy	y^2	df	y'^2	r	b
College-College	2276.94	1132.80	2652.40		2088.82	.4609	.4975
General-College	1393.90	316.80	1403.59		1331.59	.2265	.2273
Within Groups	3670.84	1449.60	4055.99		3483.47		

TABLE 31

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF SIXTY AVERAGE COLLEGE-COLLEGE MALES COMPARED WITH THIRTY-NINE AVERAGE IQ GENERAL-GENERAL MALES

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among					1	90.13	90.13
Within	97	3670.84	1449.60	4055.99	96	3483.46	36.29
Total		4203.84	1894.54	4427.41		3573.59	2.48

TABLE 32

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF ONE-YEAR COLLEGE PREPARATORY AND ONE-YEAR GENERAL MATHEMATICS AVERAGE IQ FEMALES AND ONE-YEAR COLLEGE PREPARATORY, GENERAL, AND OCCUPATIONAL MATHEMATICS AVERAGE IQ FEMALES

Groups	N	x^2	xy	y^2	df	y'^2	r	b
College Preparatory-General	74	2226.22	956.19	1835.04			.4731	.4295
College Prepatory-General Occupational	25	984.97	538.73	1567.12			.4336	.5470
Within Groups		3211.19	1494.92	3402.16		2706.22		

TABLE 33

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF ONE-YEAR COLLEGE PREPARATORY AND ONE-YEAR GENERAL MATHEMATICS AVERAGE IQ FEMALES AND ONE-YEAR COLLEGE PREPARATORY, GENERAL, AND OCCUPATIONAL MATHEMATICS AVERAGE IQ FEMALES

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		31.81	49.84	78.08	1	38.19	38.19
Within	98	3211.19	1494.92	3402.16	97	2706.22	27.90
Total		3243.00	1544.76	3480.24		2744.41	

TABLE 34

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF ONE-YEAR GENERAL AND ONE YEAR OCCUPATIONAL AVERAGE IQ MALES AND ONE YEAR ALGEBRA STUDENTS

Groups	N	x^2	xy	y^2	df	y'^2	r	b
College-Occupational	18	395.6	-212.8	672.5			.4126	-.5380
One Year Algebra		1830.2	333.3	1331.0			.2135	.1821
Within Groups		2225.8	121.5	2003.5		1996.9		

TABLE 35

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF ONE-YEAR GENERAL AND ONE-YEAR OCCUPATIONAL AVERAGE IQ MALES AND ONE-YEAR ALGEBRA STUDENTS*

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		3367.2	1240.4	457.7	1	132.6	132.6
Within	45	2225.8	121.5	2003.5	44	1996.9	45.4
Total		5593.0	1361.9	2461.2		2129.5	<u>2.9</u>

*Underlined items indicate T scores are significant at the 1% level.

TABLE 36

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF FIFTY-ONE LOW IQ GENERAL-GENERAL MALES AND TWENTY-NINE ONE YEAR ALGEBRA STUDENTS

Groups	N	x^2	xy	y^2	df	y'^2	r	b
General-General	51	2831.7	853.8	1602.8			.4007	.3015
One-Year Algebra	29	1830.2	333.3	1331.0			.2135	.1821
Within Groups		4661.9	1187.1	2933.8		2631.5		

TABLE 37

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF FIFTY-ONE LOW IQ GENERAL-GENERAL MALES AND TWENTY-NINE ONE-YEAR ALGEBRA STUDENTS

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		8616.5	2396.9	682.6	1	02.7	2.7
Within	78	4461.9	1187.1	2933.8	77	2631.5	34.2
Totals		13078.4	3585.0	3616.4		2634.2	

TABLE 38

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF THIRTY-NINE GENERAL-GENERAL AVERAGE IQ MALES AND TWENTY ONE-YEAR GENERAL MATHEMATICS STUDENTS

Groups	N	x^2	xy	y^2	df	y'^2	r	b
General-General	39	2431.2	896.8	1322.9			.5001	.3689
One-Year General	20	1393.9	316.8	1403.6			.2265	.2273
Within Groups		3825.1	1213.6	2726.5		2391.8		

TABLE 39

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF THIRTY-NINE GENERAL-GENERAL AVERAGE IQ MALES AND TWENTY ONE-YEAR GENERAL MATHEMATICS STUDENTS

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		202.9	232.3	266.1	1	081.8	81.8
Within	57	3825.1	1213.6	2726.5	56	2391.8	42.7
Totals		4028.0	1445.9	2992.6		2473.6	

TABLE 40

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF TWENTY-NINE ONE-YEAR ALGEBRA STUDENTS AND TWENTY ONE-YEAR GENERAL MATHEMATICS STUDENTS

