1969

An Evaluation of Some Predictors of Success in College Mathematics

Florence Margaret Miller
Loyola University Chicago

AN EVALUATION OF SOME PREDICTORS OF
SUCCESS IN COLLEGE MATHEMATICS

by

Florence Margaret Miller

A Dissertation Submitted to the Faculty of the Graduate School
of Loyola University in Partial Fulfillment of
the Requirement for the Degree of
Doctor of Education

February
1969

LIFE

Florence Margaret Miller was born in Evanston, Illinois, April 10, 1923.

She was graduated from St. Jerome Elementary School, Chicago, Illinois, June 1937, from St. Scholastica High School, Chicago, Illinois, June 1941, and received the degree of Bachelor of Arts from Mundelein College, June 1945. She was granted a Master of Arts degree, June 1948 and a Master of Education degree, June 1954, both from Loyola University.

From 1945 to 1955 the writer taught in the Chicago Public high schools and has been a member of the faculty of the mathematics department of Wilbur Wright campus of Chicago City College, Chicago, Illinois since September 1955. In 1959, she was co-author with Dr. Jerome M. Sachs of Mathematics 101 Fundamentals of Mathematics -- Teleclass Study Guide and taught some of the lessons for this course on television.

ACKNOWLEDGMENTS

The author wishes to express her thanks to all those who by their interest, help, and understanding made possible this study -- especially her parents Mathew J. and the late Catherine Miller without whose encouragement this undertaking would never have been possible.

Grateful acknowledgments are made to the following: Dr. Arthur P. O'Mara, the adviser of this dissertation; Dr. John Wozniak, Dr. Henry Malecki, Dr. Ernest Proulx, and Dr. James Smith, all from the Department of Education of Loyola University, who were members of the advisory board for this dissertation; Dr. Paul N. Kinery, former assistant dean of the graduate school; Miss Kay Smith, secretary of the graduate school; Dr. James R. Gray, and other present and former members of the Department of Mathematics of Wilbur Wright campus of the Chicago City College; Dr. Ellen Casey and Miss Rita Silveri for their professional advice; the personnel of the Wilbur Wright College and the Loyola University libraries; students who participated in this study; friends, relatives, and associates, who encouraged this project; and of course, all those teachers whose help carried the writer from one stage to another culminating in this dissertation.

TABLE OF CONTENTS

CHAPTER I

THE STATEMENT OF THE PROBLEM

For a period of many years the mathematics faculty of Wilbur Wright campus of Chicago City College has depended greatly upon its placement test for placing students in their first college mathematics course. Recently the members of the department of mathematics have experienced an administrative problem. During the busy registration period, the forty minutes consumed in administering the test presents great difficulty to those planning the registration procedure. The question now arises as to whether other means may be available by which the department can place its students without the time consuming placement test.

The purpose of this study is to determine:

1. a satisfactory procedure for placing students in the first college credit mathematics course at the Wilbur Wright campus of Chicago City College, District Number 508, County of Cook, and State of Illinois

2. the accuracy with which the present cut off scores of the American College Testing battery predict the student's semester grades in Mathematics 101 and subsequent courses

3. the degree to which the last high school level mathematics grade predicts success in college mathematics

4. the usefulness of the Kuder Preference Record - Form C (Vocational) in advising college students in the selection of courses in mathematics.

That the mathematics department carefully place the students in courses for which they are prepared became of prime importance when the philosophy and, indeed, the function of the junior college changed. The junior college is an institution devoted to offering the best opportunity for higher education to a wide variety of students. The history of its development in Chicago indicates this. In 1911 public junior college education originated in Chicago when two high school principals, William J. Bartholf of Crane Technical High School and William J. Bogan of Lane Technical High School, aware of the plight of young people of ability and promise who were handicapped by limited finances in continuing their education, introduced post-high school courses in their respective schools.

In 1916 fifty students were enrolled in post-high school courses at Senn, 128 at Lane, and 211 at Crane. One year later Crane alone offered these courses and thus became Chicago's first junior college. Its central location and its leader, William J. Bartholf, often referred to as "the father of the Chicago City Junior College," kept the junior college alive. At that time the junior college was designed primarily for the student who planned to continue his higher education in a baccaulaureate degree granting program. In 1917 Crane Junior College was fully accredited by the North Central Association.

In 1931 after Bartholf's retirement, Crane Junior College was reorganized so that its administration was separate from that of the high school. In July 1933, as an economy measurement, the junior college was abolished. The economic and social conditions of the early thirties, however, made it clear that a program of public education beyond the high school level for all who wished it was a social necessity. The labor market, attempting to absorb millions of unemployed, could not handle the youth being graduated from high schools. The upward extension of public education, which had been looked upon as desirable from the point of view of the educator, became necessary. To meet this need the public junior college was one of the types of institutions that expanded rapidly throughout the country.

Responding to social and economic pressures, the Chicago Board of Education in September 1934 inaugurated a program of education beyond the high school level on a different pattern from its previous offerings. For many years the city had provided a restricted type of junior college education with university and professional school preparatory work constituting the bulk of the curriculum. Consequently, the earlier junior college had attracted a select type of student best served by such a program. The junior college under the new plan was designed to meet a changing educational need. The desire to make available to all youth in Chicago the opportunity for higher education led to the reorganization of the junior college system into three branches after it had been discontinued for one year in 1933 as an economy measure.

The organization of the new junior college included a northside branch -- Wright, a southside branch in the Normal College building -- Wilson, and a westside branch in the Medill High School building -- Herzl. Herzl was moved to the Crane Technical High School building in 1954. These three branches remained the divisions of the junior college until new branches were opened in the period of expansion after 1956. On July 1, 1966 under the 1965 Illinois Public Junior College Act, the jurisdiction of this junior college system was transferred from the Chicago Board of Education to the Board of Junior College District Number 508, County of Cook and State of Illinois. The new Board directed by Chancellor Oscar E. Shabat administers the Chicago City College which encompasses Amundsen-Mayfair, Bogan, Crane, Fenger, Loop, Southeast, Wilson, and Wright campuses, and TV College.

In the organization of the new junior college, provision is made to meet the needs not only of those preparing for the liberal arts college and professional school but also of those high school graduates interested in vocational or technical programs such as nursing, medical technology, secretarial practices, data processing, engineering, and other specialized fields. As directed by state law the college is to admit any high school graduate who wishes to attend a junior college. Even the requirement of high school graduation is to be waived in individual cases if circumstances justify it. With the wide offerings and varying abilities and backgrounds of the students, it is necessary then to set pre-requisites for courses such as English, science, mathematics, social studies, and others. In the area of mathematics, many students do not present credit in regular high school mathematics courses at the time of entrance. Since the junior college is an institution devoted to offering the opportunity for higher education to a wide variety of students, it must give special attention to proper placement. Specifically, the college must take the student from where he is and lead him to his full potential as quickly and directly as possible.

Proper placement then is of utmost concern to members of the department of mathematics of Wilbur Wright College. In the early 1950's the mathematics faculty of Wilbur Wright College devised a placement test to be administered to students wishing to enroll in their first college mathematics course.[1] The sixty items for

[1]See Appendix I Placement Test of Department of Mathematics of Wilbur Wright College, Chicago, Illinois.

the test were chosen from several hundred questions given to five hundred students of various levels of ability and background attending Lane Technical High School. The group tested was considered a very good group. If twenty-five percent of these good students missed an item, it was rejected as an invalid measurement. If all but twenty-five percent of these students were successful on an item, that item was considered too easy and was also rejected. Items were selected from the areas of arithmetic, high school algebra, and high school geometry. Using the results of the high school testing, norms were set up. After many years of studying performance in the first and subsequent courses in mathematics, the mathematics faculty of Wilbur Wright College rightfully felt a great deal of confidence in the test offered by the department of mathematics as an instrument of placement.

In 1961 James R. Gray, a member of the department of mathematics of Wilbur Wright College, found it to be the best single predictor of success in the Mathematics 111 course at Wilbur Wright College. However, he also concluded that a better predictor was a four variable regression equation using the department's placement test, the College Aptitude Test total score, and the spatial and word fluency factors from the Primary Mental

Abilities Test[2] was the very best prognosticator of success in the same course.[3] Mathematics 111 is the first of a two semester sequence in introductory mathematical analysis offered to a very select group of beginning freshmen students of mathematics. The department decided against using the four battery device as its merits were outweighed by the difficulties arising from the length of time that would be needed to evaluate each student and the in-service training of personnel necessary to administer and interpret such a placement procedure. As Dr. Gray stated:

> . . . . Although no one can reasonably hope to develop a placement system which is perfect, certainly one ought to seek improvements until he reaches a practical limit of excellence. . . . . In selecting data to be analyzed one must concern himself not only with their probable predictive validity, but also with their availability.[4]

[2]SRA Primary Mental Abilities, Revised, Grades kgn-1, 2-4, 6-9, 9-12; 1946-63; . . . ; IBM for grades 5-12; 5 levels; no data on reliability and validity of present edition; . . . ; L.L. Thurstone (earlier editions) and Thelma Gwinn Thurstone; Science Research Associates, Inc. . . . . (d) Grades 6-9. 5 scores: Verbal meaning, number facility, reasoning, spatial relations, total; IBM: 1 form . . . . (e) Grades 9-12. 5 scores; same as for grades 6-9, IBM; 1 form ('62, c 1946-62, 24 pages); manual ('63, 40 pages); profile ('63, 2 pages); . . . . (Oscar Krisen Buros ed., The Sixth Mental Measurements Yearbook; Highland Park, New Jersey: The Gryphon Press, 1965, pp. 1046-1047).

