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SECONDARY STUDENTS' MATHEMATICS COMPETENCIES IN RELATION TO EMPLOYMENT TESTS.

BY- LANDIS, WILLIAM HARPER
UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES

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THE PURPOSE OF THIS STUDY, A DOCTORAL DISSERTATION, WAS TO DETERMINE IF THERE WAS A MEASURABLE DIFFERENCE OF SUCCESS SHOWN ON THE MATHEMATICS SECTION OF EMPLOYER'S SCREENING TESTS BETWEEN MATCHED GROUPS OF TERMINAL SECONDARY STUDENTS WHO VARIED IN HIGH SCHOOL MATHEMATICS EXPERIENCE. A SAMPLE OF 45 EMPLOYERS, REPRESENTING APPROXIMATELY 35 PERCENT OF THE AVAILABLE ENTRY JOBS IN A 13-COUNTY AREA OF CALIFORNIA, SUPPLIED JOB APPLICANT CARDS FROM WHICH A SAMPLE OF 2,018 TERMINAL SECONDARY STUDENTS WAS SELECTED. GROUPS WITHIN THIS SAMPLE WERE MATCHED ON THE BASIS OF SEX, SOCIOECONOMIC LEVEL, ACADEMIC APTITUDE, READING AND MATHEMATICS ACHIEVEMENT LEVEL, AGE, YEARS OF HIGH SCHOOL, AND SEMESTERS OF MATHEMATICS. CONCLUSIONS INCLUDED--(1) STRUCTURED MATHEMATICS EXPERIENCES WERE SIGNIFICANTLY MORE EFFECTIVE IN PREPARING YOUTH TO PASS EMPLOYER MATHEMATICS TESTS THAN TRADITIONAL, OCCUPATIONAL, OR GENERAL MATHEMATICS EXPERIENCES, (2) TRADITIONAL COLLEGE PREPARATORY MATHEMATICS EXPERIENCES WERE NOT SIGNIFICANTLY MORE EFFECTIVE THAN GENERAL, OCCUPATIONAL, OR NO MATHEMATICS EXPERIENCES, (3) FOR MALES, STRUCTURED MATHEMATICS EXPERIENCES WERE NOT SIGNIFICANTLY MORE EFFECTIVE THAN OCCUPATIONAL MATHEMATICS EXPERIENCES, (4) FOR FEMALES, STRUCTURED MATHEMATICS EXPERIENCES WERE NOT SIGNIFICANTLY MORE EFFECTIVE THAN TRADITIONAL OR NO MATHEMATICS EXPERIENCES. RECOMMENDATIONS CONCERNED (1) ADOPTING STRUCTURED MATHEMATICS AS THE UNIFYING FORMAT OF MATHEMATICS INSTRUCTION IN THE SCHOOLS, (2) IDENTIFYING MATHEMATICS SKILLS USED IN SPECIFIC JOBS IN COMMERCE AND INDUSTRY, AND (3) IMPLEMENTING A FOLLOWUP OF THIS STUDY AND RESEARCH ON EXPERIMENTAL METHODOLOGIES, CORRELATION OF MATHEMATICS INSTRUCTION AND JOB NEEDS, AND EXPERIMENTATION WITH HIRING PROCEDURES TO DIFFERENTIATE BETWEEN TRAINABILITY FOR JOB COMPETENCE AND ACADEMIC ABILITY. (EM)

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William Harper Landis

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

The study of mathematics, historically fragmented into 'subjects' and 'topics', is currently undergoing evolutionary change. A new dimension has been introduced with the 'modern', or structured, mathematics; a coherence in content is developing which implies that the variable in curricula structuring may be time of exposure, not choice of topic.

I. THE PROBLEM

Statement of the Problem. It was the purpose of this study to furnish inductive evidence for the comparison of various types of secondary mathematics experiences, using as the basic criteria, the results scored on employer's screening tests by youth who had not completed college preparatory programs in secondary school. For the purpose of generating clear hypotheses to be tested, the problem was stated as follows:

> Is there a measurable difference of success with employers' screening tests between matched groups of terminal secondary students wherein the variable is their high school mathematics experience?

II. THE IMPORTANCE OF THE STUDY

Traditionally, the goals of secondary education are subsumed under such headings as spiritual and/or intellectual development and education for citizenship. (16:64-65) In an era in which the work of Piaget, Bruner, Suchman, Bloom and many others offer insights into how learning happens, perhaps more specific goals, couched in behavioral terms, should also be identified. Instead of generalizations concerned with "what knowledge is of the most worth", those learnings could be considered which will motivate, will serve the direct ends of the students, will develop socially valuable skills, and will concurrently develop growth toward maturity. (16:24-25) These goals might well form conjunction with the role of the secondary school as Brameld (11:25) sees it; "...the structuring of dynamic teaching-learning situations which develop active learners in whom learning is a conscious and desirable part of living."

Secondary schools are regularly faced with the necessity to make curricular choices available to the student who will not continue his education beyong high school. Among the many questions facing the developer of mathematics curricula are commonly found the following:

1. What mathematics competencies does an individual

need to successfully enter the world of work?

2. What particular mathematics skills and conceptual patterns are pertinent to particular vocations?

3. What are some efficient approaches to the presentation of these mathematics learnings? (94:--)

The general and vocational student commonly becomes a job applicant shortly after leaving high school. To 'successfully enter the world of work' the job applicant is increasingly faced with a screening test employing at least some mathematical items. A comparison of the effectiveness of various secondary mathematics programs, by types (as traditional, college preparatory, structured, occupational and general) seemed possible, as widely disparate high school mathematics experiences are available in the high schools of the thirteen San Francisco bay area counties.

Evidence of effectiveness of certain types of mathematics is of particular pertinence at this time. More than three hundred different mathematics textbooks have been in use in the past five years in the San Francisco bay area counties. With the proliferation of secondary mathematics textbooks and the development of competing series, choices of such textbooks and series must be made by teachers and curriculum designers. Such choices should be made on the basis of empirical evidence; evidence of socio-economic utility, evidence of desired behavioral change and/or new behaviors, and evidence of articulation with the goals of the individual students.

For the college preparatory student, the articulation of high school mathematics courses is evident, as they meet college entrance requirements and satisfy prerequisites for the desired college program. For the remainder of the high school population, limited evidence of articulation exists. Business mathematics and vocational mathematics courses are certainly directly articulated, but such courses are normally evaluated in terms of the related business of technical-industrial courses.

For the non-college bound high school student, program articulation means, at least in part, getting a job. In the spring of 1965, more than eighteen hundred youth were tested by the Federal Civil Service Commission at the San Francisco Naval Facility at Hunter's Point. Their objective was entry into the Electrician's Union Apprenticeship Program. Of the eighteen hundred, only one hundred thirty-three were declared eligible for consideration on the basis of this testing. Testing officers for The Hunter's Point facility are on record as having stated that incompetence in mathematics was a major contributor to this high rate of failure. (97:--) Such results indicated the need for a study in depth into the mathematics experience of the non-college bound high school student; either the criteria were quite unrealistic or these youth labor under a definite academic handicap.

With an increasing number of major employers using screening tests to identify potential employees, particularly in the 'career' jobs (civil service, public utilities, nation-wide industries, and similar employment), it becomes as important to the non-college oriented youth to prepare for successful job entry as it is for the college bound to meet the prerequisites for the college of his choice.

What should secondary programs in mathematics be doing for the vocational and general secondary student? In 1959, the report of the National Council of Teachers of Mathematics' Secondary School Curriculum Committee discussed the needs of all students, vocational, general, and college preparatory, as published in The Mathematics Teacher:

> ...If the mathematics is to have value, it must be ultimately a body of concepts and understandings built into a related system recognized not only as a significant part of our culture but also as providing the individual with a meaningful tool either for solving his problems or for continuing his education in more advanced study of mathematics. The mathematical program for the slow learner thus contains the same basic structure, the same usefulness, and many of the same concepts as it does for the average or fast learner. (50:417)

More specifically, in March, 1964, the Preliminary Report of the Conference on the Low Achiever in Mathematics, said in part:

> ...It is necessary that these children get certain skills from the mathematics courses in the high schools that will make them good risks for employers. The mathematics in the later courses can be directly related to future work experience. (59:5)

In structuring mathematics courses intended to offer the skills-learnings to students that "will make them good risks for employers", a number of difficulties are present: (1) employers have little knowledge of the mathematics skills their employees need and use (a questionnaire-survey sponsored by the Alameda-Contra Costa Industry-Education Council is evidence for this statement) (2) business education teachers are facing a revolution in accounting procedures due to the growth and development of data processing equipment: (3) technical and industrial education teachers are rarely equipped to teach more than the rudiments of the mathematics in their vocational field: and (4) education is charged with the task of preparing youth for vocations and occupations which have not yet been invented.

Inductive approaches require that measures extraneous to the thing being measured be used. A primary, and extraneous, measure of the efficacy of secondary mathematics programs is evidence of the students' ability to "pass" employers' screening tests and thus be considered for employment.

III. DEFINITIONS OF TERMS USED

The following definitions are those of the terms used in a particular sense in this study. Specific definitions relating to statistical treatment, such as populations, et cetera, will be found under "Delimitations of the Study".

Terminal Secondary Student. This student is the youth who has no formal education beyond the twelfth grade, has or has not graduated from high school, did not complete a college preparatory program in high school, and is not academically eligible for matriculation into the California state system of four-year colleges. This definition is not based upon his ability but upon his recorded behavior.

College Preparatory Student. This student is the youth who has completed a program which will allow his matriculation at any of the California state system of four-year colleges. This definition is not based upon his ability but upon his recorded behavior.

Structured Mathematics Programs. Such an approach to mathematics develops the inherent structure through a study of the systems of number as developed from naive set theory. Operational concepts will include the symmetric, the reflexive, the transitive, the associative, the commutative, the distributive, the inverse function, and the identity elements. The concept of limit and of function will be evident. Skills of logical analysis and synthesis leading to patterns for problem solving and computation will be emphasized through challenging the student to develop personal approaches and algorisms. (52:22-27)

Traditional College Preparatory Mathematics Programs. Such programs concentrate on the "how" of solving a developed hierarchy of increasingly difficult problems, with only incidental asides in explanation of the general concepts involved. Quite often the course is identified as a series of 'topics'. Generalizations are incorporated in the text as a series of 'laws', axioms, and postulates, to be memorized. 'Proofs' are commonly limited to parallel derivations of statements.

Occupational Mathematics Programs. The business mathematics, "shop mathematics", bookkeeping, and similar courses necessarily confine the mathematics taught to the specifics of particular occupational fields. Again, the emphasis is on the "how" of computation, with a series of algorithms presented to the student for memorization.

<u>General Mathematics Programs</u>. Some courses so labeled by the schools actually used structured mathematics textbooks and were so identified. The great bulk of such courses recapitulate the same problems and same procedures which have led the student into frustration and failure in preceding grades. The "how-to" work-book, voluminous practice pages approach is very evident in the textbooks used in such classes.

<u>Mathematics Experiences</u>. In-class experience is considered predominantly mathematical in each case where a mathematics textbook is indicated in the <u>October Report</u> (as required by the California State Department of Education). Such class experiences are categorized both as to type and to duration in semesters.

<u>General Academic Achievement</u>. For the purpose of this study, general academic achievement refers only to the reading and mathematics scores of the individual student, as recorded on the standardized tests employed in the California State Testing Program, (1:--) or these same tests as used in district programs for the tenth, eleventh, or twelfth grades. All such scores are reported in stanines in this study.

General Academic Aptitude (Ability or Intelligence Quotient). These data are also based upon the California State Testing Program, (1:--) and are also expressed in stanines.

IV. DELIMITATIONS OF THE STUDY

The Criterion. To compare mathematics competencies of recent high school students, it is first necessary to define the criterion. The ability to score adequately on an employers' screening test was accepted as an extrinsic measure of competency when such tests had sufficient mathematics items to assure that a passing score without such competency is improbable. Treatment of tests and resultant groupings are discussed fully in Chapter III, "Design of the Study". To reduce individual variation to governable limits, data on large numbers of students were required, allowing the drawing of "passing" and "failing" groups in which the remaining variable was their high school mathematics experience.

The Populations Sampled. Two populations were involved in the study: the youth and the employers of the San Francisco Bay Area Counties.

Of all San Francisco Bay Area youth, samples were drawn from the population of youth that were:

1. Job applicants.
2. Born between July 1, 1943, and July 1, 1949.
3. Attended a Greater San Francisco Bay Area high school.
4. Have had no schooling beyond high school.
5. Did not complete a college preparatory program.
6. Graduated or would have graduated in 1962, 1963, 1964, 1965, or 1966.

The employer population consisted of employers who:

1. Employ four hundred or more individuals.
2. Use screening tests in their employment procedures.
3. Have places of work in the thirteen counties comprising the Greater San Francisco Bay Area.
4. Have industries listed in the "Directory of Large Manufacturers". (95:--)
5. Have businesses listed in "A Directory of Major Corporations". (93:--)
6. Have businesses or industries listed in local Chambers-of-Commerce directories.
7. Are governmental units, as city, county, state, or federal installations, meeting criteria one and two above.

The Screening Tests. In considering screening tests as a sample, certain assumptions were necessary. They are; (1) each employers' tests gives an acceptable prognosis of on-the-job success as far as the skills and/or learnings tested are concerned, (2) the mathematics learnings tested are generalized and comparable between tests on the basis of Burns' project (67:--), (3) employment testing programs differentiate on a 'pass-fail' dichotomy between job applicants, (4) items concerned with number ordering, manipulation of geometric figures, and other mathematics skills are properly considered "mathematics items" for the purpose of this study, (5) the tests used by the participating employers are an unbiased sampling of all the commercially produced employment tests, available and purposeful, for testing for low skill job-entry positions.

For the purpose of this study only those tests were usable in which the ratio of the number of mathematics items to the total number of test items exceeded the "cut-off" score-ratio to the total number of items at the 1% level of probability. That is, the probability of a passing score on the total test without some competence in mathematics was to be held at less than one chance in a hundred. The ordering of items in levels of difficulty by the authors of the tests would seem to make this a very conservative procedure with a real probability of success without any mathematics competency of the order of one chance in ten thousand. Where batteries of tests were administered only the mathematics-dominant battery results were reported.

Data Collected. The data collected consist of three major types:

1. On the individual youth:

   a. from the job-applicant card--name, age, sex, passed or failed an employer's screening test, present address, highest grade completed, last high school attended and year, location of school, employed full time before (yes or no);

b. from the cumulative history in the school--academic achievement and aptitude (I.Q.), mathematics experience by semesters and type, parents' occupation, head of the family and/or in-school address.

2. On the employer:

   a. from published sources--number of employees, type of business or industry;

   b. from the employer--personnel practices, number of job-entry positions generally available annually, special problems, concerns, promotional patterns after hiring, special uses made of tests (job assignments, et cetera).

3. On the tests:

   a. standardized--publisher's descriptions, (91:--) correlations between tests encountered, (67:--) ratio of mathematics items to total of items versus ratio of cutting score to total items;

   b. company-made--employer's justification of use, comparison with standardized tests, ratio of mathematics items and ratio of cutting score to total of items.

The Assumptions. The underlying assumptions are: (1) self-identification of a job seeking youth makes him an element of an unbiased sample of all the job seeking youth of the thirteen bay area counties; (2) participation in the study by an employer makes him an element of an unbiased sample of all the major employers in the thirteen bay area counties; (3) the methods used by the California State Department of Education in determining percentile equivalents for all state mandated tests makes the scores of such tests directly comparable; (4) the in-school home address of students allows the matching of students on a socio-economic scale; (5) "Head of Household" occupation allows the matching of students on a socio-economic scale; (6) course title and the related textbook title and description furnish enough information to allow identification of a mathematics course as "traditional", "occupational", "general", or "structured"; (7) any sixty-day period for the administration of the job-applicant cards by an employer is enough like any other sixty-day period so that no bias is introduced by this procedure; and (8) including job applicant cards from job entry screening tests which are administered quarterly or bi-annually does not introduce biased elements into the sample of job-seeking youth.

Hypotheses. The following hypotheses have been tested (null hypotheses format):

1. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is structured mathematics versus traditional college preparatory mathematics.

2. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is structured mathematics versus occupational mathematics.

3. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is structured mathematics versus general mathematics.

4. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is traditional college preparatory mathematics versus general mathematics.

5. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is structured mathematics versus no mathematics.

6. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is traditional mathematics versus occupational mathematics.

7. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is traditional mathematics versus no mathematics.

Type of Study. While this is a descriptive study, it relies heavily upon techniques usually employed in an analytic study. It is hoped that the relationships and correlations described here will soon be reflected in the needed action research. As McGrath says:

> ...the data derived in descriptive research can be meaningful and helpful in diagnosing a situation or in proposing a new and better program. Descriptive can thus be referred to as the preparation stage for action research. (30:78)

V. ORGANIZATION OF THE STUDY

The structure of this study is based upon the major divisions essential to a descriptive study; The Problem, the Review of the Literature, the Design of the Study, the Findings, and the Summary, Conclusions, and

<u>Recommendations</u>, followed by the <u>Bibliography</u> and the <u>Appendices</u>.

In Chapter I, the problem under investigation has been described. The setting and the importance of the study have been summarized and a definitive statement of the problem has been made. Delimitations have been set and terms defined. The organization of the study has been described.

Chapter II reviews the related research and the pertinent literature from the fields of mathematics, vocational education, vocational guidance, and the development of secondary curricula. More complete criteria for inclusion are in section one of Chapter II.

Chapter III specifies the particulars of the design. The area sampled is described both geographically and demographically. The groups studied are examined and characteristics and/or data pertinent to the study listed, with the justifications for the inclusion of each group. Screening procedures encountered are discussed. The statistical procedures used are described, explained, and justified, as is the tabular organization of the findings.

Chapter IV reports the findings pertinent to the question under examination and the hypotheses being tested. Most of the tabular data is described in this chapter.

Chapter V restates the problem, the procedures, and the findings in summation, with the conclusions delimited to the import of the hypotheses.

This study employs a selected bibliography, not in the sense that there is a tremendous amount of pertinent material, but due to the effect of interrelating many areas; public and private employment, public and private schools, and the fields of psychology, sociology, and mathematics, to name but a few involved. Personal interviews quoted in the study are listed in the bibliography as a matter of convenience.

The appendices contain facsimiles of the materials employed in the initial survey, demographic information on the area, and tables of data which are referred to in several separate places.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter contains reviews of the related research and the pertinent literature from the fields of mathematics, vocational guidance, vocational education, and the development of secondary curricula. It is organized with these divisions; (1) introduction to the pertinent literature, (2) history of the problem, (3) present status of the problem, (4) recent studies, and (5) the chapter summary.

I. INTRODUCTION TO THE PERTINENT LITERATURE

For the developers of secondary curricula, a fundamental problem remains, "What mathematics experiences, if any, should be available to terminal secondary students?" Mathematics learnings appear to be a crucial need for intelligent living in a technological society; "...mathematics is a subject of great humanistic value; its importance to the educated man is almost as great as its importance to many technical specialists." (54:9)

Criteria For Inclusion. The problem has been examined to determine these criteria for inclusion; (1) how youth become employed, (2) what employers expect of him, and (3) the rationale, or lack of one, for non-college oriented mathematics programs in secondary schools.

In addition, certain references for the specifics of the study design, the statistical treatment of data, and other formalized procedures were included.