Groups	N	x^2	xy	y^2	df	y'^2	r	b
One-Year Algebra	29	1830.21	333.28	1331.03		1270.3	.2135	.1821
One-Year General	20	2431.20	896.80	1322.95		992.1	.5000	.3689
Within Groups		4261.41	1230.08	2653.98		2298.9		

TABLE 41

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF TWENTY-NINE ONE-YEAR ALGEBRA STUDENTS AND TWENTY ONE-YEAR GENERAL MATHEMATICS STUDENTS

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		736.80	432.96	254.96	1	146.2	146.2
Within	47	4261.41	1230.08	2653.98	46	2298.9	49.98
Totals		4998.21	1663.04	2908.41		2445.1	

TABLE 42

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF FORTY-ONE COLLEGE-GENERAL AVERAGE IQ MALES AND TWENTY ONE-YEAR GENERAL MATHEMATICS STUDENTS

Groups	x^2	xy	y^2	df	y'^2	r	b
College-General	1560.4	870.2	2243.5			.4651	.5577
One-Year General	2431.2	896.8	1322.95			.5000	.3689
Within Groups	3991.6	1767.0	3566.45		2784		

TABLE 43

ANALYSIS OF COVARIANCE FOR IQ AND PROFICIENCY SCORES OF FORTY-ONE COLLEGE-GENERAL AVERAGE IQ MALES AND TWENTY ONE-YEAR GENERAL MATHEMATICS STUDENTS

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		537.3	375.25	262.15	1	31	31
Within	59	3991.6	1767.00	3566.45	58	2784	48.8
Total		4528.9	2142.25	3828.6		2815	

TABLE 44

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF GENERAL-OCCUPATIONAL STUDENTS AND GENERAL MATHEMATICS STUDENTS

Groups	x^2	xy	y^2	df	y'^2	r	b
General-Occupational	455	61	310			.1636	.1350
General Mathematics	2431	897	1323			.5000	.3689
Within Groups	2886	958	1633		1315		

TABLE 45

ANALYSIS OF COVARIANCE FOR IQ AND PROFICIENCY SCORES OF GENERAL-OCCUPATIONAL STUDENTS AND GENERAL MATHEMATICS STUDENTS

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		106.5	119.4	094.4	1	24.9	24.9
Within	36	2886.0	958.0	1633.0	35	1315.0	37.6
Total		2992.5	1077.4	1727.4		1339.9	.66

TABLE 46

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF AVERAGE IQ MALES STUDYING GENERAL-GENERAL MATHEMATICS COMPARED WITH TWENTY-NINE ONE-YEAR ALGEBRA STUDENTS

Groups	x^2	xy	y^2	df	y'^2	r	b
General-General	1393.90	316.80	1403.59		1331.59	.2265	.2273
One-Year Algebra	1830.21	333.3	1331.00			.2135	.1821
Within Groups	3224.11	650.10	2734.59		2604.00		

TABLE 47

ANALYSIS OF COVARIANCE OF IQ AND PROFICIENCY SCORES OF AVERAGE IQ GENERAL-GENERAL MALES COMPARED WITH ONE-YEAR ALGEBRA STUDENTS

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		262.36	10	1	1	6	6
Within	66	3224.11	650	2734	65	2604	41
Total		3486.47	660	2735		2610	.15

TABLE 48

COVARIANCE DATA FOR IQ AND PROFICIENCY SCORES OF AVERAGE IQ GENERAL-GENERAL FEMALES COMPARED WITH ONE-YEAR ALGEBRA STUDENTS

Groups	x^2	xy	y^2	df	y'^2	r	b
General-General	2144	952	1981			.4619	.4439
One-Year Algebra	1830	333	1331			.2135	.1821
Within Groups	3974	1285	3312				

TABLE 49

ANALYSIS OF COVARIANCE FOR IQ AND PROFICIENCY SCORES OF AVERAGE IQ GENERAL-GENERAL FEMALES COMPARED WITH ONE-YEAR ALGEBRA STUDENTS

Groups	df	x^2	xy	y^2	df	y'^2	M.S.
Among		304	225	172	1	66	66
Within	98	3974	1285	3312	96	2896	30.2
Total		4270	1510	3483.84		2950	2.2

TABLE 50
MEANS AND STANDARD DEVIATIONS OF IQ, CHRONOLOGICAL AGE, ATTITUDE, AND PROFICIENCY OF ALL POTENTIAL GROUPS OF STUDENTS UTILIZED IN THE STUDY