[3]James R. Gray, "A Study of Factors Contributing to Success in Mathematics" (unpublished Doctoral dissertation, Loyola University of Chicago, 1961), p. 58.

[4]_Ibid._ p. 1.

As of 1964, the procedures for placing students changed. All incoming full time freshmen at Wilbur Wright College were to have American College Test scores on file. It was thought that the use of the Mathematics Usage score of the ACT might permit the mathematics department to abandon the forty minute department placement test which was considered very good but too time consuming to administer while also requiring more personnel than the mathematics department could provide to administer and give the necessary immediate interpretation of this instrument. As a pilot study cut off points were decided upon, using the Mathematics Usage scores of the ACT battery of some students then enrolled in the mathematics classes. Presently, students wishing to take Mathematics 101 -- the first college mathematics course at Wilbur Wright College -- must have an ACT mathematics score of 17-21 points inclusive and one year of high school algebra and one year of high school geometry to qualify.

It is with the placement of students in Mathematics 101 that the writer is especially concerned. The catalogue describes the course:

> Mathematics 101 (Fundamentals of Mathematics I) - This course deals with fundamental principles and processes of mathematics. Starting with an introduction to logic and sets, it develops the number system and its applications. Algebraic concepts and techniques through quadratic equations are reviewed and developed. Selected topics from geometry, arithmetic (logarithms) and modern algebra may be included. Prerequisite: one year of high

> school algebra and plane geometry or Mathematics 95 and 96. Three periods per week. 3 credit hours.[5]

The writer became particularly interested in Mathematics 101 during her first years of college teaching because she taught several sections of Mathematics 101 each semester and worked with Dr. Jerome Sachs on the development and teaching of the first college mathematics course -- Mathematics 101 -- on television, Channel 11, WTTW.[6]

The norms now used do not give the degree of satisfaction that is desired. There is a constant attempt being made to arrive at a more satisfactory procedure. In 1965, Dr. James R. Gray studied the relationship between grades on the placement test of the department of mathematics of Wilbur Wright College and the American College Test scores but found little correlation. The writer was a member of a committee making another pilot study in the spring of 1967. The placement test of the department of mathematics of Wilbur Wright College was administered to some classes to determine if the students were properly placed by the ACT mathematics score. The placement test of the department of mathematics showed that of the 276 Mathematics 101 students tested, only eighty-one were properly placed. Eighty-eight

[5]Chicago City College 1968-69 Catalog, p. 93.

[6]Jerome M. Sachs and Florence M. Miller, Mathematics 101 Fundamentals of Mathematics -- Teleclass Study Guide (Chicago Public Schools, 1959).

were placed too low and 107 were placed too high. Of the 276 students placed in Mathematics 101 by ACT results, 110 received D or F grades in the course. If the placement test of the department of mathematics had been used instead of ACT mathematics scores, seventy of these 110 who did not succeed would have had a better chance for success. If placed by the placement test of the department of mathematics, sixty-seven and one-tenth percent of the students who received an A or a B in Mathematics 101 would have been deemed capable of success in a more advanced level mathematics course and thus placed. Admittedly, if the placement test of the department of mathematics had been used, seven students who actually earned an A or a B in mathematics would have been placed in a lower level course and their progress would have been unnecessarily slowed down. This would have been unfortunate but the number of students so afflicted were few -- an error one might expect since no measuring instrument is perfect. It is the claim of the members of the department of mathematics that its placement test has less of this type of disadvantage than any of the others they have investigated.

Paul L. Trump, president of the American College Testing Program, recognizes the shortcomings of the ACT as a placement device, indicating that ACT plays a supporting role by providing information in advance of the student's enrollment in college so that reasonable choices may be made in planning the curriculum.

In the student's booklet of the American College Testing Program, the student is told that:

> The fact that test scores are neither perfect nor complete forecasters of your ability to perform in college makes other kinds of information necessary for reliable planning. Your high school academic record is important. In fact, your test scores and high school grades together are usually the best indication of your degree of academic success in college.[7]

The use of high school success in placement procedures is substantiated in the third chapter of Barron's Guide to the Two-Year Colleges, entitled "Will you Succeed in a Two-Year College?". The authors state that most college officials make their estimates of an applicant's chance of success on the basis of his high school average and rank in class because it has been shown that these are the best predictors of college achievement.[8]

Since occupational motivation becomes a very prominent part of the junior college student's drive for learning, the writer has selected the Kuder Preference Record - Form C (Vocational) to study the student's interests. In the administrator's manual

[7]American College Testing Program, Student's Booklet (Iowa City, Iowa: American College Testing Program, 1966-67), p. 4.

[8]Seymour Eskow and Lawrence L. Jarvie, Barron's Guide to the Two-Year Colleges (Great Neck, New York: Barron's Educational Series, Inc., 1960), pp. 11-12.

the following is written:

> People often choose occupations because of some chance influence rather than as a result of a careful review of the occupational field. Even if an individual thinks of surveying the whole range of occupations, he is likely to be discouraged by the immensity of the task. He needs some way of narrowing the field so he can investigate occupations most likely to suit him.
>
> The Kuder Preference Record - Form C helps make a systematic approach to this problem by measuring preference in ten broad areas:
>
> 0. Outdoor: . . . .
> 1. Mechanical: . . . .
> 2. Computational: . . . .
> 3. Scientific: . . . .
> 4. Persuasive: . . . .
> 5. Artistic: . . . .
> 6. Literary: . . . .
> 7. Musical: . . . .
> 8. Social Service: . . . .
> 9. Clerical: . . . .
>
> One additional scale, The Verification or V scale, is included. This scale is not a measure of vocational preference, but is an accuracy check, intended to identify persons who may have responded carelessly.[9]

In this dissertation an attempt will be made to evaluate some predictors that have indicated success in learning college mathematics. Ideally the mathematics student should become an active, interested, involved learner, who will experience success in the study of mathematics and find practical application of it in his specialized area. It is the writer's aim to help the student make the best possible selection of mathematics courses so

[9] G. Frederick Kuder, Kuder Preference Record - Form C (Vocational) (Chicago, Illinois: Science Research Associates, Inc., 1960), p. 2.

that time, effort, and potential will be wisely spent. Specifically, the college must take the student from where he is and lead him to his full potential as quickly and directly as possible.

CHAPTER II

SURVEY OF THE LITERATURE

This survey of the literature is made by the researcher in an effort to find predictors of students' success in Mathematics 101. Meaningful analysis of available information about the student is important before placing him in his first college mathematics course.

In a study of the teaching of elementary college mathematics, Joseph Seidlin states that the teaching of college mathematics is sometimes considered ineffective because students who did excellent work in high school mathematics lose interest in courses in college mathematics.[1] Each student should have the joy of discovery in many fields and should learn to think in many fields. A justifiable requirement should not be scorned by a young student merely on the ground that he wishes to devote his full time to specialized preparation. The student may have made a choice because it seemed more important to him to settle his future early than to settle it wisely. If he is not ready for

[1]Joseph Seidlin, A Critical Study of the Teaching of Elementary College Mathematics, Teachers College, Columbia University Contributions to Education, No. 482 (New York: Teachers College Columbia University, 1931), p. 100.

specialized preparation, he may become indifferent or even hostile to the path he has chosen or he may miss his need for work in areas other than his major interest. The Educational Policies Commission says, "An intense interest is not necessarily a spur to one's broadest development."[2] One of the objectives of schools at all levels should be to open new possibilities to students and to encourage them to continue their preparation whenever it appears they have the capabilities to succeed in occupations of greater challenge than the one for which they may be willing to settle. The child learns those things that are of primary importance to him. Dr. Calvin P. Midgley says, "It would seem axiomatic that if a student is intensely interested in a subject, there must be some way to teach it to him."[3] He is disturbed because he loves chemistry and so many fear it. As a consequence, he has decided to work at teaching it. In his profession he learned to listen, to counsel, and has brought these principles to his classroom. He says that no child is frightened by any subject provided it is made neaningful to him in his own theory. He further feels that it may be our lecturers

[2]Educational Policies Commission, Universal Opportunity for Education beyond the High School (Washington, D.C.: United States Government Printing Office, 1964), p. 21.

[3]Calvin P. Midgley, "Teaching of Chemistry in the Elementary School," Transactions of the Illinois State Academy of Science, LI, Nos. 1 and 2 (1958), p. 35.

and textbooks that make phases of learning less likeable because they are as impersonal as a telephone directory.[4]

Daniel A. Prescott said in a Horace Mann lecture series:

> Currently many school people seem to feel that the child is a mechanism and that learning occurs in a child chiefly as a result of something that is done to him from the outside. They build elaborate learning materials and develop intricate methods to evoke the learnings they desire. They think of teachers as doing the work on the basis of which the child learns. They seek ever for a fool-proof method that will work for all children. They could not be farther from the truth as to how learning really happens. . . . . learning is an active process, always originating in the child. We find that, for the human being, learning is as needed, as natural, and as sought after as is food or sleep or movement. . . . among humans the capacity to learn is inherited and the dynamic desire to learn is an innate property of living and growing. It does not have to be evoked by tricks. It needs only to have the opportunity to occur in situations and ways appropriate to the maturity level of the human individual. . . . biologists and psychologists contend that children and youth will work tirelessly to accomplish their own learning goals because they feel within themselves the need to learn, because learning is life realization.[5]

In promoting learning, the experience must, on the whole, be successful because it helps the student maintain his integrity and self-esteem. Failure contributes to unfavorable attitudes

[4]Ibid.