Development of Sources. The materials cited in this study were identified by the following activities:

A. A comprehensive survey of the Education Index beginning with the July, 1959, edition. Headings surveyed were: (1) "Mathematical Ability", "Mathematics (Aims and Objectives, Correlation with other Subjects, Courses of Study, Curriculum, Projects, Evaluation, Research)", and "Mathematics, Applied"; (2) "Vocational Education"; (3) "Vocational Guidance"; (4) "Curriculum (Vocational Schools, Differentiation, Evaluation, Theories and Principals)"; (96:--)

B. References listed and cited in key publications, committee reports, and current periodicals; and

C. A survey of the Dissertation Abstracts since 1950, under the headings of "Education; Theory and Practice", and "Mathematics". (92:--)

II. HISTORY OF THE PROBLEM

> From the very earliest period in which the American people sensed their uniqueness, the principal theme of their educational history has been the search for a school which in its scope, program, organization, and administration might best support and advance their most cherished ideals. (53:23)

As this search has progressed, school men have been aware of the need to specify. Kimball Wiles expresses it succintly; "From an image of the desired, it is necessary to develop the specifics of implementation." (39:108) He further states that: "Present institutions are products of the past. To understand their nature, structure, and intended function it is necessary to know the decisions that have determined their development." (39:2)

To place existing mathematics programs in historical perspective, two delineations are used; (1) the changes in the ways in which youth has become employed and so a part of the adult world, and (2) the development of secondary mathematics programs.

<u>Changing Patterns in the Employment of Youth</u>. For the first three hundred years of our existence as a people, there has been a shortage of labor. With the exception of periodic depressions, any man in good health desirous

of working could find some occupation commensurate with his ability. In colonial times and during the early westward movement, young people were a decided economic asset. The simple technologies of the period, as subsistence farming, handicrafts, and animal husbandry, required little formal training.

Agricultural skills were learned by young people by working with and emulating their elders. The embryonic artisan, generally indentured, was trained by the artisan, merchant, or land holder holding his indenture. The artisan commonly worked for the consumer of his product, with only the most general of products produced in volume for the casual purchaser. (31:6)

A transitional period which saw large numbers of laboring people move from agricultural to industrial work is commonly identified as the years from 1840 through 1890. By 1890 almost thirty per cent of the total work force was involved in commercial and manufacturing enterprises. Throughout this period, most of the specific training, (in number knowledge as well as the job skills) was still accomplished on the job, whether identified as an apprentice program or not. (31:53)

At the turn of the century, young people were still an economic asset to a nation whose frontiers, interior and exterior, demanded great supplies of unskilled man-power. However, in the words of Rayback,

> The modern era of the history of American labor, which began about 1890, is a period of ever-growing domination by the machine. When the era began the machine already had a commanding position in the major industries of the nation... Among the basic industries iron and steel were essentially machine produced. Bridge building, shipbuilding, the manufacture of iron pipe and steel wire had become mechanized. Lathes, planes, drilling machines, grinding machines, trip hammers, and hydroelectric presses had taken over the foundries. Copper refining and the production of virgin aluminum, lead, zinc, silver, and cement had largely become machine processed. Among the consumer goods industries, meat packing, by virtue of refrigeration, had become a factory enterprise. The cereal, brewing, distilling, and sugar industries were carried on in factories... Cotton, woolen, and silk textiles were almost totally mechanized; machines had invaded the clothing industry. The manufacture of bathroom fixtures, furniture, stoves, and hardware was done by machines. Office equipment, [fire] arms, papermaking, and printing had become factory enterprises. (31:197-198)

In the nineteen twenties, systems of apprenticeship still offered limited opportunity to youth in a variety of job-entry patterns. During the thirties, the Civilian Conservation Corp and National Youth Authority did much to develop general skills fundamental to wage-earning employment, and, until the full employment of World War II, furnished a large number of our youth with meaningful work. The fifteen million plus who were unemployed at the height of those depression years did not contain a disproportionate number of youth. (22:42)

Starting from the highly mechanized basic industries of the early nineteen hundreds, these United States have entered the technological age. In the foreseeable future, automation, forced upon all production by free competition, will necessarily further up-grade all jobs. To brief Venn; "...as a technological economy expands, the largest increase in jobs will occur in occupations that require the most education and training...there are ...four million unfilled jobs in the country today." (37:18-19) The competition for the academically capable youth is evident in any 'help wanted' section of a metropolitan newspaper. At the same time the unskilled and little skilled jobs are disappearing. As an example, the untrained and little trained in agricultural workers dropped from 9.5 million in 1940 to 3.9 million in 1965. There was a several-fold increase in volume of agricultural products for the same period. (6:216)

Since the advent of Sputnik, a new characteristic in employment practices has become evident. With the ultra-sophistication of space age hardware and military materiel, a shortage of scientists, technicians and generally capable manpower has received broad publicity. The validity of these claims is questioned by Ginzberg on the basis of his eight-year study of human resources;

he states that the apparent shortage of engineers and scientists is probably due to their dated preparation or their inefficient use by their employers. At the height of the hue-and-cry, this country had over 600,000 engineers. (22:129)

Despite Ginzberg's and others' remarks, attacks on public education began, indirectly influencing the employability of youth. Major employers more and more used screening test results as a criteria for employment. Such procedures drew heavily upon the military's experience in World War II with the Army General Classification Tests. (23:97) The fact that two and three-fourths millions of youths were rejected for military service prepared employers to think of this sizable group as 'unemployable'. (22:9)

It is pointed out by Super and Crites that most testing used in personnel screening is comprised of materials dealing with "...group differences and relationship to success in training, rather than with success in an occupation [authors' emphasis]". (35:44-45) This is explained by Super and Crites as caused by the difficulties inherent in generating a large enough sample for longitudinal study for validating tests predictive of occupational success in a period of high mobility of labor, rapid automation, and with great variance in job description interpretation. (35:44-45) An examination of test materials in common use (see Appendix F for listings) indicates much emphasis upon the ability to read and to comprehend printed instructions.

Despite the commonly held opinion that an untrained youth can be turned into a productive element in an industrial complex within six weeks, it is becoming more economical to develop machinery to perform these simple tasks. The age of automation is having a serious effect upon the employability of the untrained. In a conference called by the National Educational Association in 1962, Spears had the following comments:

> It is hard to trace the exact effect upon occupational opportunities. However, it has been generally accepted that the chain reaction in the displacement of workers results obviously in fewer positions for beginning workers, since workers who have been employed for some time are generally taken care of first. Consequently, the problem of limited work opportunities for youth is apparent...In California it is now easier for high school graduates to get into college than it is to get into a job...There is no substitute for a specific skill or ability in securing a position in todays' highly specialized economy." (58:57-58)

In assessing current patterns in the employment of youth, one of the more evident characteristics is the mobility mentioned in connection with validation of tests. Youthful workers are mobile in the sense that as many as fifty per cent of a given youth sample find their first jobs in a county other than that in which they live. It is questionable if this is a conscious series of moves for economic betterment or simply that "...young people entering the labor market are...floundering around in a new world for which they are ill prepared and for which they have made few plans." (27:297)

Grant Venn describes the situation in these words:

> In a recent year more than 8,000,000 different workers changed jobs...job changes among younger workers...is two and one half times more frequent than among older workers. Young workers who have no skill to offer prospective employers, especially those in the unskilled and semi skilled categories, are the most susceptible to lay-offs and firing. Many are in "wrong" or frustratingly low level jobs and quit for economic and psychological reasons. (37:130)

In summary, youth have evolved from an economic asset during the colonial, frontier and agricultural growth periods to a present-day status of "lease usable" worker. American production has a parallel evolution in which the constant increase in the sophistication of production has required an ever increasing level of competence for production workers. Customary job-entry and low-skill jobs are rapidly being automated out of existence. There is a definite set of criteria for employment operating against the drop-out and the high school graduate with limited academic aptitude. In an era when tremendous needs exist to accomplish the world's work the young person seventeen to twenty-five years of age must rely upon intense training to instill in him some skill to offer to a technological society.

<u>The Development of Secondary Mathematics Programs</u>. The history of mathematics is the story of man's effort to discover order in diversity. The history of how these learnings have been passed on from generation to generation shows little use of the type of thinking mathematics is expected to develop.

The early Sumerian, Babylonian and Egyptian schools trained the priests for bureaucratic positions in their governments. Arithmetic and simple geometric mensuration were basic to their all-important bookkeeping. The dialectic of Socrates prepared the Greeks for the Platonic Schools of Philosophy, in which latter, the study of music, number, geometry, and astronomy were thought basic to philosophical studies. The Romans eventually combined these with the existing schools of rhetoric and the seven liberal arts of medieval times were born: the quadrivium (arithmetic, geometry, astronomy, and music) and the trivium (grammar, rhetoric and logic). (16:4-9)

In medieval times, only arithmetic maintained some semblence of the content taught in the Greek and Roman schools. All else had been reduced to trivia or dropped from the curriculum. With the renaissance, the formalized medieval Latin learning was exchanged for a functional curriculum in the court schools of the period. A combination of discovered works of the 'ancients' and great strides made by contemporary mathematicians made the mathematics of the court schools both rigorous and meaningful. (16:4-9)

As had happened with each break-through in organized education lesser men eventually rigidly formalized the structure, dropping the meaningful (and thought-provoking) subjects and emphasizing that content most amenable to rote learning. The result was the Ciceronian school:

> The formalized Ciceronian Latin Grammar School was the secondary school that the Puritans brought with them from England. From its very inception, this school, like all the other humanist schools, was essentially aristocratic. Its sole purpose was to prepare boys for college entrance. Because the college entrance requirements, to take those of Harvard for example, were the ability to read Cicero extemporé, to make and speak true Latin in prose and verse, and to decline paradigms of Greek nouns and verbs, the masters of the Latin grammar schools tended to limit themselves to these studies. (16:10)

The Latin grammar schools flourished for over a century as the major route to the college: the original Boston Latin Grammar School celebrated its tricentennial a generation ago. (28:391) The seven to fifteen year old sons of the well-to-do suffered through the Ciceronian methodology, not because of any innate worth of content, but because, in the words of Brubacher, "Relatively few families could afford this sort of education for their boys; therefore, worthless as they thought it was in content, they valued its rarity as a badge of class distinction." (13:425)

The church dominated Latin grammar schools were in turn supplanted by newer institutions. The demand of the colonists for a practical education for leadership led to the Grammar School of the City of New York in 1732, which included mathematics and navigation in its course offerings. The concept of the Academy, voiced and pushed by Benjamin Franklin, resulted in the Philadelphia Academy of 1751. (36:7-9)

The Academy offered the best of the Latin grammar school, the study of the classics, but also offered the sciences, art, and vocational business (bookkeeping). While not church dominated, these schools were much influenced by various denominations. (33:190)

The humanist tradition still prevailed in the Academies, and, with the Jacksonian era, the real separation of church and state and the public funding of secondary education was emphasized. Again in Boston, the

Public High School was begun in 1821 for boys only. Referred to as the English High School, it soon led to a Girls Public High School in 1826. It also led to the Massachusetts Law of 1827, requiring every town of 500 to support a high school in which U. S. History, Mathematics, Bookkeeping and Surveying should be taught. Additional subjects were required if the town had over 4,000 population. (36:16-17) In 1837 the complete separation of church and public schools was begun when Horace Mann forbade any use of sectarian texts in the schools. (33:190)

In the years 1830 through 1850 there were more than 6,000 academies east of the Mississippi. Academies for girls were quite common. (36:7-9) During this same period, the public high schools expanded in number very slowly; there were only about forty such schools in the nation before the Civil War. In the next forty years, however, the public high school came into its majority. By 1897-1898, there were 5,315 such schools, with 17,941 teachers and 449,600 students. (33:5) In this same period, the number of academies dropped to about 1200. The rapid growth of the public high school appears to have been fostered by a post-civil war psychology, the establishment of the U. S. Bureau of Education in 1867, and the establishment of a legal rationale for public tax support, as in the Kalamazoo decision in 1872. (36:19)

The great diversity of program in these high schools may not be commonly realized. Due to the tremendous impact of the Committee of Ten report, (9:--) it is generally accepted that the role of the high school prior to 1900, was preparation for college. This may have been over-emphasized, for, of the 449,600 students mentioned above, only 14.02 per cent were college preparatory, and of high school graduates only forty per cent of the males and twenty-five per cent of the females were college preparatory. It must be noted, in this connection, that of 1,487 institutions preparing teachers, 507 were public high schools. (33:7) On the basis of these figures it can also be pointed out that the secondary schools of the period had a "drop-out" rate of 53.64 per cent. Further, the colleges differed greatly as to the proper lines of college preparation. The afore-mentioned diversity of high school programs posed one of the most serious educational problems of the nineties. In 1891, The National Education Association appointed a committee consisting of five college presidents, a college professor, three secondary school principals, and the United States Commissioner of Education, to search for guidance.

Chaired by Harvard's president, Charles W. Eliot, this was the "Committee of Ten" which reported in 1893. (36:25)

In furnishing a general pattern for high school curricula, the much critized report of the Committee of Ten undoubtedly simplified the problem of whom to accept for college and up-graded the general course offerings of both the high schools and colleges. This first truly national meeting of educators did have its positive side. In the opinion of Cremin "...The report itself is a model of clarity and...entirely self-consistent...a statement which summed up with impressive coherence the best of the generation which had preceded it." (53:7-9) Of more pertinence to this study and the terminal secondary student was the Committee's concept of the role of the secondary school:

> The secondary school is viewed as an institution designed to prepare a small segment of American youth "for the duties of life" [sic] by improving their intellectual abilities...the studies were made equivalent...to teach a young person to think was to teach him to think, whether he strengthened his mind on the materials of languages, the humanities, or the sciences. And so to strengthen his mind was the best possible preparation for life. Close articulation between secondary school and college...was...all to the good...the secondary school was to remain...a downward extension of the college. In the words of the day, it was to be truly the university of the people. (53:7-9)

The highly influential Committee on College

Entrance Requirements of 1895 reinforced the idea that the dominant function of the secondary school was to furnish a college preparatory program. (36:25) The Committee of Ten report was accepted overwhelmingly and in the next decade most American secondary schools had moved into line behind its proposals. At the same time, this was a period in which political, economic and social changes were of such magnitude as to occasion new and different demands on the high schools.

> Industrialism, immigration, the rise of political reform, and a new philosophical concept...namely, that man, through his rational powers, could master the laws of nature and thereby achieve for himself a life of goodness and plenty on this earth...[this] thesis very obviously bestowed a tremendously important role on education...therefore to supply universal education was a primary function of any beneficent state administered in the interests of its citizens. (53:15)

These and like concepts culminated in the second national conference called by the National Education Association, the Commission of the Reorganization of Secondary Education, intended to "...embrace, coordinate, and review the work of...a dozen...committees...[each] studying the reorganization of a single high school subject". (53:20) Five years of intense effort resulted in a landmark report, the Cardinal Principles of Secondary Education:

> The purpose of democratic education is to "develop in each individual the knowledge, interests, ideals, habits, and powers whereby he will find

> his place and use that place to shape both himself and society toward ever nobler ends." To give this proposition meaning, it is necessary to analyze the life activities of the average individual in a democratic society. The results of such analysis yield seven primary educational objectives: health, command of fundamental processes, worthy home membership, vocation, citizenship, worthy use of leisure, and ethical character ...How can the secondary school do this? By so reorganizing the offering in each of the subject areas and by so arranging the activities of the school that growth on the part of the individual students in health, command of fundamental processes, and so forth will be facilitated. (53:21)

This publication brought this period to a close and ushered in the modern high school. It also set the tenor of subsequent content area specialists' meetings.

In the fourteenth yearbook of the National Council of Teachers of Mathematics, Ivan Turner refers to the 1923 National Committee on the Teaching of Mathematics. He paraphrases their recommendations as follows:

> ...plane demonstrative geometry, algebra, solid geometry, trigonometry, elementary statistics, elementary calculus, history and biography, and additional elective subjects, such as shop mathematics, surveying and navigation should be taught in the schools. (61:71)

The inclusion of the elective subjects, particularly shop mathematics, is one of the earlier references in this century to mathematics programs intended to meet the needs of the terminal secondary student. Mr. Turner goes on to say that a survey made ten years later (1933) indicated that these recommendations had had no practical impact on secondary programs. In 1939, nearly all secondary schools still limited the mathematics curricula to the college preparatory prerequisites. (61:71)

Turner indicates that from 1909 until 1934, the high school students taking algebra in the ninth grade dropped from 40.15 per cent to 30.41 per cent. He uses these figures to illustrate the lessening of interest in algebra. (61:71) The Statistical Abstract of the United States for 1965 shows a growth in grades nine through twelve and post graduate of 4.8 million to 7 million in the years 1930 through 1940. (6:106) This could simply indicate an increase in the ratio of terminal secondary students to the total school population.

In direct parallel, the fifteenth yearbook of the NCTM has a very thorough 'grade placement chart' developed from an analysis of mathematical needs. These needs are discussed under three headings; (1) for ordinary life, (2) for leadership and higher culture, and (3) for specialized use as a vocational tool. The only vocation referred to specifically is that of skilled mechanic. They are expected to have;

> ...facility in dealing with formulae and graphs that involve positive and negative numbers, square roots, quadratic and simultaneous equations sines, logarithms, very large and very small numbers, occasional interpolation to seconds; knowledge of many geometric facts needed in working with triangles, and experience in analysis;

> an extensive mathematics vocabulary and ability to read technical books and articles. (60:212-213)

The above quote in this context is not intended as a disparagement of the work of the joint committee, the Mathematics Association of America and the National Council of Teachers of Mathematics. It is evidence of the limited consideration of the needs of the terminal secondary student.

In 1940, a special committee prepared a statement on work as part of the curriculum for the American Youth Commission of the American Council on Education. It was suggested also that reading as a subject of instruction should be included in the secondary curriculum. It was further pointed out that:

> ...most secondary schools include in the ninth grade a course in algebra and in the tenth grade a course in demonstrative geometry, which, for want of alternatives, becomes a required course for most pupils...The failure in both of them is so high that they discourage no small number of young people from continuing in school... Resistance to reorganization comes from teachers who have specialized in mathematics, from parents who think of the present courses as having sanctions that cannot be questioned, and from all those who are afraid that modification of the present curriculum will break down the standards which have been built up since ancient times. (62:15-18)

In the Sixteenth Yearbook of the National Council of Teachers of Mathematics, the visceral awareness of many teachers of an unmet need is shown by the title, "Arithmetic in General Education". "Arithmetic", at least up until 1960 and the publication of the NCTM's twenty-fifth yearbook, is the euphemism used to refer to the mathematics taught in the elementary school. (55:2-4) However, in the Sixteenth Yearbook, Benz suggested an arithmetic course for the secondary schools. He cites four general types of material: (1) applied arithmetic, emphasizing computation, information or both; (2) arithmetic as a science, as an integral part of mathematics, as a system of ideas; (3) the everyday applications of number science to meet certain needs of daily living; and (4) that which would be now classified as enrichment topics, which Benz includes "because of their interest value". (51:122)

To paraphrase Clark, Klein and Burks; since 1954, high school enrollment in mathematics has been increasing, except for general mathematics and solid geometry. In the ninth grade, the increase in algebra enrollment has been at the expense of the general mathematics course. As late as 1958, ninth grade general mathematics courses were available in only 70.5 per cent of the public secondary schools. On the same basis, elementary algebra was available in 98.5 per cent, plane geometry in 94.4 per cent, and intermediate or advanced algebra was available in 90.3 per cent of the public secondary schools. Nationally, the college-preparatory sequence still retained essentially the same structure as defined by the Committee of Ten at the beginning of this century. (16:268-270)

Kinsella's comprehensive summation of the U. S. Office of Education report on offerings and enrollments in high school mathematics substantiates the findings of Clark, Klein, and Burks. Kinsella points out that about forty per cent of the ninth grade students were enrolled in general mathematics classes. He also repeats the startling fact that one third of the high schools require all students to take algebra - which may account for the thirty per cent of the schools which do not offer general mathematics to ninth grade students. He sums up this 1953 report thusly:

> ...accounting for a very small percentage of the total enrollment in mathematics courses, were high school arithmetic, college algebra, tenth- or eleventh-grade general mathematics, mathematics review, and consumer mathematics...Except for college algebra, these miscellaneous courses were, in most cases, chosen by those whose previous mathematical achievement has been substandard or whose plans for future schooling had not yet "jelled" [sic]. (25:2-3)

In summary then, it appears that the 'extension downward of the college' concept still dominates the general secondary school program. Those responsible for the development of secondary mathematics courses have shown greatest concern, as evidenced by the course offerings up until 1958, with those mathematics courses which best prepare the student for just one activity; further study of mathematics.