Group Description	N	IQ X	IQ SD	Chronological Age X	Chronological Age SD	Final Attitude X	Final Attitude SD	Mathematical Proficiency X	Mathematical Proficiency SD	Occupational Index X	Occupational Index SD
Females	724	103.5	13.19	202.5	5.79	63.6	18.98	27.9	10.78	4.85	1.60
Males	627	102.2		203.5	6.24	66.9	16.82	31.4	12.04	4.96	1.6
Occupational Males Group 1	26	110.3	12.54			66	21.58	40.73	12.41		
Occupational Males Group 2	25	104.6	11.79			59.84	18.52	33.36	12.01		
Occupational Males Group 3	34	106.4	13.23			63.15	19.44	33.85	13.44		
Occupational Males Group 4	152	104.1	12.0			66.99	17.02	33.38	11.41		
Occupational Males Group 5	132	100.6	12.27			64.76	16.90	29.95	11.74		
Occupational Males Group 6	181	100.9	14.29			68.44	14.60	30.18	11.92		
Occupational Males Group 7	39	102.4	11.00			69.21	15.44	30.05	10.64		
Occupational Males Group 8	38	95.8	14.72			64.68	18.29	25.45	11.32		

TABLE 50--Continued

Group Description	N	IQ X	IQ SD	Chronological Age X	Chronological Age SD	Final Attitude X	Final Attitude SD	Mathematical Proficiency X	Mathematical Proficiency SD	Occupational Index X	Occupational Index SD
Female Occupational Groups											
Occupational Group 1	35	111.8	10.36			64.31	19.87	31.17	12.71		
Occupational Group 2	25	109.8	9.96			63.12	17.29	33.08	9.07		
Occupational Group 3	54	108.4	9.19			61.85	19.09	30.78	10.25		
Occupational Group 4	175	104.5	11.80			64.37	19.41	29.74	11.32		
Occupational Group 5	139	102.0	12.35			63.16	18.72	26.90	10.52		
Occupational Group 6	223	101.6	12.79			64.27	18.84	26.16	10.10		
Occupational Group 7	43	98.6	12.02			59.23	17.27	23.23	8.30		
Occupational Group 8	30	102.6	12.86			65.93	21.64	29.17	11.92		
10 - F - H	66	121.7	5.56	200.3	4.24	80.03	14.68	47.0	6.80	4.26	1.90
11 - F - H	11	117.0	0	202.0	0	98.0	0	30.0	0	5.0	0
12 - F - H	0										
13 - F - H	0										

TABLE 50--Continued

Group Description	N	IQ X	IQ SD	Chronological Age X	Chronological Age SD	Final Attitude X	Final Attitude SD	Mathematical Proficiency X	Mathematical Proficiency SD	Occupational Index X	Occupational Index SD
College College	195	107.6	10.81	201.7	12.17	58.03	17.67	29.39	7.92	4.42	1.75
General General	203	91.5	11.18	205.6	8.01	58.89	17.25	20.52	6.11	5.48	1.35
College Occupational	27	100.3	9.53	203.7	6.84	60.36	17.57	25.54	7.83	4.29	1.62
College General	152	99.7	9.49	203.9	6.72	62.64	16.72	23.68	6.79	4.87	1.64
General Occup.	48	96.2	8.77	203.4	6.43	62.21	17.87	19.92	5.00	5.42	1.14
College Gen. Occup.	49	102.0	10.68	202.6	4.18	66.70	15.85	25.44	8.01	5.44	1.32
2 College 1 General	78	104.9	9.92	202.0	5.41	63.21	16.26	30.95	7.81	5.17	1.55
2 General 1 College	59	100.1	10.46	201.6	5.03	66.17	17.35	26.93	7.06	4.95	1.23
2 College 1 Occup.	23	107.7	8.34	202.7	4.55	66.09	15.38	29.91	8.34	5.22	1.02
3 College	346	112.5	10.76	201.6	4.54	76.12	15.62	43.27	8.85	4.41	1.69
2 General 1 Occup.	64	95.4	8.92	201.0	4.76	63.34	18.90	23.44	6.86	5.27	1.25
3 General	40	97.9	10.90	202.6	4.45	68.25	16.98	19.56	5.40	5.44	1.24
1 - M - L	7	88.9	1.83	204.7	5.34	62.1	12.8	22.0	8.08	4.71	2.12
2 - M - L	51	81.4	7.52	207.8	8.85	57.1	17.1	18.51	5.66	5.63	1.70