[5]Daniel A. Prescott, Factors that Influence Learning, Horace Mann Lectures (Pittsburgh, Pennsylvania: University of Pittsburgh Press, 1958), pp. 7 ff.

and inhibits the development of interest. Failure tends to tear down the student. Students reject that which does not give them security. S.R. Heath's concept of a Reasonable Adventurer is a well adjusted student who scores highly on the following:

1. pursuit of knowledge
2. depth of communication with peers
3. degree of self acceptance.[6]

If students are properly placed they will feel confident and will try to live up to that which it is felt they can do. We must activate or, if necessary, re-activate the student's confidence in himself and his own inner dynamics to learn and develop. Fear seems to cause a great deal of failure, says Elizabeth Boyd.[7] Anything that can be done to create an atmosphere that will dispel fear will improve the work.

In 1965, the United States Department of Health, Education, and Welfare Office of Education published the following statistics on mathematics placement test which were administered by

[6]S.R. Heath, "The Reasonable Adventurer and Others," Journal of Counseling Psychology, VI (1959), pp. 3 ff.

[7]Elizabeth N. Boyd, A Diagnostic Study of Students' Difficulties in General Mathematics in First Year College Work "Columbia University Contribution to Education", No. 798 (New York: Columbia Teachers College, 1940), p. 122.

fifty-nine percent of all responding institutions: "Fifty-eight percent used the placement examination to discover the mathematical knowledge of the student."[8]

Paul L. Clifford and Joshua A. Fishman emphasize the constant need to evaluate the degree of effectiveness of psychometric instruments which are developed and used to select college students.[9] The good teacher must be trained in evaluation so that he can and will make valid judgments, and he must be given the best available materials with which to make these judgments. Ben A. Sueltz says:

> Evaluation, an essential part of the mathematics program at every level, should be the handmaiden of instruction and learning. . . . . Placement in an appropriate course should be based on many evaluations such as: achievement test scores, aptitude test scores, achievement records, and teacher judgment. Student attitudes are also important with regard to potential success in a given mathematics course. . . . . The appraisal of the achievement level of a stu-

[8]United States Department of Health, Education, and Welfare Office of Education, Mathematics in College and Universities (Washington, D.C.: U.S. Government Printing Office, 1965), p. 36.

[9]Paul L. Clifford and Joshua A. Fishman, "The Impact of Testing Programs on College Preparation and Attendance," The Sixty-Second Yearbook of the National Society for the Study of Education - Part II - The Impact and Improvement of School Testing Programs, ed. Warren G. Findley (Chicago: University of Chicago Press, 1964), p. 101.

> dent should be possible at any time. Ideally it should include the student's attitude toward work; the nature of his curiosity about and ingenuity with mathematics; his work habits and his methods of recording steps toward a conclusion; his ability to think, to exclude extraneous data, and to formulate a tentative procedure; his techniques and operations; and finally, his feeling of security with his answer or conclusion.[10]

Charles F. Lindblade indicates that his findings in the literature reaffirm his conclusion that, "if prediction is possible, it is probably a function of many variables rather than one."[11]

On the other hand, several authorities on placement procedures view high school success as a major predictor of college potential. David E. Lavin finds that of all measures used in prediction batteries, the best single predictor of success in college is the high school grade point average or high school rank at the time of graduation. He further states that females tend to be more predictable than males in academic performance.[12]

[10]Ben A. Sueltz, "The Role of Evaluation in the Classroom," Evaluation in Mathematics - Twenty-Sixth Yearbook of National Council of Teachers of Mathematics, XXVI (Washington, D.C.: National Council of Teachers of Mathematics, 1961), pp. 7 ff.

[11]Charles Francis Lindblade, "A Study of Selected Characteristics of Scholastically Excluded College Students Who are Successful and Unsuccessful after Being Readmitted to a Junior College" (unpublished Doctoral dissertation, Loyola University of Chicago, 1967), p. 41.

[12]David E. Lavin, The Prediction of Academic Performance (New York: Russell Sage Foundation, 1965), p. 12.

Macklin Thomas, director of examinations at Illinois Teachers College of Chicago - South since 1965 agrees to some extent:

> . . . the definable content of a grade is its predictive value -- its usefulness as an estimate of the student's subsequent performance at other levels of education. . . . . Whatever a grade may be in its origins, in action it is, like every other scientific inference, a prediction: given Configuration X, Configuration Y will (or should) follow.[13]

Nonetheless oversimplification may be a danger. This is indicated by Henry Chauncey and Norman Frederiksen when they say:

> The prediction of academic success in college on the basis of high school record is fairly successful because of the similarity of the two situations involved. Practically all factors related to academic success in high school -- motivation, personal adjustment, study methods, and aptitude -- are also operative in college. Prediction on this basis is still far from perfect, however, motivation and quality of adjustment may change, study methods and aptitude which are adequate for high school work may be inadequate for college work, and study techniques may be improved. It is desirable to assess these various factors independently in order to have a more adequate basis than school record alone for admission to college

[13]Macklin Thomas, "Something About Marking," Illinois Schools Journal, XLVII, No. II (Summer 1967), pp. 83 ff.

> and for individual guidance of the student after he has been admitted. Prediction can frequently be improved somewhat by including with rank-in-class in a multiple regression equation independent measures of aptitude, achievement, or proficiency in tool skills such as reading and writing.[14]

Recently a study was made of some variables in predicting academic success at the University of Wisconsin. The researchers report the following:

> . . . . There is only a limited relationship between the ACT, the SAT, or the CQT and first semester academic performance as reflected in the grade point average; none of these scores by itself appears to be a predictor variable of high validity. . . . . Although high school academic G.P.A. (Grade Point Average) is somewhat more closely associated with first semester University GPA than is the high school percentile rank in multiple-variable predictions of first semester GPA, it appears to make little difference whether high school percentile rank or high school academic GPA is used, and little difference whether American College Test, Scholastic Aptitude Test, or College Qualification Test scores are used. . . . . More accurate estimates of the probability that particular individuals will receive at least a C average during the first semester of college can be made with the use of multiple variable regression weights (in the prediction formula) than with a single variable regression weight. But at best the estimation proves to be accurate only for

[14]Henry Chauncey and Norman Frederiksen, "The Functions of Measurement In Educational Placement," Educational Measurement - American Council on Education, ed. E.F. Lindquist (Wisconsin: George Banta Publishing Company, 1955), p. 89.

> approximately three out of four high school graduates. . . . . Evidence bearing on the adequacy of different variables (e.g., ACT scores, high school rank, etc.) for predicting academic success in the first semester of college suggests the existence of a factor or group of factors, thus far unidentified, which strongly influences academic performance.[15]

An investigation was made by DeLars Funches to determine the degree of relationship between the American College Test composits standard score and the year-end GPA of 369 freshmen who enrolled at Jackson Mississippi State College in the fall of 1962. The composite standard score is the mean of the four educational development scores namely: English, mathematics, social studies, and natural sciences. According to the publishers of the ACT (Science Research Associates for the American College Testing Program, P.O. Box 168, Iowa City, Iowa 52242), the ACT is designed to measure as precisely as possible the ability of a student to perform those intellectual tasks he is likely to face in his college studies. The findings of this Study are

1. There is a positive correlation of .59 between the ACT composite standard score and the year-end GPA (A positive Pearson correlation of .30 or higher ordinarily may be considered sufficient evidence of a positive degree of relationship)

[15]L. Joseph Lins, Allan P. Abell, and H. Clifton Hutchins, "Relative Usefulness in Predicting Academic Success of the ACT, the SAT, and Some Other Variables," The Journal of Experimental Education, XXXV, No. 2 (Winter 1966), pp. 26-27.

2. The ACT composite score would be a reliable factor if used to predict first-year college success.[16]

Joshua A. Fishman and Ann K. Pasanella in their extensive research on College Admission-Selection Studies point out that:

> . . . the usual research design is that of correlation and regression in which one or more predictors (measures taken previous to college admission) attempt to approximate one or more criteria (measures taken after the completion of one or more semesters of college attendance). . . . . It has become accepted to designate predictors and criteria as dealing with either intellective characteristics (personality and motivational and attitudinal measures) of individuals.[17]

Richard L. Francis of Southeast Missouri State College emphasizing the intellectual characteristics, used a regression equation for prediction of Calculus I Achievement scores. He found that the best single predictor of Calculus I achievement was the algebra score, but also indicated that there is a need for more valid placement instruments.[18]

[16]DeLars Funches, "A Correlation Between the ACT Scores and the Grade Point Averages of Freshmen at Jackson State College," College and University, XL (Spring 1965), p. 326.

[17]Joshua A. Fishman and Ann K. Pasanella, "College Admission - Selection Studies," Review of Educational Research, XXX, No. 4 (October 1960), pp. 298 ff.

[18]Richard L. Francis, "A Placement Study in Analytic Geometry and Calculus," Educational and Psychological Measurement, XXVI (Winter 1966), pp. 1041-1046.

In a recent article, Arthur R. Eckberg, director of placement at Roosevelt University states that ninety-seven percent of the 136 respondents to a survey firmly believe that junior college placement will become increasingly important[19] and junior colleges are responding with studies of their own. For example, a pilot study of the psychological determinants of academic success was made at Wilbur Wright College in the fall of 1966. The investigation had as its aim the development of a formula which would predict academic achievement more accurately than any one test. In this study, Harry D. Levine, Rueben H. Segal, and Marvin Steinberg expressed their feelings that factors other than scholastic ability affect the achievement of students.[20]

The United States Office of Education took steps in 1961 and 1962 to launch a special project to identify and educate talented children -- those whose latent or developed ability places him at least one standard deviation above the mean of the population under consideration. J.W. Cohen, director and editor-in-chief of the Newsletter of the Inter-University Committee on

[19]Arthur R. Eckberg, "Placement in the Junior Community College," Journal of College Placement (February-March, 1967), pp. 103 ff.