III. PRESENT STATUS OF THE PROBLEM

Emerging Concepts of Need. The current literature seems predominantly concerned with the needs of the college preparatory student and, for want of a better term, remedial programs. In examining the question, "What, if any, mathematics experiences should be available to the terminal secondary student," the dearth of research in general mathematics sets definite limits. If experience eventually 'proves' that mathematics is a truly homogeneous structure, then Kinsella's quoted "less of the same for the mathematically less able" may indeed be the correct approach. (25:102) However, Kinsella also points out that a nation-wide group of mathematicians, concerned about the above assumption states:

> "Yet to offer such subjects to all students as could interest only the small minority...is wasteful and amounts to ignoring the needs of ....society as a whole". (25:189)

This underlines a problem basic to any decision by curriculum people; what are the mathematics needs of society as a whole? Kinsella summarizes thus:

> What does seem essential [to all students in a time of great technological change] is the ability

> to adjust to change, and to be able to learn how to learn...it is of primary importance to have acquired some basic mathematical concepts and skills. Furthermore, it is necessary that one learns how to learn new mathematics, not necessarily modern mathematics...an important problem is to determine what is the most valuable high school mathematics program for those who are not college-capable...[keeping in mind that] high school education must take into account more than occupational needs. (25:189)

While Allendoerfer (41:690-695) characterizes the Cambridge Report as an example of the present euphoria contingent upon the apparent success of newer approaches in mathematics, the fact is that the Cambridge Report is a position paper of a representative group of present-day leaders in these mathematics developments. They have drawn a blue-print of goals for mathematics in the public schools which may set the tone for this field for the remainder of this century. It ambitiously places all mathematics now learned through grade fifteen in the first twelve grades, ending with these excerpts from the description of the Second Proposal for Grades Eleven and Twelve:

> These two years are to be spent developing further the material in calculus, probability, and differential equations...[including these topics:] (1) Limits of functions...(3) Mean Value Theorem and its consequences...(4) Define the definite integral as a limit of a sum...(5) Study the logarithmic and exponential functions...(6)... Taylor Series...(8) linear differentiation...(13) Boundary value problems and orthogonal functions. Preliminary work with Fourier series...(54:65-66)

This, of course, is built on a nearly total restructuring of mathematics in the elementary school, despite the existence of series that are quite modern in the accepted sense: see Deans, Kane, McMeen and Oesterle, Modern Mathematics Series, as an example. (90:--) Their critique of 'arithmetic' and traditional methodology (which is often the only experiences of the terminal secondary student) is as follows:

> Lest there be any misunderstanding concerning our viewpoint, let it be stated that reasonable proficiency in arithmetic calculation and algebraic manipulation is essential to the study of mathematics...such skill need not rest on methodical drill. We believe that entirely adequate technical practice can be woven into the acquisition of new concepts. But our belief goes farther. It is not merely that adequate practice can [sic] be given along with more mathematics; we believe that this is the only truly effective way to impart technical skills. Pages of drill sums and repetitious "real-life" [sic] problems have less than no merit; they impede the learning process. We believe that arithmetic as it has been taught in grade schools until quite recently has such a meagre intellectual content that the oft-noted reaction against the subject is not an unfortunate rebellion against a difficult subject, but a perfectly proper response to a preoccupation with triviality. (54:8)

While in general commending the Cambridge report, Allendoerfer points out that a 1963 report (1962 data) of the College Entrance Examination Board indicated that, of 181 schools reporting the use of SMSG materials, the majority of them used these materials at one grade level only; most frequently the ninth. These schools were a select sample which normally sent a reasonable sample to the College Board Mathematics Tests. They would be expected to employ the most recently developed materials almost exclusively, if the Cambridge Report can expect massive implementation. Additional data indicated this was far from the case. Allendoerfer went on to say that in his contacts with many schools he felt little change had occurred for any except the very top students. (41:691-692)

Allendoerfer voices three basic objections to the Cambridge Report. In his words:

> My first objection...is that this is a program for the super-elite and that it is misleading to suppose that it can be adopted widely throughout the nation in any foreseeable period...My second objection is that the report is very vague when it describes exactly what is to happen in the elementary school...the program for the elementary school which is outlined in this report can be offered only to the most gifted young people... My third objection is that the report completely ignores the very substantial problem of what mathematics should be taught to the lower seven-eighths of the ability group, and in particular to the lower third...here the mathematics community is in serious trouble. These are the children who...would grow up to take unskilled jobs, but these jobs are disappearing. These children include the culturally deprived and those who are likely to be the poor of the next generation...in spite of some attention to them by the NCTM and the SMSG, their problems have not been seriously faced. If the Cambridge Report is to be taken as the blue-print for curriculum reform in the next decades, these children will continue to be neglected, and this is something that we just cannot let happen. (41:692-693)

Allendoerfer goes on to say that the real revolution in mathematics must be based upon how young people learn mathematics, with special emphasis upon the development of intuition. This intuition seems to be almost a pre-verbal sensing of the rightness of relationships. He says "...it is here that children vary widely in their rate of growth. The most 'brilliant' [sic] see things in a flash; with the slower ones we give up and have them memorize." (41:694) He suggests an interim step putting much more emphasis upon remedial work in arithmetic in the high schools with a cross-discipline team of high school and college mathematicians working with psychologists and sociologists in a major, large-scale effort. (41:694-695)

Despite Allendoerfer's critique, the Cambridge Report does offer guidelines for a broad restructuring of mathematics and does not avoid concern with methodology. The Report has this to say in this context:

> It will be recalled that a basic strategy of our courses in grades K through six [sic] is to produce arithmetical skill as a side effect of the study of mathematical ideas. The problems... should also furnish the student with good reasons for wanting to know the answers...extensive use may be made of "discovery exercises" in the sense of Beberman and of "discovery problems" in a still more ambitious sense...The difficulty of teaching heterogeneous classes may be reduced if less able students do routine problems on the basis of ideas and techniques that have been taught to them, while the brilliant students discover...most of the mathematics for themselves ...Our hope would be to convey continually to

> the student that every mathematical idea appeared first as the solution of some problem by some person. (54:28-29)

It is pointed out in the report that a general pattern of "pre-mathematics" is to precede and introduce each topic, "to be followed later by as much formal study as may be appropriate." They go on to state that much manipulative realia must be available to the student so that he has some "intrinsic criterion for deciding the correctness of answers, without recourse to authority". (54:35) This implies a close relationship between the mathematics studied and its use.

In line with these emerging concepts is Vincent J. Glennon's call for synthesis of content and methodology in the study of mathematics. He points out that intelligent concern for the guidance of psychologists and those involved with the cultural foundations (as philosophy, sociology, cultural anthropology, and similar fields) will increase the probability that our learners learn. He sees a history of swinging from sociological to psychological to logical and back again in the structuring of mathematics curricula, and a parallel vacillation in methodology: expository versus discovery versus psychotherapy. He asks that "full, honest reports of the findings [of the extremists be reported] to the community of mathematics educators" and states flatly that negative results of some experimentation goes unreported, despite the importance of "knowing what does not work as well as what works". (47:134-141) He summarizes his position in the following paragraph:

> To my way of thinking...this is the synthesis in our model for research and development of improved mathematics education -- integration of the thesis of content [sic] with the antithesis of method [sic] to form a higher union, a synthesis in mathematical education. To achieve this synthesis in our time will require a sustained effort of such an order of magnitude as to dwarf our best efforts to date. (47:141)

In summary, it does seem that awareness of the need for meaningful mathematics programs for the terminal secondary student is growing. In the 1959-1961 Education Index, 61.40 per cent of the headings in this survey were concerned with the gifted. No titles were listed for terminal secondary students. The 1964-1965 volume shows interest in the gifted has dropped to 50 per cent, with 16.67 per cent of the titles concerned with the educationally disadvantaged. (96:--) The statements of Allendoerfer, Glennon, and the distinguished group involved in the Cambridge Report all indicate that the general mathematics curricula will receive increasing attention.

IV. RECENT STUDIES

Recent Secondary Curricular Patterns In General Mathematics Education. Experimentation reported seems to be variations on these four approaches: (1) tracking, as an awareness of need dictates; (2) time modules, or other variations from the class "period"; (3) Schools-within-a-school to deter or alleviate student alienation; and (4) the non-graded approach to emphasize learning and not 'passing' as the goal of education.

Within these newer formats as well as in the 'traditional', mathematics curricula for the senior high school are experiencing change and criticism.

Holland I. Payne sums up one aspect of change:

> Today mathematics must be taught as a communication skill. Pupils must learn to: (1) communicate ideas in ordinary English; (2) communicate their ideas in a language of mathematics when applicable and (3) argue forcefully and validly in defense of their position. Mathematics has become more than the mere working of problems and arriving at answers. Now, one must know not only "how" but "why" to support the answers arrived at. (49:27)

Payne goes on to say that job forecasts for 1970 imply that 80 per cent of the desirable jobs will be mathematically oriented. "Thus, somehow better mathematics must be taught to more students so that most of our high school graduates become mathematically fluent and confident." (49:27)

Clark, Klein, and Burks summarize a major difficulty facing a positive change in general mathematics curricula:

> Frequently the criterion is: college bound, algebra; not college bound; general mathematics ...many mathematics teachers consider themselves disfavored if they are assigned general mathematics classes. The general opinion seems to be that general mathematics is for pupils of low ability, and therefore, teaching it cannot be a joy. (16:262-263)

Too often, general mathematics courses are offered for two reasons only; to give pupils a year of remedial arithmetic or to provide review work and exploratory work which will prepare the pupils for algebra. (16:262-263)

In the "spiral mathematics program", at the Pueblo High School, Tucson, Arizona, cited by the above authors as an exemplary program, "pupils who do not take the spiral mathematics program can substitute one year of Mathematics I and II, which includes remedial arithmetic and basic mathematics, and a senior course entitled 'consumer mathematics' [sic]". (16:271)

Again, it appears that even exemplary programs are strongly oriented to the one-ness of meaningful mathematics curricula. Yet Clark, Klein, and Burks also cite an experiment with junior high school students in a depressed socio-economic area of New York City. Pupils retarded at least two years in their mathematics achievement scores and with intelligence quotients between seventy and eighty, were taught statistical concepts and the language of sets. The results were all positive: these students learned and displayed "radical changes in attitude." Pupils became alert who had been passive and class cutting dropped. Follow-up testing showed good retention of learnings. (16:265)

With the criticisms and pressures following October 4, 1957, (Sputnik) the search for excellence in education has led to an increased "rigor" in secondary school offerings, with, in the words of Harl R. Douglass:

> ...more and more secondary schools...[requiring] at least two years of some sort of science, two years of mathematics, and three years of social studies beyond the eighth grade. This has necessitated a development of at least two "tracks" [sic]...to provide for groups of students with different academic capabilities and interests. (18:24)

To make these "tracks" meaningful, all levels of ability are necessarily considered:

> In some schools, as at [the] Alhambra and Fresno, California high schools, a special curriculum has been developed for the least able students. Through the eleventh grade, these students are taught academic subjects in special sections with specially prepared teachers. (18:51-52)

Regardless of cause, Lucien B. Kinney sees the multiple tracks as designed for the three groups of students that were identified by the Post-War Commission of the NCTM in 1949:

> ...These include (1) those pupils that need mathematics for home, community, and business pursuits primarily; (2) future leaders in fields other than technical; and (3) future technical specialists. (24:449)

Elicker pointedly emphasizes the desire of professional educators to assure a higher quality of education for all. He further states that realizing these goals:

> ...centers more on the quality of instruction than on any other factor in the total process of education. The professional personnel... [have] been frequently frustrated in [their] efforts by [their] own limited degree of competence and by the multitude of school assignments and responsibilities. Their daily assignments have not allowed for the freedom of action to do effectively the most important of all their professional responsibilities - teaching youth. (20:116)

In an effort to deal with the present day class loads, various arrangements of class meetings have been tried. Elicker cites as an example, the Euclid High School, Euclid, Ohio, in which the 352-minute day is divided into sixteen modules of twenty-two minutes each, with no passing time and just one module for lunch. All regular classes have three modules daily; remedial classes have two modules; advanced classes have three; and industrial arts and home economics in the ninth grade have four modules daily. (20:159)

It has also been a matter of concern that the impersonal atmosphere of the modern large high school seems to alienate a large number of youth. If a greater sense of participation, of identity with the school and its function existed, it is hypothesized that the pupil would be more self-directing and so make the role of the teacher more fruitful. Elicker gives examples of efforts in these directions; the Newton, Massachusetts, plan and the plan in the Elmont, New York, Central High School District Number Two. Both of these plans are essentially the school-within-a-school concept, with the former consisting of two senior high schools divided into 'houses' with individual house masters, and the latter a simple grouping resulting in three schools within the total junior high school. Each of these sub-units is a heterogeneous grouping of students with all facilities of the total school available to faculty and students. (20:160-161)

The Newton, Massachusetts plan also includes a "nongraded" school, the Hamilton Junior High School. B. Frank Brown, principal of the first nongraded high school in this country, Melbourne High School, also lists as nongraded the Brigham Young University Laboratory School, Middletown, in Newport, Rhode Island, and the high school in Borrego, California. Brown describes this last as a system which "may abandon both the words 'non-graded' and 'school'...calling its curriculum 'The Borrego Plan For Individual Learning'. (12:33-34)

Charles R. Keller, Director, The John Hay Fellows Program, sums up the impact of the nongraded approach in the forward to Brown's book: "Education becomes release, quest, and discovery, rather than restraint, regurgitation, and rote memory...[it is] education by appointment ...with the opportunity for students to progress at their own speed." (12:8) Brown says that "a nongraded secondary program is essential if every student entering high school is to be challenged to work meaningfully at, and eventually beyond, his own achievement level." (12:199)

In 1951 William Betz succintly summarized the problem which still faces curriculum specialists in mathematics. He spoke of three approaches to the development of mathematics curriculum. The first was the "life situation" approach, which, he said, has failed because it has tried to wed chaotic life situations to the system of ideas which is mathematics. The second approach (which is receiving tremendous emphasis at this time) was the reliance upon authority, upon experts in the field. He believed this latter approach would "end in dust-gathering syllabi." Despite the very real impact of SMSG and the UICSM materials upon secondary mathematics programs, his third postulate is extremely pertinent:

> There remains a third approach, often explored partially, but never with anything like scientific completeness or thoroughness. It is that of making a really dependable, full-length study of the role of mathematics in the modern world, from both a practical and a cultural standpoint. (32:442)

Until such massive research as Betz described produces a general format, it is questionable how productive these curricular innovations can be.

<u>Recent Secondary Curricular Patterns in Occupational Education</u>. Vocational education has received somewhat limited attention from the 'academic' community. Yet in 1944, the National Association of Secondary School Principals adopted and released the following statement:

> It is not the job of the schools....merely to supply industry with minimum skilled workers, but far more important is the responsibility for:
>
> 1. Meeting <u>all</u> youth needs, including society's needs for competent citizens, thus assisting youth to develop their full capacities [sic].
>
> 2. Giving a free worker in a free country a reserve of skills and knowledge to enable him to advance more rapidly than he would if he were only able to perform a single type job or had competence in only a narrow range of skills.

The Purposes of Vocational Education...

1. A youth, to be a successful worker, must have mastered the basic skills of his occupation and as much of the related scientific and technical knowledge as possible. Besides knowing how to do the job assigned to him, he should also know the markets for the products he produces.

2. He should have had experience in productive work under conditions of regular employment, where he can learn the requirements of work.

3. He should know the requirements for entering the occupation in which he is interested - such as education, health, apprentice training, union membership, experience - and should know how to go about getting a job in it, using the public employment service, labor unions, or personnel offices of employers.

4. He should understand the function of management and labor organizations, the relations between them, and the availability of the different services they offer - labor union purposes and operations, authority and duties of management and supervisors, collective bargaining, seniority systems, credit unions, group hospitalization.

5. He should understand the relations of the government to his occupation - federal and state laws affecting unemployment compensation, social security, old age insurance, employer's liability.

6. He should know how his chosen industry, business, service, or profession operates as a whole, and its place in the life of the city, predictions for the future, and world conditions affecting it.

7. He should know how to use the public services available to him after he leaves full-time school - placement, advanced training, recreation, health. (57:51-52)

Twenty-three years later we can only add that he should be prepared to change from a major occupation cluster to other major occupation clusters and be psychologically prepared to accept and benefit from such training as will make these changes possible.

> In a recent year more than eight million different workers changed jobs. In that same year there were 11.5 million job changes, two-thirds of which were to a completely different industry, one-half to a completely different occupational category. (37:130)

Is there evidence that these guidelines are in fact being observed? The revolt of large segments of young people, evidenced by the up-surge in juvenile crime and general alienation has caused an awareness of specific needs. Burchill states:

> Work-study education is an accepted method of helping alienated young people to achieve satisfactory adjustment during adolescence. Curriculums based on academic preparation and supervised work experience can satisfy...needs for recognition...Identification with work may provide many youngsters with an avenue for recognizing their approaching maturity with its concomitant responsibilities. The maturation process may be enhanced by appropriate personal and education-vocational preparation. (14:11)

Tanner also emphasized the obligation of public education in this area:

> In recent years, certain critics have argued that the high schools should limit their curricula to the so-called essentials of [the] academic type of courses. Some of these critics are more concerned with the goal of reducing educational

> expenditures by eliminating the expensive vocational programs. But it is indeed poor economy to have huge numbers of youth leaving high school each year in search of jobs for which they are unqualified. And nothing can be more devastating to an adolescent than the inability to find productive work and the hopeless feeling of rejection encountered by the unemployed. (36:378)

In general, vocational programs in the five conventional areas meet the requirements for federal funding. Venn points out that in an era when the technological impact on our society requires new approaches, even the on-going programs are rarely up-dated. He suggests that fewer than 5 per cent of our high school students complete a preparation for an occupation. (37:83)

Despite evidence of bias in the academic community Tanner makes a good case for occupational education in the comprehensive high school:

> In this way, students enrolled in vocational programs are not segregated from those enrolled in college-preparatory, general, and commercial programs of study. In the comprehensive high school, all students regardless of special interests or vocational plans, are able to pursue a common general education curriculum and participate in common school activities. (36:361)

Considering the 'common learnings" question in Secondary Education, leads Kimball Wiles to state a different concept of vocational education:

> <u>Courses used by a student to prepare for an occupation should be considered vocational education</u> [sic]. The difficulty has arisen when

> attempts have been made to classify courses on the basis of jobs rather than student goals. Training programs for a few occupation in agriculture, business, and industry have been prepared, and these have been designated as vocational. What about the thousands of other jobs that American youth will enter? They, too, are vocations...(39:123)

Such a definition, if widely accepted, would clarify the role of the comprehensive high school. As Wiles says:

> A number of high school faculties have created difficulties for themselves and their students by confusing general with vocational education. They have made the mistake of assuming that a course required for college entrance has a general education value and, operating on this false assumption, have required that all students consider the college entrance pre-requisites as general education. (39:123)

John S. McCauley of the U. S. Department of Labor emphasizes the extent to which industry is training and educating its workers. As an example he describes the educational operation of the Ford Motor Company which:

> ...has established a broad range of programs... maintained to develop craftsmen, technicians, engineers, supervisors, and even managers. (29:92)

McCauley sums up the findings of a survey team who studied the educational programs of the nation's 500 largest corporations:

> ...they concluded that [they] are making a significant contribution to the development of their employees' careers...the bigger companies

> ...provide general programs - those which Dr. Henry David...termed education rather than training. (29:98)

Nationally, the Vocational Education Act of 1963, Public Law 88-210, has had high impact on research, ancillary services, and, particularly, the redefinition of Vocational Education. The emphasis is upon training for gainful employment, and the rather rigid vocational categories spelled out in this and all preceding legislation may be interpreted broadly: "...And, to all intents and purposes, it makes it possible for the States to break down the categories altogether." (10:23)

Programs are proliferating, with three existant formats of seeming importance. These may be characterized as the comprehensive high school, the comprehensive district, and the special, separate installation. None of these are new, but there is innovation within the pattern.