TABLE 50--Continued

Group Description	N	IQ		Chronological Age		Final Attitude		Mathematical Proficiency		Occupational Index	
		X	SD	X	SD	X	SD	X	SD	X	SD
3 - M - L	2	87.5	0.00	211.0	9.90	69.5	26.2	26.5	7.75	6.00	0.00
4 - M - L	18	85.3	4.82	205.4	5.75	59.3	13.9	18.2	6.29	5.4	1.50
5 - M - L	5	86.6	9.29	203.6	7.16	68.6	19.1	20.8	3.67	5.80	0.00
6 - M - L	0										
7 - M - L	5	87.0	2.55	205.6	5.55	57.4	17.98	23.2	6.40	5.6	1.8
8 - M - L	18	98.8	5.17	204.0	7.20	65.1	16.2	23.1	4.27	5.06	1.11
9 - M - L	1	91.0	0.00	211.0	0.00	47.0	0.00	28.0	0.00	6.00	0.00
10- M - L	5	85.8	3.24	210.6	5.32	79.4	7.16	40.8	5.43	5.0	1.41
11- M - L	9	82.8	4.65	208.8	7.42	53.2	14.1	16.6	4.95	5.11	1.00
12- M - L	2	87.5	3.46	204.5	6.32	41.0	8.49	21.0	9.90	5.0	1.41
13- M - L	7	86.7	4.78	209.9	8.58	61.6	14.83	18.9	3.92	5.57	1.22
1 - M - A	60	103.5	6.21	202.3	4.50	60.0	15.1	28.4	6.70	4.72	1.61
2 - M - A	39	98.7	6.05	205.6	7.6	63.0	15.39	24.4	6.08	5.44	1.06
3 - M - A	4	100.3	7.12	200.3	3.65	68.0	21.95	30.8	9.70	3.50	1.91

TABLE 50--Continued

Group Description	N	IQ		Chronological Age		Final Attitude		Mathematical Proficiency		Occupational Index	
		X	SD	X	SD	X	SD	X	SD	X	SD
4 - M - A	41	101.0	6.25	206.2	7.74	64.3	13.93	24.3	7.55	4.93	1.43
5 - M - A	18	98.8	5.17	204.0	7.19	65.1	16.22	23.1	4.26	5.06	1.08
6 - M - A	14	102.5	6.27	200.4	3.75	65.8	15.52	25.9	6.74	5.71	.88
7 - M - A	35	102.3	5.97	202.7	6.21	65.9	15.03	32.9	6.88	5.17	1.55
8 - M - A	25	101.5	5.58	201.2	3.97	63.5	19.82	27.6	7.12	4.72	1.43
9 - M - A	7	102.9	5.54	203.3	5.28	63.9	15.59	21.6	5.05	4.86	.82
10- M - A	116	105.7	5.87	202.3	3.98	74.01	13.71	39.9	8.12	4.56	1.67
11- M - A	10	102.2	5.45	203.1	4.69	66.7	17.35	29.3	8.26	5.10	1.41
12- M - A	1	103.0	0	206.0	0	89.0	0	28.0	0	6.00	0
13- M - A	9	99.0	5.77	293.9	6.22	64.0	21.73	25.3	6.54	5.22	1.54
1 - M - H	11	121.4	4.02	201.9	3.87	66.2	15.90	38.9	5.59	4.64	2.57
2 - M - H	1	115.0	0	203.0	0	88.0	0	31.0	0	6.0	0
3 - M - H	1	116.0	0	198.0	0	83.0	0	25.0	0	5.0	0
4 - M - H	2	117.5	3.46	205.5	7.75	82.5	16.25	32.5	2.00	7.0	1.41

TABLE 50--Continued

Group Description	N	IQ X	IQ SD	Chronological Age X	Chronological Age SD	Final Attitude X	Final Attitude SD	Mathematics Proficiency X	Mathematics Proficiency SD	Occupational Index X	Occupational Index SD
5 - M - H	0										
6 - M - H	0										
7 - M - H	4	120.8	5.72	199.5	6.61	66.8	17.07	37.8	10.4	6.0	.82
8 - M - H	2	117.5	2.00	201.5	2.00	78.5	16.25	32.5	2.0	6.5	0.0
9 - M - H	2	117.0	2.83	199.0	0	65.0	21.21	35.5	0	5.0	1.41
10- M - H	87	122.2	6.24	200.8	4.33	77.8	16.02	48.7	7.14	4.40	1.73
11- M - H	0										
12- M - H	0										
13- M - H	0										
1 - F - L	4	88.5	1.73	206.8	9.02	57.5	19.33	23.5	8.10	5.50	1.00
2 - F - L	40	83.0	9.69	208.8	9.98	58.2	17.4	16.8	4.9	5.58	1.11
3 - F - L	1	81.0	0	204.0	0	40.0	0	30.0	0	4.00	0
4 - F - L	12	87.9	5.94	205.0	6.06	56.6	21.31	18.1	4.47	5.33	1.54
5 - F - L	8	85.5	5.78	207.9	6.30	48.1	17.02	14.6	3.76	5.50	1.07