[20]Marvin Steinberg, Rueben H. Segel, and Harry D. Levine, "Psychological Determinance of Academic Success: A Pilot Study," Educational and Psychological Measurement, XXVII (Summer 1967), pp. 413-422.

the Superior Student wrote

> We would do well to remember the wise words of Robert K. Merton. Taking his cue from Alan Gregg, he points to the problem of the late bloomer and reminds us that we often respond to the world in terms of images created by others. Thus, if we conclude our students are but average and treat them accordingly, we may find these students will accept this image and fail to realize potentialities which neither the tester nor the subject recognized. It may very well be true that most students will perform at a higher level when they are encouraged and given the opportunity to.[21]

In a report of a conference sponsored jointly by the National Education Association and the National Council of Teachers of Mathematics, Charles E. Bish, director of the project on the academically talented student states that

> . . . education in a democracy calls for equality of educational opportunity in relation to each individual's capacity to profit from such opportunity. . . . It is imperative that society provide education suitable for the maximum growth of our highly talented pupils particularly in mathematics and science, so that its complex problems may be met satisfactorily and so that such individuals may enjoy the fullest personal achievement.[22]

[21]J.W. Cohen, "Excellence and the 'Later Bloomer'," The Newsletter of the Inter-University Committee - on the Superior Student, V, No. 4 (March-April 1963), pp. 37-38.

[22]National Education Association and National Council of Teachers of Mathematics, Mathematics for the Academically Talented Student in the Secondary School (Washington, D.C.: National Council of Teachers of Mathematics, 1959), p. 3.

There is a consensus of opinion that the ability to solve mathematical problems depends upon several factors of which the most important is intelligence. One psychological research about the solution of arithmetic problems, which the investigator of this paper studied, allowed the teacher to grasp the methods of procedure of the pupils as they sought the solution of arithmetic problems. In the introduction, the director of the research, Professor Raymond Buyse states that the phrase "Magister Dixit" (It is up to the pupil to learn under the wise leadership of the master) is outmoded. The new formula is "Discat a puero magister" (The child is the center of the educational problem -- the master learns from the pupil). Professor Buyse concluded:

> Intelligence is one of the main factors in the successful solution of problems as demonstrated by the correlation between the results of problems and intelligence tests, and the relationship between intelligence quotient and spoken solution of people examined individually. . . . . Ability to solve problems depends upon several factors of which the most important is intelligence.[23]

Louise E. Dieterle substantiated this viewpoint in a study in which she found that the more intelligent pupils do markedly

[23]Anna Maria N. deMoraes, Recherche Psychodrepagogique Sur La Solution Des Problems, trans. Germaine Starrs (Belgium: University of Louvain, 1954), pp. 111-112.

better on problem solving.[24] Walter S. Monroe and Max D. Englehart found no significant difference in favor of systematic instruction in reading verbal problems in arithmetic over no special instruction.[25] Julius H. Hlavaty in a similar study says:

> The identification of the mathematically talented student must be regarded as an integral part of the total school guidance and counseling program. . . . all available pertinent data should be considered including: information from intelligence and achievement tests and from interest inventories, information on previous school performance, staff evaluation, anecdotal records, etc., and other types of data from the cumulative record.[26]

This researcher believes that it is the student with high measurable ability but whose performance in mathematics has not been

[24]Louise Elizabeth Dieterle, " The Effect of Estimating Answers in Advance to Solving Word Problems in Arithmetic on Achievement in Arithmetic in Grade 4B" (unpublished Master's thesis, Loyola University of Chicago, 1953), p. 68.

[25]Walter S. Monroe and Max D. Englehart, "The Effectiveness of Systematic Instruction on Reading Verbal Problems in Arithmetic," The Elementary School Journal, XXXIII (January 1933), pp. 183-186.

[26]Julius H. Hlavaty, Mathematics for the Academically Talented Student in the Secondary School - Education for the Gifted (Washington, D.C.: Project of National Education Association and National Council of Teachers of Mathematics, 1959), pp. 1 ff.

commensurate with his ability, who must be singled out on the junior college level. Possible reasons for the underachievement of such students are inadequate motivation, negative attitude, lack of insight into the areas of learning required for mathematics. This student may be a victim of a failure-complex. In the same vein Maurice L. Hartung emphasizes the adage, nothing succeeds like success.[27] Furthermore he points out

> The purpose of education is to change students from a given state of experience to a desired state by means of a variety of appropriate learning experiences, some of which may be used as a basis for evaluation of achievement.[28]

A school system needs to be aware of the current development in school mathematics, but this is not enough. The Johnsons say a school system must use this information to improve its own program. They emphasize active participation of teachers, administrators, counselors, librarians, students, and parents in

[27]Maurice L. Hartung, "Motivation for Education in Mathematics," The Learning of Mathematics - Its Theory and Practice - Twenty-First Yearbook - The National Council of Teachers of Mathematics (Washington, D.C.: National Council of Teachers of Mathematics, 1953), pp. 56-57.

[28]Maurice L. Hartung, "Basic Principles of Evaluation," Evaluation in Mathematics - Twenty-Sixth Yearbook - The National Council of Teachers of Mathematics (Washington, D.C.: National Council of Teachers of Mathematics, 1961), p. 23.

the development of an effective program.[29] A mathematics curriculum should:

1. plan for meeting the educational and vocational objective of the individual student
2. help each student reach as least minimal competencies
3. be designed to meet the needs of a constantly changing technological society.[30]

An investigation of a small portion of the literature of some predictors of success in college mathematics points up the need for additional research on the problem. Various predictors give confidence to the methods of placing students but there is a great difference of opinion -- even contradictory evidence -- as to the best methods.

In a person's lifetime it would be impossible to exhaust all of the material published on the subject. For the procedures to be used in this study, the literature examined here has been invaluable and has provided the chief source for the measurements selected.

[29]David C. Johnson and Donovan A. Johnson, "Evaluating a School Mathematics Program," North Central Association Quarterly, XLI, No. 2 (Fall 1966), p. 185.

[30]National Council of Teachers of Mathematics, Administrative Responsibility for Improving Mathematics Programs (Washington, D.C.: National Council of Teachers of Mathematics, 1965), p. 9.

CHAPTER III

THE PROCEDURE

The writer's plan was to study the background, interest, and progress for two consecutive semesters of students enrolled in six sections of Mathematics 101 -- the first college credit mathematics course at Wilbur Wright College in Chicago. Six day-time sections were chosen which were taught by six different full time teachers -- two men and four women. This study was begun in the fall of 1965.

The student's background was surveyed as to age (just out of high school or a lapse of time between high school and college attendance), high school attended and its curriculum, last high school level mathematics grade, and the percentile rank at time of graduation from high school. Information was gathered by means of a questionnaire[1]. Five-by-eight cards[8] were used upon which pertinent data had been transferred and analyzed so that there might be more ease in handling the data for correlations, tabulations, and investigations.

[1]See Appendix II for a sample questionnaire.

[2]See Appendix III for a sample card.

The questionnaire contained the following items:

1. Name
2. Address
3. Phone Number
4. Did you have Mathematics 95?

   If yes -- when? grade?
5. Did you have Mathematics 96?

   If yes -- when? grade?
6. Did you have Mathematics 101 before?

   If yes -- when? grade?
7. Have you had any other mathematics courses in college?

   If yes -- when? grade? what course(s)?
8. College Curriculum
9. High School

   Name

   Address
10. Curriculum in high school
11. High school mathematics courses
12. Final grade in Mathematics 101
13. Follow-up Course and Grade

14. ACT Scores: (Raw and Percentile)

    English

    Mathematics

    Social Science

    Natural Science

    Composite

15. Last High School Mathematics Grade

16. Graduation date from high school

17. Percentile Rank upon graduation from high school

18. Date of entrance into college

19. Birth date

20. What subject did you like most in high school?

21. What subject did you like least in high school?

The five-by-eight card contained the following information

1. Mathematics 101 grade

2. Follow-up course and grade

3. ACT scores and scores squared

    Mathematics

    English

    Natural Science

4. Kuder Preference Record scores and scores squared

    Mechanical

    Computational

    Science

5. High school percentile rank
6. Last high school mathematics grade
7. Date of graduation from high school
8. Name of high school from which graduated and location
9. College curriculum chosen

The Kuder Preference Record - Form C (Vocational) was administered so that the relationship between mathematical interest and success as measured by semester grades in mathematics could be investigated. The Kuder Preference Record - Form C (Vocational) which was used is published by Science Research Associates, Inc. 259 East Erie Street, Chicago, Illinois 60611. The individual's preferences in ten broad areas were measured. For the purposes of this study, only the mechanical, computational, and scientific were investigated. However, as intended, the entire test was scored by SRA and a profile made for each student.[3]

The profile should be used to consider on one hand, the low scores for the purpose of identifying occupations which are out of line with a student's preferences and on the other hand, the high scores should be used for the purpose of identifying the

[3]See Appendix IV for sample Kuder Preference Record Profile Sheets.

student's interest as an active participant in the subject area rather than as a passive participant -- one who would primarily pursue a subject for appreciation. Occupations which are clearly inappropriate to a student's ability should be eliminated. Evidence concerning ability should be obtained from all possible sources. The scores are only classifications of interest which can help him to predict that which he would enjoy doing. These scores do not indicate what he should do or what he is able to do.