The comprehensive high school does little in occupations per se, except in very large high schools as in Berkeley, California. Where the single school is large enough, the traditional shops (auto, wood, print, and machine shop) may be augmented with offerings in electronics, photography, data processing skills as in computor programming, and other modern courses. (91:--)

The comprehensive district may use its facilities to develop a fairly complete program with one occupations cluster at each high school, allowing a broad complex of offerings. This approach allows the student to remain identified with his high school for his general education and participation in school activities. (89:--)

With massive vocational education funding becoming available, the technical center is again being developed. In California, Regional Occupation Centers (see Chapter 14, Division 6, Education Code 7450 through 7456) are contemplated and some are now in being. The intent of the legislature is to "provide qualified students with the opportunity to attend a technical school and enroll in a vocational or technical training program, regardless of their residence in a county or region..." (E.C. 7450) Such a complex is soon to be in operation in the San Jose City Unified School District and will serve not only this district but four surrounding secondary districts. Joseph C. Bellinger, Director of Vocational Education for the San Jose City Unified School District, in a personal interview stated that such a complex must offer terminal, pre-technical, and pre-vocational programs, cooperating closely with employers, unions, junior colleges, and technical and four year institutions to meet the occupational plans of their students. (102:--)

Preparation for their role in the adult world must give more than passing concern to occupations as presently defined. As Grant Venn sees it:

> The need can only be met within the education system, and society will insist that the job be done there. Decisions are going to be made. But whether these decisions will be made by educators acting within a consensus that this is a legitimate and necessary form of education for our time or by legislators reacting to societal pressures to get a job done is still an open question. (37:72)

Recent Mathematics Experimentation. In the Review of Educational Research for June, 1961, the three-year compilation of research in Natural Sciences and Mathematics, Kellogg and Johnson summarize the period from 1957 through 1960. They categorize this period as a time of ferment, with a variety of experiments with new curricula, and emphasize that the work for the immediate future would necessarily be involved with evaluation of the newer materials and approaches. A close reading indicates that the emphasis is entirely on the above average or brilliant mathematics student, with the exception of one laboratory-geometry course for the non-college bound student. (48:272-276)

William R. Blank surveyed twelfth year mathematics courses, and identified those commonly acceptable by colleges for advanced placement. It is interesting to note that analytical geometry and calculus are readily accepted for advanced placement, while combination courses or even four-year series of the "un-traditional" are rarely considered. (42:208-211)

In 1964 Dessart pointed out the difficulty of evaluation of mathematics curricula due to the "inadequacy of their measuring instruments. Individual value judgements had to be made by the researchers...often the objectives of the course or topics were not adequately measured by such [standardized] instruments." (43:299) Research completed during 1960 through 1963 suggested that additional research should be undertaken to fulfill a listed number of purposes. Among them were the following of pertinence to this study:

(a) A careful delineation of an agreement concerning the objectives of mathematics instruction for all secondary school students;

(e) Development and refinement of instruments to measure achievement and various psychological variables;

(h) Realization of increased degree of coordination of research in order that limited, isolated studies can become a part of a larger, more exhaustive research program. (43:302)

Concern of the National Council of Teachers of Mathematics and the Mathematical Association of America for realistic goals is well expressed by Allen's suggested "Forum for Mathematical Education". He indicates exemplary efforts and programs are opening new lines of endeavor, such as "Project Idaho", in which twenty-three high school teachers were trained in new approaches to structured mathematics and in turn trained some 600 plus elementary teachers. This type of information is not readily available to the teaching community, and results in much duplication of effort. He suggests the Forum would provide for the interchange of information among groups concerned with curriculum revision in mathematics at levels from kindergarten through graduate classes in universities. (40:370-378)

In an article purportedly concerned with facilities for secondary mathematics instruction, J. S. Frame actually asks that the teachers of mathematics prepare to enter the twentieth century. He indicates the limited use of the great variation in facilities recent technology has made available. Efficient use of such devices as over-head projectors, computing rooms, and a host of less well-known media might inherently contain answers to instructional problems. (45:379-391).

Fremont and Ehrenberg report a pertinent research in their work with low achievers. Using methodology similar to that employed with average and above students in the "Mathematics Through Science", project of the

SMSG, but with low achievers, some interesting results were achieved. A general mathematics class for low achievers worked with physical equipment, such as springs, rollers, and similar impedimentia, to derive linear equations and thus learn algebraic operations. They voice an intriguing conclusion:

> ...The same students who were able to generalize patterns in a given set of data still could not cope with examples involving fundamental processes. Surprising as it may seem, the time may be upon us to recognize, assent, and act upon the notion that skill in carrying out fundamental operations and ability in mathematics may not be one and the same thing! [sic] The work with these general mathematics students seems to indicate a fallacy in this identification of skill with ability, and to show that standardized tests, as they are now constructed, fail to measure aptitude for mathematics...there may well be a tremendous reserve of children with natural ability in mathematics...It would seem that, under proper conditions, mathematics thinking is natural to most of our students. It is, perhaps, the forcing of unnatural patterns of thought upon our students that has resulted in their eventual loss to us and to mathematics. (46:554-556)

Dessart reports that the work of Barnes and Asher shows that the "single best predictor of success [in algebra] was the eighth grade mathematics' grade, and ...[next, but of much less impact] was the grade equivalent of an arithmetic achievement test". (43:307) This appears to tie in nicely with the supposition of Fremont and Ehrenberg, above.

Reported concern with the average and low achiever in mathematics occurs most often in the junior high school grades. Working with seventh and eighth grade students, Easterday "blended" structured mathematics with the traditional. He found that:

> ...Such a program may be effective in increasing a low-achievers' grade level in mathematics as much as three years...the basic principle of the non-graded elementary can be applied effectively to low achievers in the secondary school." (44:462-468)

Thirteen major groups working in the development of mathematics curricula are described in the Report of the International Clearinghouse. (56:--) Of these, only four have reported any involvement of terminal secondary students. Suppes, reporting for his "Computer-Based Mathematics Instruction (CBMI)", says that "In February, 1966, remedial mathematics drills were given by teletype to over forty students at an East Palo Alto high school." (56:123) The School Mathematics Study Group has developed and is distributing material for the average ability student, particularly for the 25th through 75th percentile. These publications are "Introduction to Secondary Mathematics", and "Introduction to Algebra". (56:208-209) Howard F. Fehr is just beginning a project titled "Secondary School Mathematics Curriculum Improvement Study" whose purpose is to "create a unified global program of mathematics instruction for the grades seven through twelve". (56:251) Ryan's report on the "Effects of Modern and Conventional Mathematics Curricula on Pupil Attitudes, Interests, and Perception of Proficiency" for ninth grade pupils was to be "completed by May, 1967". (56:254)

Pertinent Dissertations. The numbers in parentheses refer to the dissertation precis in the Bibliography.

A survey of the dissertation abstracts from 1960 through 1965 discloses few studies concerned with mathematics education. Although there is a gradual increase in numbers, all secondary studies are concerned solely with college preparatory mathematics. In recent years, the outstanding dissertations are simply adjuncts to the major experimentation in the field. Ziebarth (88:--), Shuff (81:--), and Williams (86:--) are all concerned with a comparison of SMSG materials with traditional, for the seventh grade through the twelfth. In each of these studies, the population sampled was restricted to bright and gifted youth.

Dixon (70:--) examined the SMSG teacher manuals in an effort to identify an underlying philosophy. His findings indicate the philosophy can be categorized as pragmatic in the Deweyan sense: his examination of "inductive approaches" in comparison with "discovery procedures" results in a statement which may do much to offset the attack on structured mathematics as of too precise a nature for the less-than-brilliant student.

An examination of methodology pertinent to the newer approaches in mathematics education was attempted by Fremont (72:--), Sayles (80:--), and Thomson (82:--). Fremont structured a year-long comparison of plane geometry classes in which a teacher used group (traditional) approaches with one class and individualized instruction with another, wherein the student planned his work, his rate of work, and determined test readiness. The conclusions reached by Fremont indicate that neither methodology or content are as definitive in developing "desirable attitudes toward mathematics" as is effective teaching. (72:88) Sayles attempted the identification and re-orientation of the college-capable underachiever; he had positive results on the basis of team teaching and excellent guidance for the individual students. Thomson, while working in Social Studies for twelfth grade students, did study an area of pertinence to this study: flexible grouping of students with a team of teachers possessing a variety of specialties and employing a variety of teaching aids and audio-visual equipment. His findings were that this sort of team effort resulted in far superior student attitude and participation. Even here, the evaluative devices available imposed a delimitation on replicative results.

Babcock (66:--) contacted all guidance-counselors in New York State in large senior high schools (except for New York City) in a study of occupational guidance for terminal secondary students. He found that the original emphasis upon vocational guidance has shifted to educational guidance. Up-to-date occupational information is needed as is an up-grading of the teaching of "job-getting" skills. (66:99-102)

Examination of the dissertation abstracts for the four month period July through October, 1966, indicates a definite upsurge in doctoral studies in the field of mathematics education. The eighteen dissertations listed in this field have been grouped for clarity.

Williams (87:--) studied the pre-service and in-service mathematics preparation for the teaching of mathematical arithmetic by elementary teachers. His findings indicate unacceptable levels of achievement for teachers on his criteria. Frank W. Recker (77:--) surveyed the familiarity of Ohio teachers with experimental and reformed programs in mathematics. He also sampled their attitude towards teaching machines, programmed texts and the use of programs for additional mathematics training. He found little awareness or involvement.

An examination of the new programs in the elementary schools was made by Ashlock and Unkel. Robert B. Ashlock (65:--) developed a test which would measure pupil understanding of selected properties of a number system with relatively high validity and reliability and is apparently suitable for use with first and second grade students. Esther Ruth Unkel (83:--) studied the inter-action of socio-economic groups and sex factors with the discrepancy between anticipated achievement and actual achievement in elementary school mathematics. The analysis of variance showed significant differences in the discrepancies scores between socio-economic groups at the .001 level.

Madden, Neil and El-Naggar looked at junior high school mathematics from three quite different perspectives. El-Naggar (71:--) compared programs in Egypt and the United States to identify the status of modern mathematics programs. Modern mathematics programs were found to be either essential or desirable. Madden (75:--) experimented with class size with junior high students of general mathematics. His findings indicate that class size is a very minor factor in levels of student accomplishment. Neill (76:--) was concerned with the effect of teacher attributes upon the achievements and variance of pupil performance. The teachers' academic preparation registered the greatest effect, but all teacher attributes were minimal compared to pupil characteristics.

In those dissertations concerned with senior high school mathematics, of six such studies, five were concerned with the college preparatory student. Roberts (78:--) compared reinforcement theory and Gestalt theory and found there was meaningful opportunity for their application in both SMSG and UICSM. Rollins (79:--) compared three stratagems for teaching mathematical concepts and generalizations by guided discovery. No difference was found between the three inductive stratagems: agreement, difference, and joint agreement and difference. Clark (69:--) compared the achievement of SMSG algebra students and modern algebra students who had had one year of general mathematics plus one year of modern algebra. The SMSG students had had the two year SMSG algebra course. No statistical difference was discovered between group test results.

Ackerson (63:--) studied the relationship between achievement in PSSC physics and experience in recently developed courses in mathematics. He discovered a tendency of students with SMSG experience to achieve better than those with traditional mathematics. It was also shown that the higher the level of SMSG completed, the higher the tendency to achieve. Geiss (73:--) ran an analysis of relationships between courses taken in high school and success on the college level. He found no difference between those students who had taken algebra, geometry, and trigonometry in high school and those who had any other combination of mathematics classes. The kind of mathematics preparation had no relation to success in a technical college.

Wiebe (85:--) examined the comparative effects of three methods of utilizing programmed mathematics materials with low achievers. His findings indicate that teacher instruction is superior to programmed instruction for both low-verbal, low-quantitative males and females, and low-general intelligence females.

Carrino (68:--) identified ten attributes associated with early leaving (or "dropping out" of school) from 1958 through 1963. Follow-up indicated these attributes would allow early identification of potential drop-outs: low scholastic ranks, social problems, retention, parents' academic level, and, the higher the number of absences in the first three grades the earlier the tendency to withdraw.

Hungerman (74:--) studied the achievement and attitude of sixth grade pupils in conventional and contemporary mathematics programs. Her conclusions indicate that Dessart's identification of evaluative criteria is well taken: the conventional groups did better than the contemporary mathematics groups in conventional tests. The contemporary group achieved superior on seven of ten items on a contemporary test. Attitudes seemed less a function of the type of mathematics program than might have been expected from the findings of other research.

Vontress (84:--) showed experimentally that set or attitude of the subjects affected test scores more than surrounding conditions. He did this by testing two groups of Negro students in an environment of taped noise, telling one group that taped noise would increase their number of correct responses and telling the second group it would decrease the number of correct responses. They performed on the basis of suggestion, not of actual environment.

Adler (64:--) completed a study of the identification and development of giftedness in Jewish and Negro ethnic groups. The socio-economic background emphasizing worth of academic giftedness was a measurably major factor in individuals being so identified and, hence, receiving 'development'.

V. SUMMARY

This chapter contains reviews of the literature and research pertinent to the question "what mathematics experiences, if any, should be available to terminal secondary students?" In analyzing these materials in the perspective of the basic problem studied, certain areas of agreement and of disagreement were encountered. The following statements should serve to place this study in its proper context.

<u>Areas of Agreement</u>.

1. Mathematics learnings appear to be a crucial need for intelligent living in a technological society, inclusive of, but going well beyond, the importance of mathematics to technical specialists.

2. Nationally, young people who are not academically inclined, who are not readily 'trainable' in the industrial sense, suffer a decided disadvantage, economically.

3. A major goal of mathematics education in the public schools seems to be the learning of more mathematics.

4. Increasing concern for the 'general mathematics' student is now becoming evident.

5. Almost all measurable change in mathematics programs has occurred in programs for the bright, the gifted, and the college-capable youth.

<u>Areas of Conflicting Opinion</u>.

1. A basic problem exists in mathematics education. Is structured mathematics the proper mathematics for all students? If the answer is 'yes', then how can this approach be so implemented as to make it available to the slow and average student? If the answer is 'no', the problem then remains to devise a 'general mathematics' which is considerably more meaningful and inherently more motivating.

2. The increasing importance of the role of mathematics in a technological society implies that educators must be projecting the content needs of mathematics education for all students well into the twenty-first century. This area is more a matter of the degree of concern than of conflict.

CHAPTER III

THE DESIGN OF THE STUDY

This chapter contains the specifics of the study design. It includes descriptions of the geographic and demographic areas studied, the various populations sampled, the procedures employed for the collection of the data, the data collected, and the statistical treatment of the data. These specifics are intended to furnish the rationale for the choice of this study design.

This study grouped job applicants who had recently been terminal secondary school students, graduates and non-graduates, on the basis of; (a) their individual characteristics, (b) their success with employer's screening tests, (c) their academic aptitude and achievement, and (d) their socio-economic background. This grouping was for the purpose of comparing the efficacy of their secondary mathematics experiences by types.

I. THE AREA SAMPLED

Geographic Description. The thirteen counties involved in this study constitute an interrelated megalopolis. The counties are Alameda, Contra Costa, Marin, Napa, Sacramento, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma, and Yolo. The San Joaquin, American, and Sacramento Rivers join and form a series of bays and straits. Suisan Bay, San Pablo Bay, San Francisco Bay, and the navigable portion of the rivers listed above have historically furnished major trade routes which today are paralleled by freeways and railway services. The many ports, such as San Francisco, Oakland, Vallejo, Richmond, and those of numerous oil complexes, make the area a transshipment point of world importance. The relative ease of access to both inland and overseas markets has resulted in an industrial and business complex definitely characterized by the interrelatedness of its parts. The interrelationships are so evident that a recently formed Association of Bay Area Governments is increasingly recognized as the logical arbiter of the numerous intercity problems. Reference is made to Appendix A, a map of the region.

The coastal range, with several mountain peaks of over three thousand feet elevation, surrounding the bays and extending as far as fifty miles inland, gives a pleasant relief to the topography of the region. The normally frost free and generally salubrious climate assures a stable work force in this area and allows a near-total use of all industrial installations.

Demographic Description. Much of the data are available only as reported for Standard Metropolitan Statistical Areas. These SMSA's are: the San Francisco-Oakland SMSA, which includes the counties of Alameda, Contra Costa, Marin, Solano, San Francisco, and San Mateo; the San Jose SMSA, which includes the counties of Santa Clara and Santa Cruz; the Sacramento SMSA, which includes the counties of Sacramento and Yolo; and the Stockton area, not reported as an SMSA, but containing the major concentration of business and industry in San Joaquin County. As parts of Napa and Sonoma Counties are reported in the San Francisco-Oakland SMSA, these counties are included. Additional data listed by counties is reported. Reference is made to Appendices B, C, and D.

Appendix B relates the laboring force in this study to that of California and the United States. In 1964, the wage and salary workers in this area comprised 26.18% of the total of such workers in California, and accounted for 2.72% of all such workers in the United States in that year (2:66). This indicates that this area contains major employers as described under "Delimitations of the Study" in a sample representative of the state of California as a whole, and reasonably representative of such metropolitan complexes nationally. The extent of the area chosen is logical when the extreme mobility of these workers is considered. As shown in Appendix B, as many as 50% of the workers are employed outside their county of residence, with up to 15% employed outside the SMSA which includes their county.

Again, as shown in Appendix C, the distribution of wage and salary workers in the various job categories is not unlike that for the state. Some 78.7% of the adjusted gross income goes to wages and salaries, and this ratio is closely paralleled in the counties in this study. Consumer price indices indicate a spread of less than two-tenths of one per cent for California's SMSA's. (2:184)

The educational levels by counties are reported in Appendix D. The approximate numbers of youth of an age bracketed by the delimitations are indicated; these numbers are extensions from data and are approximations. The youth in the area studied are about 30% of those in this age group state wide. These 421,000 plus young people may be grouped as follows: 114,500 are full time students (1:161); 81,000 are full time wage earners (6:217); about 100,000 are married women who compete in the job market with limited enthusiasm (1:59); 33,000 are identified unemployed who have been employed before (1:81); 7,440 are active apprentices (1:106); 2,420 are in Man Power Development and Training programs (1:107);

the remaining 83,000, plus the 33,000 unemployed and an indeterminant number of married women, are job seekers. These 120,000 (minimum) young people compete for the 70,000 jobs which become available in this area annually. (1:159)

Summary. The rather extensive area studied is justified for the following reasons: (a) samples should be drawn which are representative of the State of California; (b) a large population is needed if random selection is to result in groups capable of being matched on a reasonable number of characteristics; and (c) only such a broad area contains enough major employers to assure a representative sampling of screening procedures for employment.

II. THE POPULATIONS SAMPLED

Major Employers. The employer population consisted of those employers who employ four hundred or more individuals, have places of work in the thirteen counties described above, are listed in the "Directory of Large Manufacturers" (95:--) or "A Directory of Major Corporations" (93:--) or are major governmental units meeting the above criteria.