TABLE 50--Continued

Group Description	N	IQ		Chronological Age		Final Attitude		Mathematical Proficiency		Occupational Index	
		X	SD	X	SD	X	SD	X	SD	X	SD
6 - F - L	7	84.3	6.82	203.4	5.34	60.4	8.84	16.1	2.52	5.86	1.00
7 - F - L	2	89.5	0	205.5	1.34	59.0	5.66	19.5	2.00	5.50	2.00
8 - F - L	5	88.4	2.60	199.0	4.58	59.8	16.67	18.0	5.39	4.60	.87
9 - F - L	0										
10- F - L	6	88.3	5.12	201.7	3.32	68.5	16.62	31.7	8.68	5.17	.89
11- F - L	11	86.6	3.19	206.5	5.98	65.3	18.45	21.7	7,03	5.91	1.00
12- F - L	4	85.0	5.83	204.3	5.60	73.3	6.83	15.8	6.43	5.43	.82
13- F - L	12	86.3		206.1		64.6		18.7		5.92	
1 - F - A	82	105.8	5.43	202.5	4.72	56.2	18.6	28.4	7.56	4.49	1.60
2 - F - A	71	98.9	5.53	202.3	4.46	57.8	18.1	21.7	5.32	5.35	1.33
3 - F - A	45	100.7	6.8	204.1	6.71	58.4	15.76	23.4	6.7	4.44	1.62
4 - F - A	74	102.7	5.52	202.5	6.18	62.4	17.7	24.7	5.01	4.61	1.75
5 - F - A	17	101.2	6.41	200.7	4.27	63.9	17.79	18.8	4.18	5.65	1.32
6 - F - A	25	104.0	6.27	204.0	3.64	68.3	15.7	26.7	7.92	5.12	1.57

TABLE 50--Continued

Group Description	N	IQ X	IQ SD	Chronological Age X	Chronological Age SD	Final Attitude X	Final Attitude SD	Mathematical Proficiency X	Mathematical Proficiency SD	Occupational Index X	Occupational Index SD
7 - F - A	25	105.0	4.92	201.6	4.27	57.4	16.32	28.4	7.45	5.0	1.53
8 - F - A	17	103.8	5.13	202.2	6.58	65.5	16.87	27.6	4.94	5.12	1.20
9 - F - A	11	119.2	2.78	179.0	5.74	66.0	17.24	33.1	8.26	5.38	1.12
10- F - A	66	107.2	5.46	201.8	4.88	74.3	18.6	40.0	8.37	4.18	1.51
11- F - A	33	99.0	5.11	202.3	4.70	63.4	19.8	23.9	5.02	5.15	1.30
12- F - A	9	105.4	5.57	201.1	3.74	69.8	16.10	20.0	3.16	5.56	1.50
13- F - A	12	99.3	5.83	203.0	6.06	52.3	16.03	22.8	6.48	5.25	.95
1 - F - H	31	119.9	4.19	202.1	5.24	54.7	20.74	32.5	7.97	3.35	1.76
2 - F - H	1	116.0	0	201.0	0	67.0	0	26.0	0	4.0	0
3 - F - H	1	124.0	0	198.0	0	67.0	0	48.0	0	2.0	0
4 - F - H	5	119.8	6.52	119.2	5.10	72.0	16.29	33.4	8.93	4.2	1.41
5 - F - H	0										
6 - F - H	3	111.3	26.2	158.5	8.17	72.0	26.4	48.0	28.4	5.5	1.00

TABLE 50--Continued

Group Description	N	IQ		Chronological Age		Final Attitude		Mathematical Proficiency		Occupational Index	
		X	SD	X	SD	X	SD	X	SD	X	SD
7 - F - H	7	123.1	5.23	198.1	1.83	73.9	16.64	33.1	6.90	4.71	1.78
8 - F - H	2	123.5	6.32	201.0	7.07	81.5	3.46	36.0	4.24	4.5	0
9 - F - H	2	122.0	8.49	201.5	3.46	71.5	21.91	36.0	9.90	5.0	1.41
10- F - H	66	121.7	5.56	200.3	4.24	80.03	14.68	47.0	6.80	4.26	1.90
11 -F - H	1	117.	0	202.	0	98.	0	30.	0	5.	0
12- F - H	0	0	0	0	0	0	0	0	0	0	0
13- F - H	0	0	0	0	0	0	0	0	0	0	0

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