The American College Test was also administered. The first part is the Student Profile Section inquiring about the extra-curricular achievements and educational plans of the student. The second part consists of four tests -- English, mathematics, social studies, and natural sciences. A composite, or average, of the scores on each of the four tests provides an overall estimate of the student's ability to succeed academically in college.

The plan was to correlate:

1. ACT percentile scores in mathematics with the grade in Mathematics 101 and again with the average of two semesters of work in mathematics for those students continuing in mathematics

2. composite scores in mathematics and English with grade in Mathematics 101 and again with average of two semesters of work in mathematics for those students continuing in mathematics
3. composite scores in mathematics and natural science with grade in Mathematics 101 and again with average of two semesters of work in mathematics for those students continuing in mathematics.

These correlations were to be made with intentions of offering specific recommendations for a procedure for advising students to select Mathematics 101.

A tetrachoric r[4] was computed from data in which both X and Y had been reduced artifically into two categories. The result is a coefficient that is approximately equal to the Pearson r. The complete equation for the tetrachoric r is a long and complicated one, involving a series including many powers of r. Numerous short-cut methods have been devised for estimating the tetrachoric r. One of them is the cosine-pi

[4] J.P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw-Hill Book Company, Inc., 1965), pp. 326-329.

formula which is as follows:

$$r_{\text{cos-pi}} = \cos\left(\frac{180^\circ}{1 + \sqrt{\frac{ad}{bc}}}\right)$$

where a, b, c, and d are the frequencies as defined in the two by two table:

FOURFOLD TABLE FROM WHICH A TETRACHORIC COEFFICIENT OF CORRELATION IS COMPUTED

QUESTION 1

		YES	NO	TOTAL	PROPORTION
QUESTION II	YES	a	b		p
	NO	c	d		q
	TOTAL				1.000
	PROPORTION	p'	q'	1.000	

The use of the cosine-pi formula gives a very close approximation to r only when both variables X and Y are dichotomized at their medians. The proportions should always be between .4 and .6. The like-signed cases (Yes-Yes and No-No) are represented by a and d and the unlike-signed cases by b and c.

For the correlation of composite scores in ACT mathematics and ACT English and the composite scores in ACT mathematics and ACT English, a multiple correlation was used. Multiple Correlation is the amount of correlation between a dependent variable and two or more independent variables.[5] The formula the writer used for some of the multiple correlations was:

$$R^2_{1.23} = \frac{r^2_{12} + r^2_{13} - 2\, r_{12}\, r_{13}\, r_{23}}{1 - r^2_{23}}$$

To find intercorrelations among five variables, including one index of scholarship -- Mathematics 101, and four prediction indices, the mean and standard deviation of each had to be found. The four indices were selected because they had the highest correlation with Mathematics 101 -- the criterion.

[5] *Ibid.*, p. 404.

The mean[6] is

$$\frac{\Sigma X}{N}$$

where X represents the score and N the number of scores.

For standard deviation,[7] the investigator used raw scores, the following formula

$$\sigma = \frac{1}{N} \sqrt{N\Sigma X^2 - (\Sigma X)^2} \,,$$

and a calculator.

After these deviations were obtained, the researcher was able to calculate regression equations and to compute the multiple Rs from beta coefficients which were found for the regression equations.[8] The regression equation is

$$X_1' = a + b_{12.3}X_2 + b_{13.2}X_3$$

where X_1' is the Mathematics 101 grade to be predicted,

$$a = M_1 - b_{12.3}M_2 - b_{13.2}M_3 \,,$$

[6] *Ibid.*, p. 44.

[7] Ibid., p. 84.

[8] Ibid., pp. 395-398.

the partial regression coefficients are

$$b_{12.3} = \frac{\sigma_1}{\sigma_2} (\beta\, 12.3) \qquad \text{and}$$

$$b_{13.2} = \frac{\sigma_1}{\sigma_2} (\beta\, 13.2),$$

and the betas are

$$\beta_{12.3} = \frac{r_{12} - r_{13}\, r_{23}}{1 - r^2_{23}} .$$

$$\beta_{13.2} = \frac{r_{13} - r_{12}\, r_{23}}{1 - r^2_{23}} .$$

Since betas had already been obtained, the shortest method for finding the multiple R was to use the formula

$$R^2_{1.23} = {}_{12.3}r_{12} + {}_{13.2}r_{13} .$$

The reliability of the regression equation as a prediction instrument in estimating criterion scores can be determined by this coefficient of multiple correlation.[9]

[9]Henry E. Garrette, Statistics in Psychology and Education (New York: Longmans, Green and Co., 1953), pp. 378-380.

CHAPTER IV

RESULTS OF THE INVESTIGATIONS AND THE SIGNIFICANCE OF THE PREDICTORS

The correlation of each variable used in this research with the semester grade in Mathematics 101 is given in the following table.

VARIABLES	CORRELATION WITH CRITERION X_1' - SEMESTER GRADE IN MATHEMATICS 101
X_2 - High School Mathematics Grade	.462[1] [1]
X_3 - Kuder Scientific	.438[1]
X_4 - ACT Mathematics	.215[5]
X_5 - Kuder Computational	.139
X_6 - Kuder Mechanical	.070
X_7 - ACT English	0
X_8 - ACT Natural Science	- .131
X_9 - Follow-up Course	.225
X_{10}- Mathematics 101 and Follow-up Course	1 [1]

[1]Significant at .01 level or .05 level as the number indicates.

The correlation of each variable with the criterion was calculated using the cosine-pi formula. The significance of the coefficients of correlation at the .01 and .05 level for varying degrees of freedom were checked by means of a table devised by H.A. Wallace and G.W. Snedecor.[2]

Using these data, the four most promising predictors of success in Mathematics 101 were selected and intercorrelations calculated as well as the mean and sigma of each. The table on page forty-three summarizes these results.

[2]Guilford, pp. 580-581.

INTERCORRELATIONS OF FOUR PREDICTORS OF SUCCESS AND MATHEMATICS 101
(N=119)

VARIABLE	X_2	X_3	X_4	X_5	X_1'
X_2		-.052	-.040	.174[5]	.462[1]
X_3	-.052		.070	-.052	.438[1]
X_4	-.040	-.070		.016	.215[5]
X_5	.174[5]	-.052	.016		.139
X_1'	.462[1]	.438[1]	.215[5]	.139	
M_X	1.8	55.4	18.9	55.4	2.08
σ_X	.765	33.6	3.93	27.3	.908

X_2 - Last High School Mathematics Grade

X_3 - Kuder Scientific

X_4 - ACT Mathematics

X_5 - Kuder Computational

X_1' - Criterion Semester Grade in Mathematics 101

The coefficients of multiple correlation between the criterion and two of the variables at a time were calculated next using the beta coefficients. The beta coefficients are the standard partial regression coefficients which are necessary for getting the <u>b's</u> of the regression equation, and give a short method for calculating the coefficient of multiple correlation.

VARIABLES	COEFFICIENT OF MULTIPLE CORRELATION WITH X_1'
X_2X_3	.654[1]
X_2X_4	.519[1]
X_3X_4	.510[1]
X_2X_5	.466[1]
X_3X_5	.440[1]
X_4X_5	.255[1]

The last high school mathematics grade -- X_2 and the Kuder Scientific score -- X_3 correlated highest with the criterion - semester grade in Mathematics 101 -- X_1'. These were used to obtain a regression equation which would be the best predictor of the semester grade in Mathematics 101. To make the computation practical for use, it was decided to use a three variable regression equation.

For a three variable problem, the regression equation has the general form

$$X_1' = a + b_{12.3}X_2 + b_{13.2}X_3$$

where X_1' is the criterion. The regression equation for predicting the criterion from variables two and three is

$$X_1' = .38 + .576X_2 + .012\,X_3 \;.$$

The Kuder Preference Record scores are not available for all students of Wilbur Wright College at the present time. The coefficient of multiole correlation between the criterion -- X_1' and the variables two and four is second highest and these scores are available now. The regression equation for predicting the criterion from variables two and four is

$$X_1' = .049 + .561X_2 + .054X4 \;.$$

Although X_5 is included on page 43, it will not be used in a regression equation since the two regression equations, which are being given, have a higher multiple correlation with the criterion than will any three variable regression equation using X_5.

As a matter of interest, the following three tables, giving some background data regarding the characteristics of the population are included.

HIGH SCHOOL ATTENDED

	PRIVATE	PUBLIC	TOTAL
CHICAGO	36	70	106
SUBURB OF CHICAGO	9	21	30
OTHER	1	4	5
TOTAL	46	95	141

Approximately two-thirds of the students in this sample of students from Wilbur Wright campus of Chicago City College are from public schools and one-third from private schools. Only 3.5% are from out of town. It is a city college and is predominately populated by students from that city.

NUMBER OF STUDENTS ENROLLED IN CURRICULUMS REQUIRING VARYING AMOUNTS OF MATHEMATICS

		NUMBER OF HOURS REQUIRED		
		0	3-10	20 OR MORE
GRADES	C OR BETTER	46	21	29
	BELOW C	15	4	8
	TOTAL	61	25	37

NUMBER OF YEARS ELAPSED BETWEEN HIGH SCHOOL GRADUATION AND ENROLLMENT IN A COLLEGE MATHEMATICS COURSE

YEARS ELAPSED	NUMBER OF STUDENTS	GRADES C OR ABOVE	GRADES BELOW C	PERCENT OF STUDENTS WITH C OR BETTER
o	67	53	14	79
½ to 1	49	37	12	76
2 to 10	33	25	8	76
above 10	1	1	0	100

Lapse of time from high school graduation until enrollment in college does not seem to have any effect upon grades. Experience and maturity seem to do as much for the student as does recent attendance in school.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Of the predictors of success in Mathematics 101 at Wilbur Wright College used by the researcher, the one which correlated highest with the criterion was the last high school mathematics grade. The coefficient of correlation was .462 which was significant at the .01 level. The predictor which correlated second highest with the criterion was the scientific interest test of the Kuder Preference Record - Form C (Vocational). The coefficient of correlation was .438 which was also significant at the .01 level. It was noticed that the coefficient of correlation between these two variables was -.052. This low intercorrelation between the two predictors leads one to expect the coefficient of multiple correlation, obtained by using both of these variables, to be much higher than either correlation. The predictor which correlated third highest with the criterion was the ACT mathematics score. The coefficient of correlation was .215, having significance at the .05 level.