This study was concerned with the above population because;

(a) only employers with substantial numbers of employees have a great enough turn-over of workers to screen representative numbers of young people;

(b) only such employers find it economical to employ testing devices and keep comprehensive personnel records;

(c) only such employers are able to perform studies to validate their testing programs.

Reference is made to Appendix E, a descriptive listing of participating employers.

Job-Seeking Youth. This population consisted of those youth who were born between July 1, 1943, and July 1, 1949, attended a high school in the defined area, have had no schooling beyond high school, did not complete a college preparatory program in high school, graduated, or would have graduated, in 1963, 1964, 1965, or 1966, and were job-seekers.

This study was concerned with the above population because:

(a) this age group brackets the School Mathematics Study Group (SMSG) experimentation in this area and so furnished a reasonable sample of individuals with structured mathematics in their high school experience;

(b) a survey indicated that approximately 40% of all job seekers were in this group and so this group would furnish large enough samples of those having had the various types of mathematics experience to furnish "matches' to test the hypotheses;

(c) this population offered a direct entry into an understanding of the limitations on opportunity affecting those particularly handicapped by depressed socio-economic factors.

<u>The Screening Tests</u>. The tests used by participating employers fell into two groups, commercially prepared tests and company manufactured tests. The commercially prepared tests were rather limited in number of titles. They were grouped as single purpose, general tests with a mixture of items, and, test batteries, in which items were grouped by type. In the latter case, only mathematics batteries were reported.

For the general tests, a probability formula which relates the possibility of exceeding certain scores to the ratio of mathematics items to the total number of items was applied. The formula is $1-(1-p)^n$, and the Nomogram for the calculations in Burington and May was used. (15:285) Reference to Appendix F is made. For each of the general tests the probability of exceeding the passing score without involving the mathematics items is given. Correlations of the various commercial tests as reported by Burns (67:--) are also listed.

In each case where company made tests were involved it was possible to isolate the mathematics section, either as a separate battery, or by special scoring procedures. These tests are also listed and the manner of reporting results indicated.

This study was concerned with these screening tests because:

(a) when properly validated on mathematics content, they can be used as one criteria to evaluate the mathematics competencies of job-seeking youth;

(b) such tests have been developed with a different orientation and for differing purposes than have similar mathematics batteries and/or test items in the secondary schools; (17:1-5)

(c) such tests furnish a pragmatic insight into the mathematics skills and abilities thought to be important in business and industry. (21:4-5)

III. SAMPLE-GENERATING PROCEDURES

Employer Participation. With the sponsorship of the Contra Costa County Superintendent of Schools Office and the endorsement of the Northern California Industry-Education Council, 212 major employers were contacted by mail. The package contained a brief of this study, a stamped, self-addressed response card, and a sample of the job-applicant card. The employers' response card requested the following information: (a) personnel contact person, (b) whether or not tests were used as a criteria for employment, (c) whether tests could be examined, (d) whether they could allow job applicants to fill out the data card, and (e) the approximate number of applicants screened in a sixty-day period. On the basis of the personnel contact identification, further information concerning the firm was developed, either by telephone or in conference. Additional contacts were made with governmental hiring units, all 'civil service' in structure. A reasonable sampling of these was developed. Reference is made to Appendices E, and G through J.

The participating employers then administered the job applicant cards as part of their hiring procedures. Each job applicant identified himself by completing the card, and, in so doing, indicated his willingness that such data be used in this study. Test results were reported as 'tested -- not tested' and 'passed -- not passed' in a simple check-off section on the job applicant card.

Secondary Schools Participation. An unbiased sampling of 188 of the 201 public secondary schools in the area resulted, due to the random identification of such schools on the job applicant cards. Further guarantee of lack of bias was due to the high mobility of the job seeking youth. Such youth tend to go far afield in search of employment, All school districts, except San Francisco, agreed to participate and allowed the collection of the academic data. San Francisco generated only 480 out of a sample of 6,117, so it is felt that their non-participation has little effect on the out-comes.

Most parochial and private schools in the area were also represented in the sample, but these elements could not be used. Both the standardized achievement tests and tests of academic aptitude contained enough differences to force the exclusion. The courteous cooperation of the administrators and faculty of these schools was deeply appreciated by the investigators.

The job applicant card (see Appendix G for the cards used) furnished the name and location of the 'last high school attended'. This information, as well as all individual data, was converted to a numerical code and key-punched on IBM cards. Card sorts were run on schools, districts, and counties. The schools were contacted and two approaches were employed: if fifteen or fewer youth had identified a specific school district, that district was requested to supply the academic information; if the number was greater than this, the research team visited the schools and did the necessary clerical work. This involved personal visits to 138 public high schools.

IV. SPECIFIC DATA COLLECTED

<u>Determining Socio-Economic Levels</u>. Three approaches were used; (a) identification of average family income by census tract, (b) identification of employment of head-of-family, and (c) identification of family structure,

as both natural parents, one natural parent, foster parents, and other variations. It was expected that such information would be available in most schools: it was not. Both (b) and (c) were available for approximately 40% of the sample, which made such information useless for the purpose of this particular study. Where (b) and/or (c) was available and reasonably current, it was recorded.

All schools had some identification of residence of their students, either as the street address while in attendance, or by identification of their school service boundaries; fortunately, all of the latter schools served a socio-economically homogeneous population. Identification of levels was based upon the census tract information from the 1960 census reports. (3:--, 4:--, 5:--) Three levels were determined: above $10,000.00 family income (high, level 1); average to $10,000.00 (middle, level 2); and below average (low, level 3). The figure of $10,000.00 was chosen as this level represented the demarcation line for loan qualification for better homes in 1960 as well as the general level for the established professional in that year (2:172-173). The "average" is the SMSA family income average: for the Sacramento SMSA, the amount is $7,092.00 (3:-- census tracts); for the San Francisco-Oakland SMSA it is $7,100.00 (4:-- census tracts); and for the San Jose SMSA it is also $7,100.00 (5:-- census tracts).

To identify the socio-economic level of each job applicant in the sample, census-tract boundaries were drawn on street maps of all areas involved.

The census tracts on the street maps were color coded according to the family-income level, the in-school street address of the job-applicant located on the map, and the pertinent level indicated on his card. With housing development and financing socio-economically stratified, the in-school address is an increasingly valid indicator of socio-economic status (27:296 and 39:131).

On the Employer. To identify elements in the sample of employers as representative of the population of employers in the area the following data were collected:

(a) description of operation,

(b) total number of employees,

(c) approximate number of new hires annually,

(d) approximate number of new hires for job entry positions.

Reference is made to Appendix H, Employer Description Cards and Appendix E, Participating Employers.

On The Job Applicant (student sample). To match groups of recent terminal secondary students, it was necessary to account for all variables except mathematics experience. The following data were collected: name, Mr., Miss, or Mrs. (maiden name), birthdate, highest grade completed, last high school attended and the year, location of school by city and county, prior employment if any, results of state mandated testing in reading, mathematics, and academic aptitude (intelligence quotient), a listing by title, textbook and grade of the mathematics experience in high school (by semesters), the job description for the head of family and/or the home address while in high school. See Appendix G for a facsimile of the card.

On The Employment Tests. To identify the tests used by employers as elements in a sampling of screening tests, it was necessary to determine the correlation existing between the commercially produced general tests by methods of multi-variate analysis of variance. This was recently accomplished in the Burns' study (67: correlation matrix appendix 3). Additional data were as follows; the use of test results in job assignments, the general mathematics content, and the cutting score. See Appendix F for details on the tests encountered.

On The Mathematics Textbooks Used In Schools. A master list was compiled from the October Reports of all secondary school districts in the thirteen Bay Area

Counties. Textbooks which were drawn from these reports were those listed as being used in classes in mathematics, business education, vocational education programs, remedial mathematics, and mechanical drawing. The October reports were used for the years 1962 through 1965 for this purpose. This listing was then compared with the Schools Mathematics Study Group listing; almost total agreement resulted. Actual textbooks used by elements in the job-applicant sample are not reported to prevent identification of individual schools. The total list is in Appendix K with the type and level of use identified.

V. ORGANIZATION OF THE DATA

The Appendices. Descriptive data have been organized as a series of tables, referred to and discussed in this chapter. The findings are also tabulated in this manner, with excerpts in the body of Chapter Four, but with each complete table in the Appendices.

These Appendices are:

(a) A map of the region under study;

(b) Data on the laboring force and the mobility of workers;

(c) A listing of numbers employed in those jobs covered by unemployment insurance, with total populations and gross income, by counties;

(d) The education levels, by counties, with the approximate numbers of youths in the age population sampled;

(e) A descriptive listing of participating employers;

(f) A descriptive listing of tests encountered;

(g) A facsimile of the Job Applicant Data Card;

(h) A facsimile of the Employer Data Card;

(i) A facsimile of the letter to employers;

(j) A facsimile of the employer-response card;

(k) A list of textbooks encountered, with type and general level of use indicated;

(l) The development of the sample - sources and levels of attrition;

(m) Evidence of "Normality" for the sample;

(n) Chi-square tests of matched group significance and testing the hypotheses;

(o) Chi-square tests of characteristic variance;

(p) Correlations matrices for "within-groups" variance and for mathematics types versus standardized test and employers' test results;

(q) F-tests on variances arising from seven measures, or characteristics;

(r) The "t-test" on the adjusted means as an additional check on the hypotheses;

(s) A comparison of "Pass-fail" ratios on Employer's tests with Academic Aptitude stanines.

Reporting To Employers. The participating employers will receive a comparison chart which compares success with their tests with the means of academic aptitude scores arranged in stanines. The means of the stanines for the "passing" group are compared with the stanine means for the "failing" group. A composite chart is included in this study, but with identification of the companies limited to broad groupings. Reference is made to Appendix S.

Reporting To Schools. Each of the participating schools will receive a brief of the completed study. Those who request them may have a duplicate deck of the IBM cards, which, with the code developed, will allow analysis of their own courses. Of course, they may only have duplicates of their own student's IBM cards.

IV. STATISTICAL PROCEDURES

The design of this study depended upon the generation of a large enough sample to allow the drawing of the matched sub-samples of a size which was statistically usable without employing small sample treatments. Due to the very large beginning sampling, 17,268 job applicants, the smallest groups compare sets of one hundred twenty-nine individuals.

The Statistics Chosen. Job-seeking youth are not necessarily normally distributed in the total population of youth. With this in mind, chi-square, a distribution-free statistic, was chosen for the majority of statistical tests. The chi-square statistic also has certain additive properties which allow comprehensive and time-saving manipulations to identify sources of variation when several characteristics of each element in the sample must be considered. (23:228-229)

All data collected were punched into IBM cards. A total of fifty-two entries were required, in nineteen fields. Five fields were used for identification, with the remaining fourteen fields used to record the characteristics needed for forming matched groups and testing the hypotheses.

Assuring "Normality" of the Sample. Expected frequencies were compared with observed frequencies, according to a procedure described by Guilford. (23:121-125) Details are given in Chapter IV.

Forming Matched Groups. Using an IBM 2040 Card-sort machine, data was tabulated from card-sorts on eleven characteristics. Examination of the ratios for "pass-fail" indicated seven characteristics which should be used for matching the groups. They were; age, sex, socio-economic level, the state mandated standardized test results for academic aptitude, reading, and mathematics, and average semesters of mathematics experience.

Using the IBM 2040, sub-groups were formed in the following steps: (a) sorting on sex; (b) sorting these into sub-groups on socio-economic levels; and (c) sorting these into sub-sub-groups on the five types of mathematics experiences. These groups were then matched, following this procedure: (a) the members of each group were put into order by academic aptitude stanines; (b) each stanine group was compared with its matching stanine group in the other mathematics group, and (c) where a stanine of one group had more members than the same stanine of the other group, the excess members from the larger group were excluded randomly (the deck was shuffled, a list of random numbers was entered randomly, and the cards corresponding to the last digit of the random numbers, taken as listed, were removed). This procedure was repeated with reading stanines and then with the mathematics stanines. (7:991-995)

The decks were next ordered by age, in years and months. Tabulation sheets were developed on which the totals for each year and month were tallied. Allowing plus or minus one month, cards with no match were eliminated in the random order in which they came from the card-sort. Visual inspection of the resultant groups indicated a close correspondence in all characteristics matched.

This procedure was repeated twenty-two times. There was an inadequate number of cases to allow matching in eight categories; those with no mathematics experience at all, in each of the socio-economic levels (six categories); and those with occupational mathematics who were at the highest economic level (two categories).

These sub-sub-groups had now been matched on sex, age, socio-economic level, and standardized test scores. The totals of passed and failed in each of the sub-sub-groups were now combined.

Inconclusive Tests of The Hypotheses. To test the hypotheses, two-by-two contingency tables were developed, and the chi-square test for significant deviation applied. The groups so tested represented at most 44.8% of the refined sample (complete data was available on 2,018 job-seeking youth -- reference is made to Appendix L, which records the various attrition levels). This indicated that at least as much information was ignored as was included. Mathematically, the above matching procedures would require many repetitions to approach validity.

Validating the Findings. Dr. Edward G. Begle, Director of the School Mathematics Study Group, consented to re-compute the data at the Stanford University Computation Center. In addition to chi-square treatments identifying sources of variation, a stepped multiple-regression run was made which results in a series of 'adjusted means'. These adjusted means are the results of 'weighting' to allow for eleven sources of variation. As reported under "Findings", the initial chi-square values were shown to be in the expectancy range derived from these adjusted means.

In all, four runs were made on the data at the Stanford University Computing Center: a simple data description tabulation (category counts); a cross-tabulation with variable stacking; a step-wise discriminant analysis; and a step-wise regression analysis (or multivariate multiple regression analysis).

Outline of The Statistical Treatments.

1. Assure data arose from a normal population:

   a. chosen measurement - Academic Aptitude (ability or Intelligent Quotient):

   b. compute standard deviation, variance, Z scores (Sheppard's correction for coarse grouping applied);

   c. Develop normal curve on the mean and standard deviation of the data.

d. Compare expected frequencies and observed frequencies (Appendix M).

2. Develop matched groups where the remaining variable was the type of mathematics:

   a. Identify the pertinent characteristics;

      i. run ratios on pass-fail for each characteristic,

      ii. identify significant variation,

      iii. structure card-sorts on the basis of characteristics whose ratios indicate significant variation;

   b. Grouped individuals were matched on the basis of sex, socio-economic levels, standard test scores, age, and semesters of mathematics, through random elimination.

3. Two-by-two contingency tables were then entered with the data from the matched groups and the chi-square test for significance determined the acceptance or rejection of the hypotheses. (Appendix N)

4. Validation of these results implied a choice of;

   a. replication, or

   b. change of treatment.

5. "Change of treatment" was chosen. The four runs administered through the Schools Mathematics Study Group are summarized as follows:

   a. The chi-squares run on the raw data to identify sources of variation are reported in Appendix O.

   b. The within groups and mathematics type correlations matrices are reported in Appendix P;

   c. The "f - tests" on variances are reported in Appendix Q;

d. The "t - tests" on the adjusted means are reported in Appendix R, as an additional check on rejection or acceptance of the hypotheses.

Use of Standardized Test Results. The standardized test results for California were reported for the years of 1962, 1963, and 1964 in the annual report, California State Testing Program, Summary Data (1:--). The 1964 report was available in 1966. The above years bracket the 11th grade testing of the elements in this sample.

The test results are reported by the State Department of Education in percentile rankings. The standard deviations for each test battery are also reported. In converting in-school test data to stanines, the tests were carefully evaluated, applying both conversion methods (percentiles and standard deviations). (19:260-263) No measurable discrepancies were observed, possibly due to the "coarseness" of grouping by stanines. This coarse grouping is considered when checking the sample for "normality" as shown in Appendix M.

VII. CHAPTER SUMMARY

This chapter has presented the design of the study. It has indicated the geographic area involved, the populations sampled, how the data was collected, and methods for the organization and interpretation of such data. This appears to be the most productive design for the objectives of the study. This study employs the descriptive technique, as described by McGrath, Jelinek, and Wochner. (30:78-81)

CHAPTER IV.

THE FINDINGS

This chapter reports the findings by sources: the Literature, the area survey, the populations sampled, and the hypotheses tested. Tests of the hypotheses basic to the goals of this study are in turn reported as: statistical tests to assure "Normality" of the sample; the chi-square test of matched-group "pass-fail" means; validating the statistical treatment of the data; tests of variance; and the second test, a "t - test", on the adjusted "pass-fail" means.

I. THE LITERATURE

Program Emphasis. Mathematics programs for the terminal secondary student are just now receiving emphasis and attention. Wiles (39:--), Tanner (36:--), and Clark, Klein and Burks (16:--) devote considerable space to a call for reassessment of goals for these students. Kimball Wiles particularly emphasized the need to remove the term "vocations" from pedagogese and give cognizance to vocational goals (occupational goals) for all youth. (39:123)

Grant Venn, in his definitive study, Man, Education, and Work (37:--) describes the chaotic job-seeking activities of these terminal secondary students, and makes the point that not one in twenty has any preparation directly related to job entry.

Dis-oriented Youth. Many of the sources cited refer to the problems engendered by 'dis-oriented' youth: Burchill, in a series of case-studies, shows the constructive impact of work-study programs upon dis-oriented youth. He further cites cases which indicate that employability is one of the basic prerequisites to adult-hood. (14:9,15)

Summary Statements. The literature shows a definite awareness of these problem areas:

1. A major segment of our youth are unemployed, underemployed, and mis-employed, which leads directly to alienation of these individuals from the "mainstream" of our society.

2. Secondary school mathematics programs have historically been oriented toward the needs of the bright, the gifted, and the college preparatory student.

3. A growing interest in mathematics programs for the terminal secondary students is evident, but with primary emphasis on the junior high school years.

4. Various experimentations with class size, class time, and building and student administration may offer

opportunities for innovative programs aligned with these learnings and the general needs of terminal secondary students.

II. THE AREA SURVEY: DEMOGRAPHIC

There is a non-agricultural work-force of 1,652,700 in the thirteen counties in this study. Of these, less than 90,000 are full-time workers under twenty-three years of age. Approximately 70,000 job-entry positions become available annually, and some 120,000 young people compete for them. (6:217, 1:159)

The work force is increasingly mobile (Appendix B), with up to fifty per cent of the workers employed outside their county of residence, and as many as eighteen per cent employed outside their Standard Metropolitan Statistical Area, each of which, in this sample, contains two or more counties.

III. THE POPULATIONS SAMPLED

The Employers. The forty-five participating major employers are drawn from a population of approximately 275 in the area studied. They represent 328,479 of the 1,652,700 jobs in this area, or 19.8 per cent of the total. However, they also represent approximately 34.6 per cent of the job-entry positions available annually.

These and additional findings, are contained in Appendix E.

Job-Seeking Youth. Of the 120,000 job-seekers (annual figure) in this age bracket, 2,018 were in the final sample and were generated in a "sixty-day run" or its equivalent. This means that the 2,018 in the sample represents approximately ten per cent of the total of job-seeking youth in the area studied. As indicated in Appendix D, they are drawn from a population that closely approximates the norm for both the state of California and the nation.

All environmental conditions are represented; metropolitan, urban, and rural.

Employers' Tests. While Burns study (67:--) lists seventy-eight commonly used tests, it is felt that this study involved a sufficiently broad sample. Complete data on the tests are in Appendix F. A total of sixteen generally used tests which are available to any employer under proper controls are listed. In-addition twelve tests available only to governmental units were involved. The eight tests and batteries of tests developed for and used by specific individual companies completes the sampling. This is a total of thirty-five different tests encountered. It is emphasized that some employers use more than one test, using them alternately to avoid "test" familiarity for those who apply more than once with the same company.

For batteries of tests, particular care was taken to identify all mathematics-dominant sections. The importance of literacy in mathematics is illustrated by the following (for a major utility):

249 in the sample.