In terms of the present instruments available at Wilbur Wright College, the researcher suggests the use of a regression equation based on X_2 -- last high school mathematics grade and X_4 -- ACT mathematics score to predict X_1' -- the semester grade in Mathematics 101. The multiple regression equation is

$$X_1' = .049 + .561 X_2 + .054 X_4 .$$

The multiple correlation of X_2 and X_4 with X_1' is .519. However, the multiple correlation of X_2 -- last high school mathematics grade and X_3 -- Kuder scientific score with X_1' is .654; and the regression equation

$$X_1' = .38 + .576 X_2 + .012 X_3$$

represents a substantial improvement over the equation based on X_2 and X_4. Accordingly, the researcher recommends that the admissions department add the Kuder Preference Record - Form C (Vocational) scientific test to the battery of tests presently required of each student so that this regression equation may be used for the purpose of deciding whether or not to place a student in Mathematics 101.

The researcher further recommends that if these results are used the mathematics faculty of Wilbur Wright campus of Chicago City College should not feel its work has been completed. As the student body changes, as their needs may vary, the College and the Department of Mathematics should keep abreast of the literature and research concerning the screening of students and continue its own research into the problem so that the most accurate as possible measuring devices will be used in their placement procedure.

In this research increasingly larger samples will be available, leading to increased confidence in results. Furthermore, this will make it possible for changes in the nature of the population to make themselves evident.

BIBLIOGRAPHY

American College Testing Program. Student's Booklet. Iowa City, Iowa: American College Testing Program, 1966-67.

Bloom, Benjamen S. and Lois J. Broder. Problem-Solving Process of College Students -- An Exploratory Investigation. Chicago: University of Chicago Press, 1950.

Boyd, Elizabeth N. A Diagnostic Study of Students' Difficulties in General Mathematics in First Year College Work. Columbia University Publications: Education, No. 798, New York: Columbia Teachers College, 1940.

Buros, Oscar Krisen (ed.). The Sixth Mental Measurements Yearbook. Highland Park, New Jersey: The Gryphon Press, 1965.

Chauncey, Henry and Norman Frederiksen. "The Functions of Measurement in Educational Placement," Educational Measurement - American Council on Education, ed. E.F. Lindquist, 89, Wisconsin: George Banta Publishing Company, 1955.

Chicago City College Catalog, 1968-69.

Clifford, Paul L. and Joshua A. Fishman. "The Impact of Testing Programs on College Preparation and Attendance," The Sixty-Second Yearbook of the National Society for the Study of Education - Part II - The Impact and Improvement of School Testing Programs, ed. Warren G. Findley, LXII, 101. Chicago: University of Chicago Press, 1963.

Cohen, J.W., "Excellence and the 'Later Bloomer'," The Newsletter of the Inter-University Committee - on the Superior Student. V, No. 4. Boulder, Colorado: ICSS.(March-April, 1963).

Dieterle, Louise Elizabeth. "The Effect of Estimating Answers in Advance to Solving Word Problems in Arithmetic on Achievement in Arithmetic in Grade 4B." Unpublished Master's thesis, Loyola University of Chicago, 1961.

Ecberg, Arthur R. "Placement in the Junior Community College," Journal of College Placement. (February-March 1967), 103-106.

Eskow, Seymour and Lawrence L. Jarvie. Barron's Guide to the Two-Year Colleges. Great Neck, New York: Barron's Educational Series, Inc., 1960.

Fishman, Joshua A., and Ann K. Pasanella. "College Admission - Selection Studies," Review of Educational Research, XXX, No. 4 (October, 1960), 298-310.

Francis, Richard L. "A Placement Study in Analytic Geometry and Calculus," Educational and Psychological Measurement, XXVI, (Winter, 1966), 1041-1046.

Funches, DeLars. "A Correlation Between the ACT Scores and the Grade Point Averages of Freshmen at Jackson State Colleges," College and University, XL (Spring, 1965), 326.

Garrette, Henry E. Statistics in Psychology and Education. New York: Longmans, Green and Co., 1953.

Gray, James R. "A Study of Factors Contributing to Success in Mathematics." Unpublished Doctoral dissertation, Loyola University of Chicago, 1961.

Guilford, J.P. Fundamental Statistics in Psychology and Education New York: McGraw-Hill Book Company, Inc., 1965.

Hartung, Maurice L. "Basic Principles of Evaluation," Evaluation in Mathematics, XXVI, 23, Washington, D.C. : National Council of Teachers of Mathematics, 1961.

Hartung, Maurice L. "Motivation for Education in Mathematics," The Learning of Mathematics - Its Theory and Practice, XXI, Washington, D.C.: National Council of Teachers of Mathematics, 1953, 56-67.

Heath, S.R. "The Reasonable Adventurer and Others," Journal of Counseling Psychology, VI (1959), 3014.

Hlavaty, Julius H. Mathematics for the Academically Talented Student in the Secondary School - Education for the Gifted. Project of NEA and NCTM, 1959.

Johnson, David C. and Donovan A. Johnson. "Evaluating a School Mathematics Program." North Central Association Quarterly, XLI (Fall, 1966), 184-191.

Kuder, Frederick G., Kuder Preference Record - Form C (Vocational). Chicago: Science Research Associates, Inc., 1960.

Lavin, David E. The Prediction of Academic Performance. New York: Russell Sage Foundation, 1965.

Lindblade, Charles Francis. "A Study of Selected Characteristics of Scholastically Excluded College Students Who are Successful and Unsuccessful after Being Readmitted to a Junior College." Unpublished Doctoral dissertation, Loyola University of Chicago, 1961.

Lins, L. Joseph, Allan P. Abell, and H. Clifton Hutchins. "Relative Usefulness in Predicting Academic Success of the ACT, the SAT, and Some Other Variables," The Journal of Experimental Education, XXXV (Winter, 1966), 1-20.

Midgley, Calvin P. "Teaching of Chemistry in the Elementary Schools," Transactions of the Illinois State Academy of Science, LI, Nos. 1 and 2 (1958), 35.

Monroe, Walter S. and Max D. Engelhart. "The Effectiveness of Systematic Instruction in Reading Verbal Problems in Arithmetic," The Elementary School Journal, XXXIII, (January, 1933), 183-186.

Moraes, Anna Maria N. de. Docteur en Sciences Pedagogiques, Recherche Psychodrepagogique Sur La Solution Des Problems. Trans. Germaine Starrs. Belgium: University of Louvain, 1954.

National Council of Teachers of Mathematics. Administrative Responsibility for Improving Mathematics Programs. Washington, D.C.: National Council of Teachers of Mathematics, 1965.

National Education Association and National Council of Teachers of Mathematics. Mathematics for the Academically Talented Student in the Secondary School. Washington, D.C.: National Council of Teachers of Mathematics, 1959.

Prescott, Daniel A. Factors That Influence Learning. Pittsburg, Pennsylvania: University of Pittsburgh Press, 1958.

Sachs, Dr. Jerome M. and Florence M. Miller. Mathematics 101 Fundamentals of Mathematics -- Teleclass Study Guide. Chicago: Chicago Public Schools, 1959.

Seidlin, Joseph. A Critical Study of the Teaching of Elementary College Mathematics. Teachers College, Columbia University: Education, No. 482, New York: Teachers College, Columbia University, 1931.

Steinberg, Marvin, Rueben H. Segel, and Harry D. Levine. "Psychological Determinants of Academic Success: A pilot Study," Educational and Psychological Measurement, XXVII, (Summer, 1967), 413-422.

Sueltz, Ben A. "The Role of Evaluation in the Classroom," Evaluation in Mathematics, XXVI, Washington, D.C.: National Council of Teachers of Mathematics, 1961, 7-15.

Thomas, Macklin, "Something About Marking," Illinois Schools Journal, XLVII (Summer, 1967), 83-94.

United States Department of Health, Education, and Welfare Office of Education. Mathematics in Colleges and Universities. Washington, D.C.: United States Government Printing Office, 1965.

United States President's Committee on Education Beyond the High School. Second Report to the President. Washington, D.C.: United States Government Printing Office, July, 1957.

APPENDIX I

WILBUR WRIGHT COLLEGE

DEPARTMENT OF MATHEMATICS

PLACEMENT TEST

Time - 40 minutes

Name.. Section................................ Form.................... Score..........................
Last First

Instructor's Name ....

Directions: Darken the letter which gives the correct answer to the question.

Thus: a ■ c d e (Be sure to darken thoroughly the letter you select).