22 passed the mathematics sections, who failed the total test.

3 failed the mathematics sections and passed the total test.

224 passed or failed the mathematics and passed or failed (in the same order) the total test.

Appendix S compares the means of academic aptitude stanines for "pass" versus "fail" on employer's tests. Comparison with Appendix L will show that a reasonable sampling of all testing prevailed.

IV. TESTING THE HYPOTHESES

Determining the Best-fitting Normal Distribution for a Set of Data. According to the procedures described by Guilford (23:121-125) it is possible to identify "Normality" for the sample by comparing expected frequencies on some standardized measure with observed frequencies on this measure. This procedure was followed as reported in Appendix M. A normal curve was constructed based on the same mean and standard deviation as those computed from the actual data. The academic aptitude stanines were used as a standardized measure in the sample. As indicated in Appendix M, the observed frequencies lie extremely close to the curve representing the expected frequencies. Only at two points on the curve do the observed frequencies exceed one per cent difference for the total sample. These points are in the third stanine and in the first stanine. In the third stanine there is a negative difference of 55 cases (fewer than expected) and in the first stanine a positive difference of 33 cases. As the graph indicates, these differences are minor with an N equal to 2,018 cases.

In using the stanines to determine the intervals it was necessary to apply Sheppard's correction for coarse grouping. When there are fewer than twelve class intervals for a range in excess of a hundred points, which was the case in some of the standardized tests of academic aptitude, it is possible for frequencies to vary excessively from the mid-points of class intervals. The effect of grouping errors upon the computation of the mean is usually inconsequential but, "Their effect upon the standard deviation is often large enough to be concerned about...Grouping errors tend to enlarge the standard deviation and the coarser the grouping the greater is the systematic error in sigma." (23:96-97) On the basis of this treatment the sample is normally distributed.

First Treatment: Chi-square Test On Matched Groups. As described in Chapter III, individual elements of the sample were matched on seven characteristics for chi-square tests of the Hypotheses. These seven characteristics were identified by comparing the pass-fail ratios generated by direct card-sort counts in all categories.

Appendix N (four pages) compares groups matched on age, sex, socio-economic levels, average semesters of mathematics, and their standardized test scores for academic aptitude, reading, and mathematics. This procedure resulted in rejecting the hypothesis of no difference at the .001 level of significance for _structured mathematics versus traditional college preparatory mathematics_. It is pertinent to point out here that the Academic Aptitude Mean of the total sample is a stanine of 4.659 (Appendix S).

The hypothesis of no difference for _structured mathematics versus occupational mathematics_, is rejected at the .001 level of significance. Not enough cases occurred in the highest socio-economic level to allow matching.

The hypothesis of no difference for structured mathematics versus general mathematics is rejected at the 0.01 level of significance.

The hypothesis of no difference for traditional college preparatory mathematics versus general mathematics is accepted. A chi-square of 0.249 is bracketed by the .70 to .50 levels of significance.

For tests of hypotheses five and seven, involving groups with "no mathematics", it is important to recognize the small number of cases with "no mathematics". Due to the nature of statistical inference, it is doubtful if a sample of two males and seventeen females can be compared with samples of 147 and 214 males, and 225 and 366 females respectively. With only nineteen cases of "no mathematics experiences in secondary school" out of a total sample of 2,018 cases, it is assumed that most students with no mathematics experiences commonly "drop out" of school and so contribute to the 2,351 cases lost to this sample through inadequate in-school records (primarily a lack of standardized test results due to high absence rates, multiple transfers and similar causes).

The Chi-square Tests of Variance of Characteristics. A Stanford Computer Center Run (program BMDO8D-cross-tabulation with variable stacking) was used to verify the prior identification of sources of variation. One statistically very significant variable for both males and females was Type of Mathematics. These chi-squares exceeded the .001 level of significance in both cases. For females, the chi-square for Family Income (Socio-economic levels) also exceeded the .001 level of significance. The chi-squares for semesters of mathematics for both males and females exceeded the .05 level of significance and approached the .02 level. Reference is made to Appendix O.

"Within-Groups" Variance. A step-wise descriminant analysis run (Stanford Computer Center, program BMDO7M) analyzed mathematics types versus standardized test and job test results. Due to the coding of "not tested" as a one, "Passed" as a two and "Not Passed" as a three, all cards in the final sample are punched with a two or a three for the job-test results. Thus, the correlations under "4" in Appendix P are negative figures. In interpreting these within-groups variances, the lowest negative figures represent the highest positive correlations.

For the females, the lowest correlation exists between the standardized tests and structured mathematics, with the exception of academic aptitude for the cases with no mathematics. As the pass-fail ratio (on raw data) is 0.569 for structured mathematics and drops to 0.529 for traditional College Preparatory mathematics, these correlations imply a source of within-groups variance, structured mathematics, which has the highest success ratio on the job tests and relies the least on other sources of academic strengths. (38:183)

The within-groups variance correlations for the males demonstrate no particular areas of emphasis. All correlations for the various types of mathematics cluster rather closely to the total group correlations.

These correlations for within-groups variance were employed to determine regression weight through the univariate analysis of variance treatment for each of the standardized tests; academic aptitude, reading, and mathematics. Both the between and within groups source of variation was tested.

The resulting "adjusted means" allowed a meaningful application of Fisher's "t" as a further check on the major hypotheses of this study.

The test of the hypothesis of homogeneity of regression resulted in the acceptance of the hypothesis for the females: an F of 1.471 with twelve and 1319 degrees of freedom is below the .05 level of significance of 2.18. The hypothesis of homogeneity of regression was also accepted for the males on an F of 1.385 with nine and 663 degrees of freedom.

<u>Analysis of Variance for Types of Mathematics</u>. A series of F-tests on the variances of the five types of mathematics comparing each variance with the common group variance indicates a high level of probability that all such variances arose from the same population. The data is tabulated in Appendix R. The observations cast no reasonable doubt on the hypothesis of equal variance. (38:185-187)

<u>Second Treatment: Fisher's "t" Test on the Differences of The Adjusted Means</u>. Appendix Q tabulates the data used for the computations in the "t" tests. The results are on the following page of Appendix Q. For the females, Traditional College Preparatory Mathematics fails to achieve a significant level for "t" for any category. However, the Structured Mathematics "t" test of a difference of the means are very significant (beyond the .01 level) for both Occupational Mathematics and General Mathematics.

For the males, the "t's" achieve statistical significance at the .05 level for Structured Mathematics over both Traditional College Preparatory Mathematics and General Mathematics. No other combination for the adjusted means of the males demonstrates a statistically significant difference.

The data for the above procedures was drawn from the step-wise discriminant analysis run mentioned above. The precedure followed that described by Guilford (23:220-221) and its use is justified by the foregoing illustrations of the "normality" of the sample as well as the F-tests which substantiate the hypotheses of homogeneity of the variances.

V. SUMMATION OF STATISTICAL TREATMENTS

These considerations deserve emphasis:

1. The precise groups matched might never be replicated, however, this procedure removes nearly all sources of variation except the types of mathematics being compared;

2. Eight sub-categories in the matching procedures were dropped, due to inability to form "matches". These individuals are included in the data runs and may strengthen sources of regression.

3. All substantial variations favor structured mathematics experiences over each of the other types.

The testing of the hypotheses is tabulated on the following page.

Reference is made to Appendices N and Q. In short form the hypotheses are:

H_1 structured versus traditional college preparatory

H_2 structured versus occupational

H_3 structured versus general

H_4 traditional college preparatory versus general

H_5 structured versus no mathematics

H_6 traditional versus occupational

H_7 traditional versus no mathematics

The statement of "yes" or "no" indicates whether or not the hypothesis of no difference is rejected.

	Matched Groups (Chi-square)			Fisher's "t" test from computer runs	
	MALES	FEMALES	M+F	MALES	FEMALES
H_1	yes .001	yes .02	yes .001	yes .05	no --
H_2	yes .01	yes .001	yes .001	no --	yes .01
H_3	no --	yes .02	yes .01	yes .05	yes .01
H_4	no --	no --	no --	no --	no --
H_5	*	*	*	*	no --
H_6	*	*	*	no --	no --
H_7	*	*	*	*	no --

* too few cases for matching and/or treatment.

CHAPTER V.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter restates the problem, the procedures, and the findings, in summation, with the conclusions limited to the import of the hypotheses, interpretation of the results of correlations, and related statistics. The recommendations conclude the chapter and the study.

I. THE PROBLEM

Statement of the Problem. It was the purpose of this study to compare mathematics experiences and identify any which were measurably more productive in instilling the mathematics skills necessary for job entry positions. This purpose required an analysis of such mathematics skills. An available example, of common and general use in industry, was the mathematics content of screening tests used by major employers in their hiring procedures. It was decided that such tests might be used as the basic criteria for the above purpose. "Job entry positions" referred to only those jobs requiring no advanced training beyond the customary secondary school offerings.

The youth population examined was delimited to the terminal secondary student, that student who had had no education beyond high school and was not eligible for matriculation at a four-year or higher college level institution.

With these delimitations in mind, the problem was stated as follows:

> "Is there a measurable difference of success with employers' screening tests between matched groups of terminal secondary students wherein the variable is their high school mathematics experience?"

<u>The Hypotheses</u>. From this statement of the problem, seven hypotheses were developed:

1. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is structured mathematics versus traditional college preparatory mathematics.

2. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is structured mathematics versus occupational mathematics.

3. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is structured mathematics versus general mathematics.

4. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is traditional college preparatory mathematics versus general mathematics.

5. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is structured mathematics versus no mathematics.

6. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is traditional mathematics versus occupational mathematics.

7. There is no significant difference in the number of successful responses on employer's screening tests when the population variable is traditional mathematics versus no mathematics.

II. THE PROCEDURES EMPLOYED

Definition of Terms. The terminal secondary student and the college preparatory student were defined to allow a description of the population sampled. Four categories of mathematics experiences common to secondary schools were described as: traditional college preparatory mathematics, structured (or "modern") mathematics, occupational mathematics (both shop and business), and general mathematics (commonly a re-hash of "arithmetic"). Academic Aptitude, reading, and mathematics achievement levels were identified for the purpose of this study, as were "mathematics experiences".

Delimitations. The population of job-seeking youth who were sampled was described, with six data-generating categories. The major employers eligible for participation in this study were those who had 400 or more employees, used screening tests containing an adequate amount of mathematics in their hiring procedures, and were hiring reasonable numbers of youth for job-entry positions. The thirteen San Francisco Bay Area Counties were included in the area to be sampled, due to the high mobility of the laboring force involved. The data were collected with two major orientations; back-up information to control sources of variation in the sample, and data directly involved in the testing of the hypotheses. The assumptions basic to the use of the various measures were enumerated.

Survey of The Literature.

Areas of Agreement.

1. Mathematics learnings appear to be crucial for intelligent living in a technological society, inclusive of, but going well beyond, the importance of mathematics to technical specialists.

2. Nationally, young people who are not academically inclined, who are not readily 'trainable' in the industrial sense, suffer a decided disadvantage, economically.

3. The goal of mathematics education in the public schools seems to be the learning of more mathematics.

4. Increasing concern for the 'general mathematics' student is now becoming evident.

5. Almost all measurable change in mathematics programs has occurred in programs for the bright, the gifted, and the college-capable youth.

Areas of Conflicting Opinion.

1. A basic problem exists in mathematics education. Is structured mathematics the proper mathematics for all students? If the answer is 'yes', then how can this approach be so implemented as to make it available to the slow and average student? If the answer is 'no', the problem then remains to devise a 'general mathematics' which is considerably more meaningful and inherently more motivating.

2. The increasing importance of the role of mathematics in a technological society implies that educators must be projecting the content needs of mathematics education for all students well into the twenty-first century. This area is more a matter of the degree of concern than of conflict.

Data Collection. Forty-five major employers, refined from an interested sample of 212, administered a "job-applicant" card as a part of their normal screening-hiring procedures. A total of 17,268 of these cards were properly completed. In addition to test results, these cards contained information for the location of the last high school attended, and the year. The cards were screened for age (born between July 1, 1943, and July 1, 1949), attendance at a high school in the area, and no higher education. This resulted in a sample of 4,849 youth upon whom the in-school academic and socio-economic data were collected. Complete data were available on 2,023 youth. Five were lost due to key-punch operational errors. For details, see Appendix L.

Testing data were developed on the various tests used by employers. Reference is made to Appendices F and S. These tests were analyzed to assure both an adequate number of mathematics items and correlation of measured results. A correlations matrix is included at the bottom of the last page of Appendix F, as is the "Rational Cluster Structure Analysis". This study is indebted to Mr. William C. Burns, Psychologist, of the Pacific Gas and Electric Company Personnel Department (67:--) for the use of this material. In addition, probability theory was applied to the ratio of the cut-off scores, the total items, and the mathematics items in general tests. On the basis of this analysis, no test of general ability could be "passed" without a reasonable level of facility in mathematics. The probability levels are reported in Appendix F for each general test. All other tests used were either all mathematics, or only mathematics batteries were reported.

The information collected on the job applicant card was coded and key-punched into IBM cards. The cards were then sorted by county, school district, and school. Apparently due to the really randomized procedures used, 188 of the 201 public high schools in the thirteen counties were represented. With the exception of the San Francisco City Schools, all districts represented were able to participate. The San Francisco City Schools had a sample of some 480 youth; the attrition rate was 46.2 per cent, which means there were no more than 221 cases lost to the sample. Out of a total of 2,018 cases, this proved to be negligible.

The type of mathematics experiences were then coded on the basis of that type of mathematics which dominated in the individual's high school career. In the very few cases where no clear dominance was evident, traditional was allowed to dominate over structured, structured over occupational and/or general, and occupational over general, on the hypothesis that this hierarchy represented differing degrees of articulation in program.

The IBM cards now contained fifty-two entries in nineteen fields; five fields were used for identification, and the remaining fourteen fields were used to record the characteristics needed for forming matched groups and testing the hypotheses.

To test for "Normality" of the sample, as developed, a procedure described by Guilford (23:121-125) was used. Expected frequencies on academic aptitude stanines (chosen as the required standardized measure) were compared with observed frequencies. On the basis of this procedure, the sample is normally distributed. See Appendix M for greater detail.

III. TESTING THE HYPOTHESES

Using an IBM 2040 Card-Sort as described in Chapter III, simple counts were made of "pass-fail" ratios on all characteristics. These ratios indicated seven characteristics which should be used in matching. The groups were then matched as described. Contingency tables were entered with the totals and the results compared with the Chi-square distribution. Only four of the hypotheses were tested in this way due to the lack of matches in eight sub-categories. These results were statistically very significant for structured mathematics over traditional college preparatory mathematics, occupational mathematics, and general mathematics, with a level of significance beyond the .001 level for comparisons with both traditional and occupational mathematics. The results for the sub-groups by males and females are reported, as well as the composites, in Appendix N. Traditional college preparatory mathematics, when tested against general mathematics, resulted in a Chi-square of 0.249, which gives an ε bracketed by the .70 and .50 levels. The described procedure was quite time consuming and would require at least two replications for reliability. The data were taken to Dr. Edward G. Begle, Director of the Schools Mathematics Study Group, housed at Stanford University, who consented to process the data at the Stanford Computer Center.

Four runs were made; a simple data description tabulation (category counts), a cross-tabulation with variable stacking, a step-wise discriminant analysis, and a step-wise regression analysis (or multivariate Multiple regression analysis).

The data description run again identified the seven variables previously used. The cross-tabulation run developed chi-squares on the variables as against "pass-fail". Here "type of mathematics" was identified as the most significant source of variation, exceeding the .001 level of statistical significance for both males and females. For females, "family income", used as a characteristic in the card-sort matching procedures, exceeded the .001 level of statistical significance: reference is made to Appendix O. The step-wise discriminant analysis results were printed out as a cluster-graph in which structured mathematics is identifiable as a strong source of positive variation.

The step-wise regression analysis, involving a covariance analysis of variance, resulted in a set of adjusted means for the types of mathematics experiences which took into consideration eleven sources of variance. These adjusted means were used for a Fisher's "t" test as a further check on the hypotheses. All seven hypotheses were so tested and the results reported in Appendix Q. The data entered into the computer runs were held separately for males and females, and are so reported.

The various tests of the hypotheses are reported on the following page, with the level of significance.

Reference is made to Appendices N and Q. In short form the hypotheses are:

H_1 structured versus traditional college preparatory

✓H_2 structured versus occupational

H_3 structured versus general

/ H_4 traditional college preparatory versus general

✓H_5 structured versus no mathematics

✓H_6 traditional versus occupational

✓H_7 traditional versus no mathematics

The statement of "yes" or "no" indicates whether or not the hypothesis of no difference is rejected.

	Matched Groups (Chi-square)			Fisher's "t" test from computer runs	
	MALES	FEMALES	M+F	MALES	FEMALES
H_1	yes .001	yes .02	yes .001	yes .05	no --
H_2	yes .01	yes .001	yes .001	no --	yes .01
H_3	no --	yes .02	yes .01	yes .05	yes .01
H_4	no --	no --	no --	no --	no --
H_5	*	*	*	*	no --
H_6	*	*	*	no --	no --
H_7	*	*	*	*	no --

* too few cases for matching and/or treatment.

IV. THE CONCLUSIONS

Regarding the Seven Hypotheses. For the screening procedures of the forty-five major employers participating in this study, it can be stated that:

1. For the matched groups of terminal secondary students (job applicants) in this sample (matched on sex, socio-economic level, academic aptitude, reading and mathematics achievement level, age, years of high school, and semesters of mathematics);

   A. Structured mathematics experiences are very significant in effectively preparing these youth to "pass" the general tests or the mathematics sections of batteries of employer's screening tests when compared with traditional college mathematics experiences, occupational mathematics experiences, or general mathematics experiences in the secondary schools sampled. Hypotheses one, two and three are rejected at the .001, .001, and .01 (respectively) levels of significance.

   B. Traditional college preparatory mathematics experiences are not significant in effectively preparing these youth to "pass" the general tests or the mathematic sections of batteries of employer's screening tests when compared with general mathematics experiences in the secondary schools sampled. Hypothesis four is accepted.

II. For all male and female terminal secondary students (job applicants) in this sample:

   A. structured mathematics experiences are significant in effectively preparing these youth to "pass" the general tests or mathematics sections of batteries of employer's screening tests when compared with general mathematics experiences in the secondary schools sampled. Hypotheses three is rejected at the .05 and .01 (respectively) levels of significance.

B. Traditional college preparatory mathematics experiences are not significant in effectively preparing these youth to "pass" the general tests or mathematics sections of batteries of employer's screening tests when compared with occupational mathematics experiences, general mathematics experiences, or no mathematics experiences in the secondary schools sampled. Hypotheses four, five, six and seven are accepted.

III. For all male terminal secondary students (job applicants) in this sample:

A. Structured mathematics experiences are not significant in effectively preparing these youth to "pass" the general tests or the mathematics sections of batteries of employer's screening tests when compared with occupational mathematics experiences in the secondary schools sampled. Hypothesis two is accepted.

B. Structured mathematics experiences are significant in effectively preparing these youth to "pass" the general tests or the mathematics sections of batteries of employer's tests when compared with traditional college preparatory mathematics experiences or general mathematics experiences in the secondary schools sampled. Hypotheses one and three are rejected at the .05 level of significance.

IV. For all female terminal secondary students (job applicants) in this sample:

A. Structured mathematics experiences are not significant in effectively preparing these youth to "pass" the general tests or the mathematics sections of batteries of employer's screening tests when compared with traditional college preparatory mathematics experiences or no mathematics

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] of [illegible] and [illegible] of the School [illegible] of the [illegible] Ph.D. [illegible] University, 1963.

experiences in the secondary schools sampled. Hypotheses one and five are accepted.