1. a b c d e	16. a b c d e	31. a b c d e	46. a b c d e
2. a b c d e	17. a b c d e	32. a b c d e	47. a b c d e
3. a b c d e	18. a b c d e	33. a b c d e	48. a b c d e
4. a b c d e	19. a b c d e	34. a b c d e	49. a b c d e
5. a b c d e	20. a b c d e	35. a b c d e	50. a b c d e
6. a b c d e	21. a b c d e	36. a b c d e	51. a b c d e
7. a b c d e	22. a b c d e	37. a b c d e	52. a b c d e
8. a b c d e	23. a b c d e	38. a b c d e	53. a b c d e
9. a b c d e	24. a b c d e	39. a b c d e	54. a b c d e
10. a b c d e	25. a b c d e	40. a b c d e	55. a b c d e
11. a b c d e	26. a b c d e	41. a b c d e	56. a b c d e
12. a b c d e	27. a b c d e	42. a b c d e	57. a b c d e
13. a b c d e	28. a b c d e	43. a b c d e	58. a b c d e
14. a b c d e	29. a b c d e	44. a b c d e	59. a b c d e
15. a b c d e	30. a b c d e	45. a b c d e	60. a b c d e

Placement Test B

1. 91.6 + .85 =

   (a) 100.1
   (b) 92.45
   (c) 91.685
   (d) 9.245
   (e) 10.01

2. Multiply: 543.7
   3.1

   (a) 168.547
   (b) 16854.7
   (c) 1685.47
   (d) 168547
   (e) none of these.

3. 23.5 divided by 100 equals

   (a) 4.25
   (b) 2.35
   (c) 235
   (d) 2350
   (e) .235

4. Five divided by five equals

   (a) 0
   (b) 1
   (c) 5
   (d) 25
   (e) .5

5. 3/4 x 2/3 equals

   (a) 1/2
   (b) 5/12
   (c) 5/7
   (d) 9/8
   (e) none of these.

6. The ratio of two numbers is 5/7. The larger number is 21. The smaller number is

   (a) 16
   (b) 15
   (c) 14
   (d) 12
   (e) none of these.

7. Divide $27\overline{)26.7867}$

   (a) 99.21
   (b) 9.921
   (c) .09921
   (d) .9921
   (e) none of these.

8. A motor makes 35 revolutions per second. The number of revolutions per minute is

   (a) 2100
   (b) 1500
   (c) 35
   (d) 7/12
   (e) none of these.

9. The decimal .02 written as a per cent is

   (a) 20%
   (b) 2%
   (c) .2%
   (d) .02%
   (e) .0002%

10. The average of 7, 14, 20, 8, and 16 is

   (a) 20
   (b) 13
   (c) 14
   (d) 12-3/5
   (e) 11

Placement Test B

11. What fractional part of a yard is 8 inches?

(a) 2/9
(b) 2/3
(c) 1/8
(d) 8/12
(e) 8/3

12. The fraction 3/5 equals

(a) 6%
(b) .6%
(c) 60%
(d) .006%
(e) none of these.

13. 3/4 + 2/3 equals

(a) 5/12
(b) 1/2
(c) 5/7
(d) 1-1/8
(e) 1-5/12

14. The volume in cubic inches of a cube of edge 3 inches is

(a) 3
(b) 9
(c) 10
(d) 27
(e) none of these.

15. 7/8 divided by 3/4 equals

(a) 1-1/16
(b) 1
(c) 21/32
(d) 6/7
(e) 5/6

16. The decimal fraction thirteen thousandths is written

(a) .00013
(b) .0013
(c) .013
(d) 1.3
(e) none of these.

17. Add: $\begin{array}{r} 6a \\ \underline{-2a} \end{array}$

(a) 8a
(b) 12a
(c) -8a
(d) 4a
(e) none of these.

18. $(-2)^3$ equals

(a) -8
(b) -6
(c) 8
(d) 6
(e) none of these.

19. What number added to 6 gives 13? The algebraic statement is

(a) n = 13 + 6
(b) n + 6 = 13
(c) n - 13 = 6
(d) n + 13 = 6
(e) none of these.

20. If $\frac{2}{3}x + 7 = 13$, then x equals

(a) 30
(b) 4
(c) 5-1/3
(d) 9
(e) 6-2/3

21. The quantity -2(x - 1) equals

(a) x - 3
(b) 2x - 2
(c) -2x - 2
(d) -2x + 2
(e) 2x + 2

Placement Test B

22. $(x - 2)\ (x - 2)$ equals

(a) $x^2 - 4$
(b) $x^2 + 4$
(c) $x^2 - 4x + 4$
(d) $x^2 - 4x - 4$
(e) none of these.

23. $(-c)\ (-c)$ equals

(a) $-2c$ (d) $-c^2$
(b) $2c^2$ (e) none of these.
(c) c^2

24. $-2k/k$ equals

(a) -2 (d) $2k$
(b) $-2k$ (e) 2
(c) $-k$

25. $-5x - x$ equals

(a) $5x^2$ (d) $4x$
(b) $6x$ (e) -6
(c) $-6x$

26. $2^2 \times 2^3 \times 2^4$ equals

(a) 8^9 (d) 2^{10}
(b) 2^9 (e) 2^{24}
(c) 2^{14}

27. $(2x^3y)^2$ equals

(a) $8x^5y^2$ (d) $8x^6y$
(b) $4x^6y$ (e) $4x^6y^2$
(c) $4x^5y^2$

28. Multiply $a^6 \times a^2$

(a) a^{12} (d) $2a^8$
(b) a^8 (e) none of these.
(c) $2a^{12}$

29. Multiply $\begin{array}{r} 6d \\ \underline{3d} \end{array}$

(a) $18d$ (d) $9d$
(b) $9d^2$ (e) none of these.
(c) $18d^2$

30. $\dfrac{16x + 4}{4}$ equals

(a) $4x$
(b) $16x$
(c) $4x + 4$
(d) $4x + 1$
(e) $12x$

31. $\dfrac{1}{x} + \dfrac{2}{x}$ equals

(a) $3x$ (d) $3/x$
(b) 2 (e) $2/x^2$
(c) $3/2x$

32. If $d = rt$; t equals

(a) d/r (d) r/d
(b) $d - r$ (e) none of these.
(c) $r - d$

33. $(x + 5)\ (x - 5)$ equals

(a) $x^2 + 25$
(b) $x^2 - 25$
(c) $x^2 - 10x - 25$
(d) $x^2 - 10$
(e) $2x$

Placement Test B

34. If $4x + 2 = 2x + 6$, then

(a) $x = 6$
(b) $x = 4$
(c) $x = 2$
(d) $x = 3/4$
(e) $x = 2/3$

35. If A is twice as old as B, and we let x = B's age now, then the age of A two years ago was

(a) $2x - 2$
(b) $2x + 2$
(c) $x - 2$
(d) $2(x - 2)$
(e) none of these.

36. The equation $2x^2 + 6x - 5 = 0$ is

(a) a quadratic equation
(b) a linear equation
(c) a quadratic formula
(d) the equation of a straight line
(e) a quadratic function.

37. A cube whose edge is 2 inches weighs 1 pound. A cube of the same material whose edge is 4 inches will weigh

(a) 8 pounds
(b) 6 pounds
(c) 5 pounds
(d) 4 pounds
(e) none of these.

38. If - 2 is subtracted from - 14, the result is

(a) 16
(b) -12
(c) -16
(d) + 12
(e) none of these.

39. $\frac{x}{2} + 3$ equals

(a) $\frac{x + 3}{3}$
(b) $\frac{7x}{2}$
(c) $\frac{x + 6}{2}$
(d) $\frac{x + 3}{2}$
(e) none of these.

40. If $y = -x^3 + x^2 - x + 2$, when $x = -2$, y equals

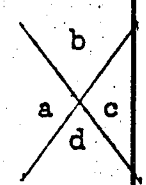
(a) 2
(b) 16
(c) -8
(d) - 12
(e) none of these.

41. If in a circle two chords are equal, than

(a) they must intersect
(b) they are perpendicular
(c) they are parallel
(d) they are equidistant from the center
(e) they cannot meet on the circle.

42. In this figure, angles a and d are

(a) vertical
(b) acute
(c) obtuse
(d) complementary
(e) supplementary



Placement Test B

43. If two triangles have three angles of one equal to three angles of the other, the triangles must be

(a) congruent
(b) obtuse
(c) similar
(d) equilateral
(e) equal in area.

44. Two angles whose sum equals 90° are called

(a) obtuse
(b) adjacent
(c) vertical
(d) complementary
(e) supplementary

45. The right triangle theorem (Pythagorean) states that

(a) $a^2 + b^2 = c^2$

(b) $a + b = c$

(c) $A = bh/2$

(d) $c = a^2 + b^2$

(e) none of these.

46. A secant is a line which

(a) cuts the circle in two points
(b) passes through the center of a circle
(c) cuts the circle in only one point
(d) does not cut the circle
(e) none of these.

47. An angle inscribed in a semi-circle is always

(a) an acute angle
(b) an obtuse angle
(c) a right angle
(d) a straight angle
(e) a reflex angle

48. How far does a point on the rim of a wheel of 10 inch diameter travel in one revolution of the wheel?

(a) 5π
(b) 10π
(c) 25π
(d) 100π
(e) none of these.

49. The angles of a triangle are 40°, 60°, 80°. Then one of the exterior angles equals

(a) 40°
(b) 50°
(c) 70°
(d) 80°
(e) 100°

50. In the given triangle ABC, AD = BD, DE is parallel to BC, and EF is parallel to AB. Then

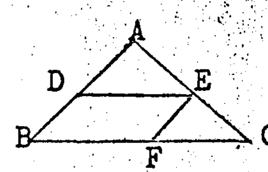
(a) BF = EF

(b) DE = EC

(c) EF = AD

(d) AE = BF

(e) none of these.



Placement Test B

51. Which of the following sets of numbers cannot possibly represent the sides of a triangle?

(a) 2, 4, 7
(b) 4, 5, 6
(c) 17, 28, 30
(d) 3, 4, 5
(e) 5, 12, 13

52. The locus of all points in a plane equidistant from a given line is

(a) two parallel lines
(b) a circle
(c) one line
(d) the perpendicular bisector of the line
(e) none of these.

53. The area of an isosceles triangle whose sides are 13, 13, 10 is

(a) 65
(b) 32-1/2
(c) 60
(d) 30
(e) none of these.

54. The straight line joining the centers of two intersecting circles

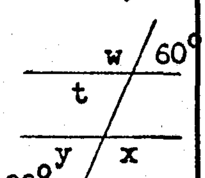
(a) bisects their common chord
(b) is called a secant
(c) equals the difference of their diameters
(d) equals the diameter of the larger circle
(e) equals the sum of their radii.

55. Which of the following has a converse which is true?

(a) If two triangles are congruent, they are also similar.
(b) If two sides of a triangle are equal, the angles opposite the equal sides are equal.
(c) If two triangles have equal bases and equal altitudes, they have equal areas.
(d) If four sides of a quadrilateral are equal, its opposite sides are parallel.
(e) The converse of none of these is true.

56. Given two parallel lines cut by a transversal, then

(a) $x = 120^\circ$
(b) $w = 60^\circ$
(c) $y = 120^\circ$
(d) $t = 30^\circ$
(e) $t + y = 180^\circ$



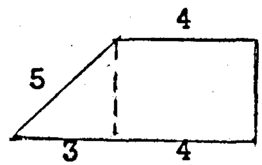
57. The bisectors of two adjacent angles of a parallelogram

(a) are parallel
(b) are perpendicular
(c) are parallel to the diagonals of the parallelogram
(d) cannot intersect
(e) none of these.

Placement Test B

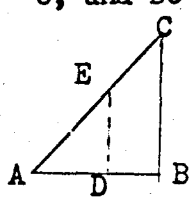
58. The area of the trapezoid in the figure is

(a) 35
(b) 55
(c) 28
(d) 22
(e) none of these.



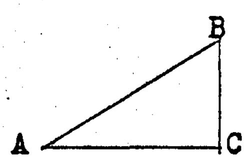
59. In the right triangle ABC, B is a right angle and DE is parallel to BC. If AD = 8, DE = 6, and BC = 9,

(a) 12
(b) 11
(c) 15
(d) 10
(e) none of these.



60. In the right triangle ABC, BC = 2, and angle A = 30°. Side AB equals

(a) $2\sqrt{3}$
(b) $\sqrt{3}$
(c) 6
(d) 5
(e) 4



GRADING

NUMBER CORRECT	PLACEMENT
1-22	Investigate first 16 - if less than 10 of first 16 are correct, place in 89 otherwise 95
23-32	96
33-38	101 if student has credit in 1 year high school algebra and 1 year high school geometry
39-up	103, 104, 111, or 161 if student has credit in $1\frac{1}{2}$ years high school algebra and 1 year high school geometry

APPENDIX II

QUESTIONNAIRE

NAME ____
LAST FIRST MIDDLE

ADDRESS ______________________ PHONE NO. ____________

HIGH SCHOOL FROM WHICH YOU GRADUATED ________________

ADDRESS ____

DATE __________ PERCENTILE RANK ____________________

DATE ENTERED COLLEGE ______________________________

HIGH SCHOOL CURRICULUM ____________________________

SUBJECT YOU LIKED MOST IN HIGH SCHOOL ______________

SUBJECT YOU LIKED LEAST IN HIGH SCHOOL _____________

COLLEGE CURRICULUM ________________________________

HIGH SCHOOL MATHEMATICS COURSES

NAME	GRADE

LAST HIGH SCHOOL MATHEMATICS COURSE ________________

GRADE ________________

COLLEGE MATHEMATICS COURSES PRIOR TO THIS COURSE

NAME	GRADE

FINAL GRADE IN MATHEMATICS 101 ____

FOLLOW-UP COURSE ______________

GRADE ______________

ACT SCORES	RAW	PER
ENG		
MATH		
SOC SCI		
NAT SCI		
COMP		

APPENDIX III

SAMPLE CARD USED FOR ASSEMBLYING DATA TO BE ANALYZED

LAST NAME, FIRST NAME

ACT K HS GRAD. CURRIC.

101 M E NS M C S R MATH DATE

GRADE SCHOOL

S R A KUDER PREFERENCE RECORD, VOCATIONAL — FORM C INTEREST PROFILE

NAME	SEX	AGE	GRADE	GROUP NO.	DATE OF TEST	PROCESS NO.	NORM GROUP
DELAURENTIS JOSEPH	M			001	12/06/65	15560000	ADULT

PERCENTILE SCALE

* STANINE SCORES	VOCATIONAL SCALE	** PCTLE. SCORES
3	OUT-DOOR	07
4	MECHAN-ICAL	20
9	COMPUTA-TIONAL	95
9	SCIEN-TIFIC	99
6	PERSUA-SIVE	56
1	ARTIS-TIC	01
5	LITER-ARY	62
7	MUSICAL	83
6	SOCIAL SERVICE	76
3	CLERICAL	31

V–SCALE

V-SCORE	39

* All Stanine Scores are based on data from employed adults.
** All Percentile Scores are based on the norm group identified at the top right of the profile.

SCIENCE RESEARCH ASSOCIATES, INC., 259 East Erie Street, Chicago, Illinois 60611
Code 7-2903

COUNSELOR'S COPY

S R A **KUDER PREFERENCE RECORD, VOCATIONAL — FORM C INTEREST PROFILE**

NAME	SEX	AGE	GRADE	GROUP NO.	DATE OF TEST	PROCESS NO.	NORM GROUP
EMAS WILLIA R	M	21		001	12/06/65	15560000	ADULT

PERCENTILE SCALE

0 10 20 30 40 50 60 70 80 90 100

* STANINE SCORES	VOCATIONAL SCALE	** PCTLE. SCORES
2	OUTDOOR	05
4	MECHANICAL	12
4	COMPUTATIONAL	15
4	SCIENTIFIC	27
4	PERSUASIVE	36
6	ARTISTIC	77
9	LITERARY	99
7	MUSICAL	83
5	SOCIAL SERVICE	52
3	CLERICAL	31

V—SCALE

28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56

V-SCORE 35

* All Stanine Scores are based on data from employed adults.

** All Percentile Scores are based on the norm group identified at the top right of the profile.

SCIENCE RESEARCH ASSOCIATES, INC., 259 East Erie Street, Chicago, Illinois 60611
Code 7-2903

~~COUNSELOR'S COPY~~

KUDER PREFERENCE RECORD, VOCATIONAL — FORM C INTEREST PROFILE

NAME	SEX	AGE	GRADE	GROUP NO.	DATE OF TEST	PROCESS NO.	NORM GROUP
MELAND JOAN M	F	19		001	12/06/65	15560000	ADULT

PERCENTILE SCALE

* STANINE SCORES	VOCATIONAL SCALE	** PCTLE. SCORES
3	OUTDOOR	20
3	MECHANICAL	40
5	COMPUTATIONAL	54
4	SCIENTIFIC	44
6	PERSUASIVE	85
7	ARTISTIC	74
2	LITERARY	04
3	MUSICAL	08
9	SOCIAL SERVICE	98
5	CLERICAL	44

V–SCALE

V-SCORE	43

* All Stanine Scores are based on data from employed adults.
** All Percentile Scores are based on the norm group identified at the top right of the profile.

SCIENCE RESEARCH ASSOCIATES, INC., 259 East Erie Street, Chicago, Illinois 60611
Code 7-2903

~~COUNSELOR'S COPY~~

70

KUDER PREFERENCE RECORD, VOCATIONAL — FORM C INTEREST PROFILE

NAME	SEX	AGE	GRADE	GROUP NO.	DATE OF TEST	PROCESS NO.	NORM GROUP
SYSLO JACQUELINE L	F	19		001	12/06/65	15560000	ADULT

PERCENTILE SCALE

0 10 20 30 40 50 60 70 80 90 100

* STANINE SCORES	VOCATIONAL SCALE	** PCTLE. SCORES
9	OUT-DOOR	99
2	MECHAN-ICAL	18
7	COMPUTA-TIONAL	87
8	SCIEN-TIFIC	96
3	PERSUA-SIVE	25
5	ARTIS-TIC	42
5	LITER-ARY	39
4	MUSICAL	30
9	SOCIAL SERVICE	93
1	CLERICAL	03

V–SCALE

28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56

V-SCORE	37

* All Stanine Scores are based on data from employed adults.

** All Percentile Scores are based on the norm group identified at the top right of the profile.

SCIENCE RESEARCH ASSOCIATES, INC., 259 East Erie Street, Chicago, Illinois 60611

Code 7-2903

COUNSELOR'S COPY

INTERPRETATION OF SCORES

If the V-score on the profile sheet is not within the range of 38-44, inclusive, there is some reason to doubt the value of the answer.

See which scores are above the 75th percentile. The 75th percentile point was chosen because it is a convenient point which lies between the 1 percent and 5 percent points of significance for normally distributed scores from tests having a reliability of .90.

NUMBER OF HIGH SCORES	
1	Look up the number of the scale in the Job Chart to find the list of suggested occupations
2	Combine the numbers of the two high scales, putting the smaller number first, and look up this "profile index" in the Job Chart to find the list of occupations suggested for consideration
3 or more	If there are three or more high scores, combine the scale numbers into pairs and proceed as in 2
none	Inspect scores above the 65th percentile

APPROVAL SHEET

The dissertation submitted by Florence Margaret Miller, has been read and approved by members of the Department of Education.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Education.

5/2/69
Date

Arthur P O'Mara
Signature of Adviser