B. Structured mathematics experiences are very significant in effectively preparing these youth to "pass" the general tests or the mathematics sections of batteries of employer's tests when compared with occupational mathematics experiences or general mathematics experiences in the secondary schools sampled. Hypotheses two and three are rejected at the .01 level of significance.

Regarding the Screening Tests Encountered. For the screening procedures of the forty-five major employers participating in this study, and using the means of the academic aptitude stanines of the terminal secondary students (job applicants) in the sample as the criteria, it can be stated that:

I. There is a low probability that those individuals scoring below the fourth stanine will "pass" the general tests or mathematics sections of batteries of employer's screening tests (the "bottom" twenty-three per cent).

II. There is a high probability that those individuals scoring above the fifth stanine will "pass" the general tests or mathematics sections of batteries of employer's screening tests (the "top" forty per cent).

III. There is an equal probability of "passing" or "failing" the general tests or mathematics sections of employer's screening tests for those individuals scoring in the fourth or fifth stanine (the "middle" thirty-seven per cent).

Regarding the Literature. The sources listed in the Bibliography

I. Approach concensus in that:

A. Mathematics literacy is a pressing need in an increasingly technological society.

B. Nationally, young people who are not academically inclined, who are not readily 'trainable' in the industrial sense, suffer a decided disadvantage, economically.

C. A major goal of mathematics education in the public schools seems to be the learning of more mathematics.

D. Increasing concern for the 'general mathematics' student is now becoming evident.

E. Almost all measurable change in mathematics programs has occurred in programs for the bright, the gifted, and the college-capable youth.

II. Express disagreement in that:

A. There is a possibility of developing a single, articulated mathematics program applicable to the needs of all students.

B. The content needs of mathematics education must be projected well into the twenty-first century.

V. THE RECOMMENDATIONS

In consideration of the findings of this study, it is strongly recommended that:

1. Structured mathematics be adopted as the unifying format for mathematics instruction in the

schools;

2. Institutions of higher learning, particularly those concerned with teacher preparation, revise their offerings, where necessary, to allow the implementation of (1) above;

3. The mathematics skills used by the adult for existence in today's world be identified;

4. The mathematics skills used in specific tasks (job roles) in industry and commerce be identified;

5. Data processing of educational data include a three to five year "follow-up" of the "product".

6. Until the implementation of (5) above, simple job-applicant cards as used in this study be incorporated into all hiring procedures and the cards returned to the schools; postage should be free for this purpose;

7. An on-going dialogue between the world of work and the world of education should be instituted for mutual advantage and evaluation;

8. Research be planned, funded and implemented in the following areas --

   a. the empirical validation of current experimental methodologies, using structured mathematics as the content with very large numbers of students [action research for educators],

   b. articulation of the content of structured mathematics with the mathematics skills used in various occupations clusters [descriptive research for educators and industry],

c. experimentation with various hiring procedures to empirically determine trainability for job competence as opposed to academic ability [action research for industry].

BIBLIOGRAPHY

A. PUBLIC DOCUMENTS

1. California State Testing Program, Summary Data - Fall, 1964. Sacramento: Bureau of Education Research, California State Dept. Educ.,1966.

2. California Statistical Abstract. Sacramento: State of California, Documents Division, 1965.

3. U. S. Bureau of the Census. Sacramento, California, Standard Metropolitan Statistical Area. Final Report: PHC(1)-129. 1961

4. U. S. Bureau of the Census. San Francisco-Oakland, California Standard Metropolitan Statistical Area. Final Report: PHC(1)-137. 1962.

5. U. S. Bureau of the Census. San Jose, California, Standard Metropolitan Statistical Area. Final Report: PHC(1)-138 1961

6. U. S. Bureau of the Census. Statistical Abstract of the United States, 1965.

7. U. S. Department of Commerce, National Bureau of Standards, Handbook of Mathematical Functions; Applied Mathematics Series, 55, 1964.

8. U. S. Department of Health, Education, and Welfare; Welfare Administration. Getting Hired, Gettin Trained. JD-2002-1965.

9. U. S. Department of the Interior, Bureau of Education. Report of the Committee on Secondary School Studies Appointed at the Meeting of the National Educational [sic] Association, July 9, 1892. Washington: Superintendent of Documents, Government Printing Office, 1893. (Title in common use: The Committee of Ten Report.)

10. U. S. Office of Education. The Vocational Education Act of 1963. (OE-80034, 1965)

B. BOOKS

11. Brameld, Theodore. Philosophies of Education. New York: Henry Holt and Co., Inc., 1955.

12. Brown, B. Frank. The Non-Graded High School. Englewood Cliffs, N.J.: Prentice-Hall, Inc. 1963.

13. Brubacher, John S. A History of the Problems of Education. New York: McGraw-Hill Book Co., 1947.

14. Burchill, George W. Work-Study Programs For Alienated Youth. Chicago: Science Research Associates, Inc., 1962.

15. Burington, Richard S. and May, Donald C. Jr. Handbook of Probability And Statistics With Tables. Sandusky, Ohio: Handbook Publishers, Inc., 1953.

16. Clark, Leonard H., Klein, Raymond L., and Burks, John B. The American Secondary School Curriculum. New York: MacMillan Co., 1965.

17. Cronbach, Lee J. and Gleser, Goldine C. Psychological Tests And Personnel Decisions. Urbana, Ill.: University of Illinois Press, 1957.

18. Douglass, Harl R. (ed.). Trends And Issues In Secondary Education. Washington: Center for Applied Research in Education, Inc., 1962

19. Ebel, Robert L. Measuring Educational Achievement. Englewood Cliffs, N.J.: Prentice-Hall, Inc.,1965.

20. Elicker, Paul E. The Administration of Junior And Senior High Schools. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1964.

21. Ghiselli, Edwin E. The Validity of Occupational Aptitude Tests. New York: John Wiley and Sons, Inc., 1966.

22. Ginzberg, Eli. Human Resources: The Wealth of A Nation. New York: Simon and Schuster, 1958.

23. Guilford, J. P. Fundamental Statistics in Psychology and Education. New York: McGraw-Hill Book Co., 1956.

24. Kinney, Lucien B. "Mathematics," The High School Curriculum, Harl R. Douglass, editor, New York: The Ronald Press Co., 1964.

25. Kinsella, John J. Secondary School Mathematics. New York: The Center for Applied Research in Education, Inc., 1965.

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

27. Lipset, Seymour M., Bendix, Reinhard, and Malm, F. Theodore. "Job Plans and Entry Into the Labor Market," Man, Work, and Society. Edited by Nosow and Form. New York: Basic Books, Inc., 1962.

28. Mayer, Frederick. A History of Educational Thought. Columbus, Ohio: Charles E. Merrill Books, Inc., 1960.

29. McCauley, John S. "Education For Manpower Development," Challenge and Change In American Education. Edited by Harris, Deitch, and Levensohn. Berkeley, Calif.: McCutcheon Publishing Co., 1965.

30. McGrath, G. D., Jelinek, James J., and Wochner, Raymond E. Educational Research Methods. New York: The Ronald Press Co., 1963.

31. Rayback, Joseph G. A History of American Labor. New York: The MacMillan Co., 1959.

32. Reeve, W. D. Mathematics For The Secondary School. New York: Henry Holt and Co., 1954.

33. Rudy, Willis. Schools In An Age of Mass Culture. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1965.

34. Shelburne, James C. and Groves, Kenneth J. Education In The Armed Forces. New York: The Center For Applied Research In Education, Inc., 1965.

35. Super, Donald E. and Crites, John O. Appraising Vocational Fitness. New York: Harper and Row, 1962.

36. Tanner, Daniel. Schools For Youth. New York: The MacMillan Company, 1965.

37. Venn, Grant. Man, Education, and Work. Washington: American Council of Education, 1964.

38. Walker, Helen M. and Lev, Joseph. Statistical Inference. New York: Holt, Rinehart, and Winston, Inc., 1953.

39. Wiles, Kimball. The Changing Curriculum of the American High School. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1963.

C. ARTICLES AND PERIODICALS

40. Allen, Frank B. "The Council's Drive to Improve School Mathematics--A Progress Report," The Mathematics Teacher, LVII, No. 6 (October, 1964), pp. 370-378.

41. Allendoerfer, Carl B. "The Second Revolution in Mathematics," The Mathematics Teacher, XII, No.8 (December, 1965), pp. 690-695. (An address delivered at the NCTM Conference at Atlanta, Georgia, November 20, 1964.)

42. Blank, William R. "A Survey Concerning Advanced Mathematics Curriculum [sic]," The Mathematics Teacher, LVII, No. 4 (April, 1964), pp. 208-211.

43. Dessart, Donald J. "Mathematics in the Secondary Schools; Achievement Relationships and Predictions, Review of Educational Research, XXXIV (June, 1964), pp. 302-314.

44. Easterday, Kenneth E. "An Experiment With Low Achievers In Arithmetic," The Mathematics Teacher, LVII, No. 7 (November, 1964), pp. 462-268.

45. Frame, J. S. "Facilities for Secondary School Mathematics," The Mathematics Teacher, LVII, No. 6 (October, 1964), pp. 379-391.

46. Fremont, Herbert, and Ehrenberg, Neal. "The Hidden Potential of Low Achievers," The Mathematics Teacher, LIX, No. 6 (October, 1966), pp. 554-556.

47. Glennon, Vincent J. "...And Now Synthesis: A Theoretical Model for Mathematics Education," The Arithmetic Teacher, XII, No. 2, (February,1965) pp. 134-141. (Adapted from a paper presented at the Forty-second Annual Meeting of the National Council of Teachers of Mathematics, at Miami, Florida, April 24, 1964.)

48. Kellogg, Theodore E. and Johnson, Donovan A. "Mathematics in the Secondary School," Review of Educational Research, XXXI, No. 3 (June, 1961), pp. 272-276.

49. Payne, Holland I. "Mathematics' Changing Role," California Education, II, No. 8, (April,1965),p. 27.

50. "Report of the Secondary School Curriculum Committee," The Mathematics Teacher, LXII, No. 1 (May, 1959), pp. 57-63.

D. REPORTS

51. Benz, Harry E. "Arithmetic in the Senior High School" Arithmetic In General Education. NCTM Sixteenth Yearbook. New York: Bureau of Publications, Teachers College, Columbia University, 1941.

52. Brown, Kenneth E. "The Drive to Improve School Mathematics," The Revolution in Mathematics Education. A Report of Regional Orientation Conferences in Mathematics. Washington: NCTM, 1961, pp. 22-27.

53. Cremin, Lawrence A. "The Problem of Curriculum Making: An Historical Perspective," What Shall The High Schools Teach? ASCD 1956 Yearbook. Washington: NEA, 1956.

54. "Goals for School Mathematics," The Report of The Cambridge Conference On School Mathematics. Published for Educational Services, Inc., Boston, Mass.: Houghton Mifflin Co., 1963. (Commonly referred to as the "Cambridge Report.")

55. Grossnickle, Foster E. "Introduction," Instruction In Arithmetic. NCTM Twenty-fifth Yearbook. Washington: NCTM, 1960

56. Lockard, J. David. Report of the International Clearinghouse On Science And Mathematics Curricular Developments. 1966. College Park, Maryland: AAAS and Science Teaching Center, University of Maryland, 1966.

57. "Planning For American Youth." A Summary of Education For All American Youth, prepared by the Executive Committee and the Committee on Curriculum Planning and Development of the National Association of Secondary-School Principals. Washington: NASSP,1951.

58. Spears, Harold. "Educational Implications of Automation as Seen by a Curriculum Specialist," Automation and the Challenge to Education. The proceedings of a symposium sponsored by the Project on the Educational Implications of Automation. Washington: NEA, 1962, pp. 50-65.

59. The National Council of Teachers of Mathematics. Preliminary Report of the Conference on the Low Achiever In Mathematics, A Report prepared and sponsored jointly with the U. S. Office of Education. Printed and Distributed by the NCTM Washington: March, 1964.

60. The Place of Mathematics in Secondary Education. NCTM Fifteenth Yearbook. New York: Bureau of Publications, Teachers College, Columbia University, 1940.

61. Turner, Ivan S. The Training of Mathematics Teachers. NCTM Fourteenth Yearbook. New York: Bureau of Publications, Teachers College, Columbia University, 1939.

62. What The High Schools Ought To Teach. The Report of a Special Committee, prepared for the American Youth Commission and Other Cooperating Organizations Washington: American Council on Education, 1940.

E. UNPUBLISHED MATERIALS

63. Ackerson, Paul Berndt. "A Study of the Relationship Between Achievement in PSSC Physics and Experience in Recently Developed Courses In Science and Mathematics." Unpublished Ed.D. dissertation, Oklahoma State University, 1965.

64. Adler, Manfred. "A Study of the Identification and Development of Giftedness in Two Ethnic Groups." Unpublished Ph.D. dissertation, Kent State University, 1965.

65. Ashlock, Robert B. "A Test of Understandings of Selected Properties of a Number System: Primary Form." Unpublished Ed.D. dissertation, Indianna University, 1965.

66. Babcock, Robert Joseph. "An Analysis of Selected Guidance Programs for Students Who Seek Employment Immediately After High School." Unpublished Ed.D. dissertation, Cornell University, 1963.

67. Burns, William C. Pacific Gas and Electric Company Personnel Testing Research Project, Report No. 1. San Francisco: PG&E, October, 1965. (Offset).

68. Carrino, Ceasar Augustus. "Identifying Potential Dropouts in the Elementary Grades." Unpublished Ph. D. dissertation, Western Reserve University, 1965.

69. Clark, Van Deusen. "A Comparison of the Achievement of SMSG Algebra Students and Modern Algebra Students Who Have Been Taught by Two Different Approaches." Unpublished Ed. D. dissertation, Arizona State University, 1966.

70. Dixon, Lyle Junior. "An Investigation of Ninth and Tenth Grade Texts and Commentaries of the School Mathematics Study Group for Indications of an Underlying Philosophy." Unpublished Ph.D. dissertation, Oklahoma State University, 1963.

71. El-Naggar, Mohamed Abu-Khalil. "A Comparative Study of Mathematics Programs in Egypt and the United States." Unpublished Ph. D. dissertation, Indiana University, 1965.

72. Fremont, Herbert I. "Individualized Instruction in Plane Geometry." Unpublished Ph. D. dissertation, New York University, 1963.

73. Geiss, Almon Lewis. "An Analysis of Relationships Between Courses Taken in High School and Success in Specific Areas at Oregon Technical Institute." Unpublished Ed. D. dissertation, Washington State University, 1965.

74. Hungerman, Ann Dorothy, "A Study of the Achievement and Attitude of Sixth Grade Pupils in Conventional and Contemporary Mathematics Programs." Unpublished Ph. D. dissertation, University of Michigan, 1965.

75. Madden, Joseph Vincent. "An Experimental Study of Student Achievement in General Mathematics In Relation to Class Size." Unpublished Ed. D. dissertation, Arizona State University, 1966.

76. Neill, Robert Dudley. "The Effects of Selected Teacher Variables on the Mathematics Achievement of Academically Talented Junior High School Pupils." Unpublished Ed. D. dissertation, Teachers College, Columbia University, 1966.

77. Recker, Frank William. "Status and Trends in Mathematics in Ohio Secondary Schools." Unpublished Ph. D. dissertation, Western Reserve University, 1965.

78. Roberts, Gerhard Herman. "A Critical Evaluation of the Presentation of First Year Algebra in Two Contemporary Courses Based On Selected Criteria for the Theory of Learning." Unpublished Ed. D. dissertation, Teachers College, Columbia University, 1966.

79, Rollins, James Hendrix. "A Comparison of Three Stratagems for Teaching Mathematical Concepts and Generalizations by Guided Discovery." Unpublished Ph. D. dissertation, University of Illinois, 1966.

80. Sayles, Donald John "Conservation of Talent: Can the Under-achiever Be Saved?" Unpublished Ed.D. dissertation, Teachers College, Columbia University, 1963.

81. Shuff, Robert Vance. "A Comparative Study of Achievement in Mathematics at the Seventh and Eighth Grade Levels, Under Two Approaches; School Mathematics Study Group and Traditional." Unpublished Ph. D. dissertation, University of Minnesota, 1962.

82. Thomson, Scott Dayton. "An Analysis of Achievement Outcomes." Unpublished Ed. D. dissertation, Stanford University, 1963.

83. Unkel, Esther Ruth. "A Study of the Interaction of Socioeconomic [sic] Groups and Sex Factors With the Discrepancy Between Anticipated Achievement and Actual Achievement in Elementary School Mathematics." Unpublished Ed. D. disseration, Syracuse University, 1965.

84. Vontress, Clemmont Eyvind. "The Effects of Stressor Conditions on Test Scores of a Selected Group of High School Students." Unpublished Ph. D. dissertation, Indiana University, 1965.

85. Wiebe, Arthur John. "The Comparative Effects of Three Methods of Utilizing Programmed Mathematics Materials With Low Achievers." Unpublished Ed. D. dissertation, Stanford University, 1966.

86. Williams, Emmett David. "Comparative Study of SMSG and Traditional Mathematics." Unpublished Ph. D. dissertation, University of Minnesota, 1962.

87. Williams, Ralph Curtis. "Teacher Preparation in Mathematical Arithmetic." Unpublished Ph. D. dissertation, University of Southern California, 1966.

88. Ziebarth, Raymond Allan. "The effect of Experimental Curricula on Mathematics Achievement in High School" Unpublished Ph. D. dissertation, University of Minnesota, 1963.

F. OTHER SOURCES

89. ________. A presentation to the Bay Area CASCD, by E. F. Stolte, Assistant Superintendent, Secondary Schools, Oakland Unified Schools, at Hayward, California, in February, 1966.

90. ________. Books in Print, Vol. II Editied by Sarah L. Prakken. New York; R. R. Bowker Co., 1966.

91. Buros, Oscar K. The Sixth Mental Measurements Yearbook, Highland Park, New Jersey: The Gryphon Press, 1965.

92. Deans, Edwina, Kane, Robert B., McMeen, George H., and Oesterle, Robert A. The Modern Mathematics Series. New York: American Book Company, 1963. (An elementary series of mathematics text-books, grades one through eight.)

93. ________. Discussion with Neil V. Sullivan, Superintendent, Berkeley City Unified Schools, May, 1966.

94. Dissertation Abstracts. Vols. XI-XXIV. Ann Arbor, Michigan: University Microfilms, Inc., 1950-64.

95. Greater San Francisco Chamber of Commerce. San Francisco: The Headquarters City, "A Directory of Major Corporations", Compiled by the Research Dept., San Francisco: 1964.

96. ________. Questions developed in a personal discussion with Dr. Elizabeth Scates, U. S. Office of Education, during the Small Grant Research Conference at San Francisco State College. February, 1965.

97. San Francisco Chamber of Commerce. Directory of Large Manufacturers, San Francisco Bay Region. Compiled by the Business and Trade Department. San Francisco: 1965.

98. ________. Textbooks in Print. New York: R. R. Bowker Co., 1966.

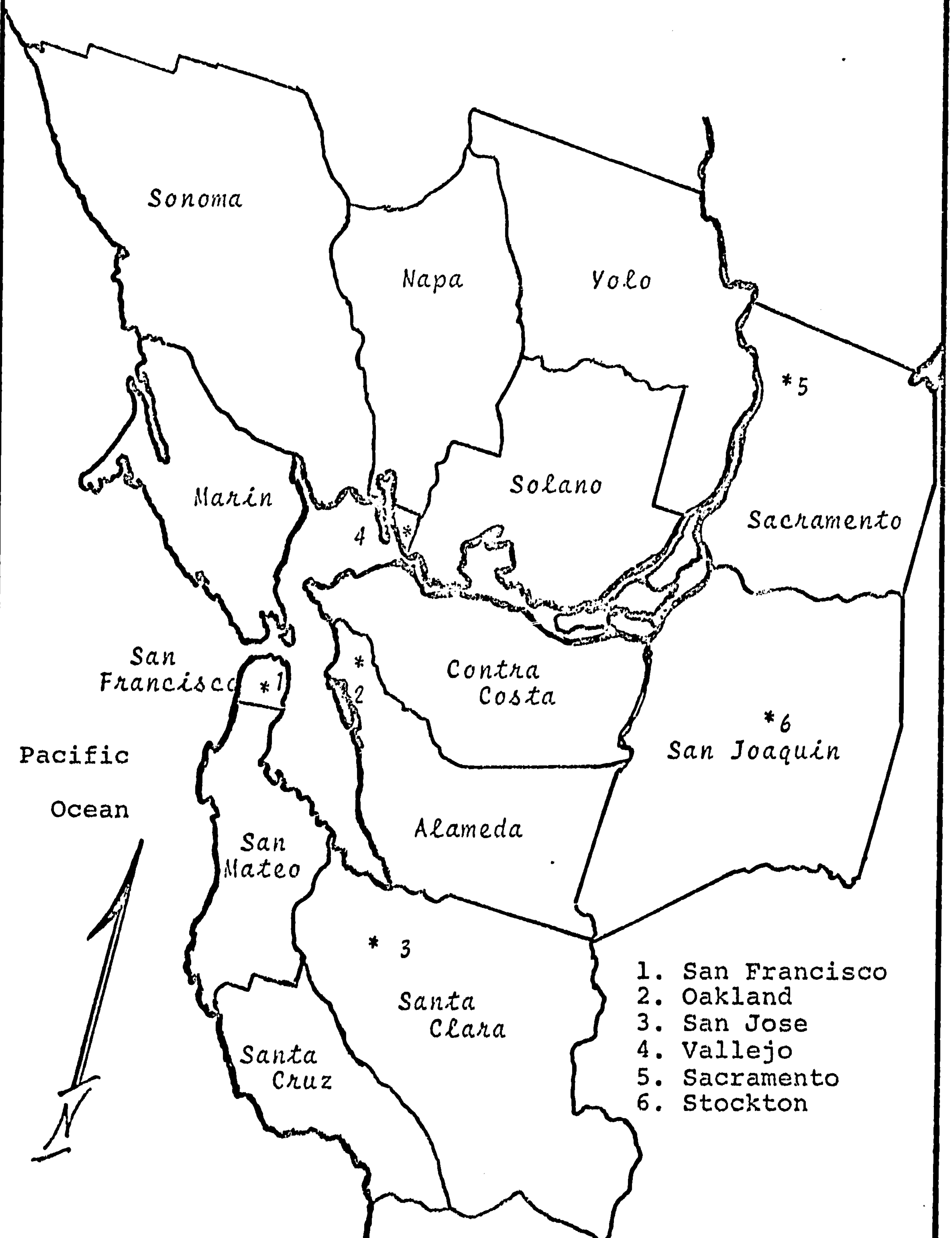
99. The Education Index. Vols. XII-XV. New York: H. W. Wilson Co., July, 1959 - June, 1965.

100. U. S. Civil Service Commission, Hunters Point Naval Facility, San Francisco, California. Personal interview with Mrs. Edna Haynes, Deputy Chief Testing Officer.

101. "Textbook Publisher Listing - Level Sequence". A report of the Schools Mathematics Study Group which types mathematics textbooks as traditional, transitional, and modern in content. Dated 4-11-67. Over 900 textbooks are listed.

Appendix A: The Thirteen Bay Area Counties.

Numbers refer to Metropolitan Areas listed below.



1. San Francisco
2. Oakland
3. San Jose
4. Vallejo
5. Sacramento
6. Stockton

Appendix B: TOTAL LABOR FORCE IN CALIFORNIA AND ITS DISTRIBUTION IN PERCENTILES - 1964; (Reported in thousands)

Grand Total: 7,064   Employed: 6,652   Unemployed: 422 (6.35%)

Manufacturing	1,435
Transportation, Communication, Municipal Districts	387
Trade	1,409
Finance, Insurance, Real Estate	342
Services	1,240
Government	1,045
Construction	413
Mineral Extraction	41
Non-Agricultural Total	6,312

Totals for SMSA's in this study: (26.18% of State Total)

San Francisco-Oakland	1,047.3
San Jose	260.2
Sacramento	223.6
Stockton	69.0
Vallejo-Napa	52.6
Non-Agricultural Total	1,652.7

MOBILITY OF LABORING FORCE (from 1960 census: in thousands)

Counties	Alameda	Contra Costa	San Mateo	Solano	Marin
Male	251.9	110.0	123.9	39.7	41.2
	126.4	44.0	58.8	13.4	17.1
	377.3	154.0	182.8	53.1	58.3
Employed: A. Inside SMSA	316.9	132.4	150.8	45.5	51.9
(Per cent)	(84.0)	(86.0)	(82.5)	(85.6)	(89.0)
B. Inside County	282.7	87.4	93.1	42.2	32.4
(Per cent)	(74.9)	(56.7)	(50.9)	(79.5)	(55.5)

Appendix C: Demographic Description by Counties. (Reported in Thousands *, Millions #)

				Average Monthly Employment Covered by Unemployment Insurance, 1964.						
	Total Population 1965 *	Adjusted Gross Income 1963. #	Wages and Salaries. #	All Industries. *	Construction. *	Manufacturing. *	Utilities, Transportation, Communication. *	Wholesale and Retail. *	Finance, Insurance. and Real Estate.*	Service. *
California	18,756	$39,020	$30,705	4,579	340	1,390	321	1,225	293	702
Alameda	1,033	2,247	1,815	247	21	77	21	71	13	36
Contra Costa	510	1,100	908	81	10	28	6	21	3	11
Marin	189	468	346	25	4	3	2	8	2	5
Napa	76	112	85	11	1	3	1	3	1	2
Sacramento	617	1,299	1,104	119	11	31	9	38	8	16
San Francisco	751	2,088	1,495	348	20	62	45	99	52	69
San Joaquin	274	449	334	64	4	14	4	16	2	6
San Mateo	532	1,362	1,056	113	12	28	18	32	5	15
Santa Clara	891	1,953	1,615	211	19	86	10	46	9	32
Santa Cruz	104	182	119	22	2	6	1	6	1	3
Solano	160	251	208	19	2	2	2	6	1	4
Sonoma	178	325	228	33	3	6	2	10	4	5
Yolo	79	133	102	15	1	3	1	4	-	2

Appendix D: 1960 Census - Educational Levels by Counties (Reported in percentages)

	Median School Years Cpltd.	Less than five years	Four years high	Four years college	Elem. youth in Private	14 - 17 age in school	Employed Professional technical & kindred
U. S. A.	10.6	8.4	41.1	7.7	14.4	87.4	11.2
California	12.1	5.7	51.5	9.8	10.7	89.7	13.7
Alameda	12.1	5.7	51.7	11.2	9.9	89.8	14.3
Contra Costa	12.2	4.8	55.3	12.7	5.4	94.0	15.4
Marin	12.6	2.3	67.1	19.0	14.0	95.0	19.2
Napa	11.2	5.6	44.6	7.0	11.6	90.3	14.4
Sacramento	12.2	4.8	55.8	10.1	9.7	93.1	14.7
San Francisco	12.0	7.4	51.0	11.1	25.1	90.3	12.2
San Joaquin	10.0	12.8	36.9	5.6	8.3	85.6	9.8
San Mateo	12.4	3.2	61.9	14.2	13.8	95.0	15.4
Santa Clara	12.2	6.2	56.2	14.7	7.1	91.6	18.6
Santa Cruz	11.0	6.9	43.1	7.4	7.2	90.2	10.9
Solano	11.9	4.7	49.1	6.5	5.2	92.1	11.2
Sonoma	11.1	7.4	43.9	6.8	8.6	88.4	12.1
Yolo	11.5	7.8	47.0	10.9	7.6	91.3	13.2

Approximate 1964 Populations, 17 through 22 years of age, by counties

Alameda	80,520	San Mateo	42,558
Contra Costa	39,710	Santa Clara	68,718
Marin	14,650	Santa Cruz	8,074
Napa	3,990	Solano	12,668
Sacramento	48,502	Sonoma	13,814
San Francisco	60,834	Yolo	6,238
San Joaquin	21,388		
		Total	421,684

Appendix E: A Descriptive Listing of Participating Employers, Hiring and Testing Agencies

Legend: *Statewode — #Special Sample — +Local

d. Dept/Employ.
c. Commercial
b. own
a. none

	Type Operation	Employees (1964) Total	Annual Hires	Job Entry	Type Test
Alameda County Civil Service Comm.	All services	7,875	825	600	
Bank of America, Nat'l Trust & Savings	Banking	28,872*	1,740*	1,600*	c
Caterpillar Tractor Co.	Diesel Injectors	850	100	95	a#
Chevron Chemical Co. (Cal.Research)	Chem.Research	1,120	72	40	c
Continental Can, San Leandro	Containers	1,389	319	319	c
Continental Can, San Jose	Cans	450	175	175	c
Contra Costa County Dept.Educ.; General Educ.Develop.Tests	Test service	---	---	---	c
Contra Costa Co. Civil Service Comm.	All services	3,785	102	75	c
Crown Zellerbach	Paper products	925	120	120	c
Dow Chemical	Chemicals	750	150	100	c
East Bay Municipal Utilities Dist.	Water Service	2,300	220	200	b
First National Band of San Jose	Banking	475	25	20	c
Foremost Dairies	Dairy Products	430	20	20	c
Friden, Inc.	Office Equip.	2,549	250	200	c
General Brewing Corp. (Lucky Lager)	Brewery	550	75	50	c
Glass Containers Corp.	Containers	299	25	25	c
Hewlett-Packard	Electronics	3,200	600	350	c
International Business Machines(Oak.)	Office Equip.	100	20	20	b
IBM - Systems Development Div.	Bus.Mach.R & D	3,060	500	400	c
Kaiser Industries Corp.	Electronics,etc.	1,934	200	160	b
Kellogg Co.	Cereals	2,000	350	300	c
Lockheed Missiles & Space Co.	Aircraft systems	24,147	1,520	490	c
Lucky Stores	Retail Food	5,550	800	750	d
Marin County Civil Service Comm.	All services	560	72	40	c

(continued next page)

Appendix E: (continued)

Legend: *Statewide d.Dept/Employ.
#Special Sample c. commercial
+Local b. own
a. none

	Type Operation	Employees (1964) Total	Annual Hires	Job Entry	Type Test
Montgomery Wards, Oakland	Retail	9,[illegible]75*	1,500*	1,500*	b
Montgomery Wards, San Leandro	Retail	760	300	300	b
Moore Business Forms	Bus.Forms	500	200	180	c
Pacific Gas & Electric	Gas,Electricity	7,000	600	240	c
Pacific Intermountain Express	Trucking	5,300	600	380	c
Pacific Telephone	Telephone	38,000*	6,000*	5,200*	b
Permanente Medical Group	Med.Services	800	230	195	c
Philco: Microelectronics Division	Electronics R & D	2,500	800	750	c
RayChem Corporation	Electronics	10,000	1,000	900	c
Safeway Stores	Retail	68,000*	2,200+	2,000+	d
San Jose City Civil Service Comm.	All services	5,200	600	500	c
Santa Cruz County Civil Service Comm.	All services	500	40	40	c
Southern Pacific Co.	Transportation	6,000	340	300	c
Standard Oil Co. of Calif.(West.Oper.)	Petroleum	2,300	400	120	c
Standard Oil Co. of Calif.(Rich.Refin.)	Petroleum	3,300	525	375	c
Stokely-Van Camp,Inc.	Food Processing	624	50	50	c
Sylvania Electronics Systems,Inc.	Electronics	1,200	120	80	c
Tidewater Oil Co.	Petroleum	1,200	50	40	c
Union Oil Co.,Oleum Refinery	Petroleum	950	40	30	b
U.S.Civil Serv.Comm.,San Francisco Reg.	Testing/all jobs	68,300	8,000	4,500	b
Westinghouse Electric Corp.	Electric Products	3,200	600	500	c,b
	Totals	328,479	32,475	24,329	

Appendix F: A Descriptive Listing of Tests Encountered.

Legend: Type of Employment.
- a. Manufacturing - durable goods
- b. Manufacturing - non-durable goods
- c. Utilities
- d. Wholesale and retail trade
- e. Finance
- f. Government
- g. Transportation
- h. Services

Publisher, Title, Form.	Math Only	P ac	P H	No. of Users*	Type of Employ.
Otis					
Arithmetic Reas. B (45)	x			1	b
Employment		.2404	.9999	1	g
IBM					
Short Employ. Test	x			2	a,f
Psychological Services					
Employee Aptitude Survey					
T 2 Num. Ability, A (56)	x			1	e
T 6 Num. Reasoning A (62)	x			1	e
Psychological Testing					
Short Employment Test (35)					
SET Numerical	x			12	a,b,c, d,e,h
Science Research Associates					
(Tests of Mental Abilities)					
Mechanical Aptitude (46)	x			2	a,b
Clerical Aptitude		.1480	.999	1	b
Non-Verbal		.3686	.9999	1	b
(Employee Aptitude Survey)					
Numerical Ability,B (5)	x			1	b
Adaptability (24)		.2694	.999	1	b
Thurston Employment		.3792	.9999	1	g
Wonderlic					
Pre-employment, A or B (10)		.1620	.999	14	a,b,e,g
Forms I,II,V		.3480	.9999	4	a,b

Appendix F: (continued)

Cooperative Personnel Services (Available to Civil Service Only)					
Accounts Clerk I	x			6	f
Clerk I & II		.1149	.99	6	f
Data Proc.Op.Trainee (IBM)		.5899	.9999	2	f
Deputy Sheriff		.1770	.999	2	f
Engineering Aide	x			3	f
Firefighter		.1216	.99	1	f
Stenographer		.1762	.999	6	f
Typist Clerk I & II		.1149	.99	6	f
All Trades,Apprentice level	x			1	f
California Dept. Employment (Available to Dept.only)					
S.A.T.B. (Special Aptitude Test Battery)	x			1	f
Contra Costa County Dept.Education					
G.E.D. (Test of General Educational Development)	x				all
COMPANY MADE TESTS.					
Chevron Chemical Co.	x			1	b
International Business Machines Data Proc.		.5899	.9999	3	a,f
Kaiser	x				a
Tidewater (Avon Ref.) Gen.Mental Abilities		.4200	.9999		b
Union (Oleum Ref.)		.5255	.9999		b
Pacific Telephone (American Tel.& Tel.)	x				c
Ray Chem	x				a
East Bay Met. Ut.Dist.	x				c

*Many Employers use more than one test.

Appendix F: (continued)

Burns Correlation Matrix
(Numbers heading columns and lines refer to numbers in parenthesis after test titles)

	5	10	24	35	45	46	56	62
5	.755	.515	.423	.705	.491	.076	.717	.506
10		.861	.848	.588	.844	.340	.666	.640
24			.832	.506	.804	.341	.642	.659
35				.835	.551	.181	.773	.492
45					.887	.358	.625	.656
46						.895	.156	.174
56							.795	.592
62								.715

Rational Cluster Structure Analysis

Numerical Simple	.782	.679	.627	.897	.632	.238	.873	.605
Numerical Complex	.575	.790	.701	.750	.717	.320	.742	.577

Appendix G: A Facsimile of the Job Applicant Data Card.

Mr.
Mrs.
Miss_______________________________
(Maiden Name)

Address_______________________________
Street City County

Do not write in this block

Not Tested_______

Passed
Yes_______ No_______

_______________ Birthdate

Education 7 8 9 10 11 12 13 14
(Circle highest grade completed)

Last High School Attended_______________ Year_______

Location of School_______________________________
(City, County)

Employed full-time before? Yes No (circle answer)

[Front]

The information on this card will be used in a survey sponsored by the Contra Costa County Department of Education and endorsed by the Northern California Industry-Education Council. You can help us greatly by filling in the card.

ALL SUCH INFORMATION WILL BE HELD IN STRICTEST CONFIDENCE - no individual will ever be identified.

Your participation is sincerely solicited.

William H. Landis
Project Director
Contra Costa County
Department of Education
75 Santa Barbara Road
Pleasant Hill, California

[Back]

Appendix H: A Facsimile of the Employer Data Card.

As indicated, an effort was made to collect additional job-entry information. The bottom half of the card was used to record on-the-job use of tests or any special information regarding training programs, apprenticeship, and advancement.

Firm Name ______________________________
Firm Address ______________________________
Personnel Contact ______________________________

Test	Open	Dept./Employ.	
			With high school graduation
			With h.s.grad. or G.E.D.
			No academic requirement
			Test, after on-job success

Test(s) Used ______________________________

SOCO ______ Hiring Only ______ Hiring/job plcmnt. ______
On-job advancement ______ Further testing ______
Special information:

Appendix I. A Facsimile of the Letter to Employers.

Dear Sir:

We are asking for your help in a pilot study which could be of mutual advantage to both industry and education. The study will attempt to determine the degree to which mathematics is involved in screening tests for job applicants in the Greater San Francisco Bay Area. Success or failure on such screening tests will be compared with the mathematical experiences of high school graduates not intending to go to college.

This study is being undertaken by the Contra Costa County Department of Education. It has been endorsed by the Northern California Industry Education Council. The undersigned, as coordinator of mathematics and science curricula, is directing the study under Dr. Floyd Marchus, Superintendent of Schools.

In light of the above, we would like to ask your organization to let us examine screening tests used for such applicants and to inform us of the role such tests play in your hiring decisions. We would also like to ask that, for a period not to exceed sixty (60) days, applicants be asked to fill in the enclosed card blank so that certain data can be tabulated.

All information will be confidential and we will furnish you a copy of the results if you so desire. I am enclosing a card blank, a card for <u>your</u> response, and a brief of the study.

I would appreciate an opportunity to discuss this matter further with you if there is any lack of clarity.

Very sincerely,

William H. Landis

William H. Landis, Coordinator
Mathematics and Science

Appendix J. A Facsimile of the Employer-Response Card.

RESPONSE CARD

Firm Name ______________________________

Person to Contact ____________________ Phone (Ext.) __________

(PLEASE CHECK)

We do___do not___use tests as a criteria for employment.

You may___may not___examine our tests for mathematics content.

We can___cannot___allow job applicants to fill out your data card.

We screen approximately____applicants in a sixty-day period.

[Back]

CONTRA COSTA COUNTY
DEPT. OF EDUCATION
75 SANTA BARBARA RD
[illegible]
POSTAGE HAS BEEN PREPAID BY

PLEASANT HILL
AUG 16 '65
CALIF.

U.S. POSTAGE
.04
T-N

Floyd Marchus, Superintendent
Contra Costa County Schools
75 Santa Barbara Road
Pleasant Hill California

Attn: William H. Landis

[Front]

Appendix K: Textbook List.

Code:

Landis		SMSG	Grade level(s) and use.
s	structured	1 or 9	2 - 7,8,9 general
tr	transitional	3	3 - 9 general/occupations
t	traditional	5	4 - 9 college prep.
	not listed	n	5 - 10 college prep.
			6 - 11, 12 college prep.

Type Landis	SMSG	Grade Level	Title, Authors, Publisher, Copyright
s	1	2	Arithmetic Concept and Skills Brumfiel, Eicholz, Shanks, O'Daffer Addison-Wesley '63
s	1	2	Introduction to Mathematics With Supplementary Problems. Brumfiel, Eicholz, Shanks, O'Daffer Addison - Weslery '65
s	1	2	Basic Modern Mathematics, First Course Eicholz, O'Daffer, Brumfiel, Shanks Addison - Wesley '65
s	1	2	Basic Modern Mathematics, Second Course Eicholz, O'Daffer, Brumfiel, Shanks Addison - Wesley '65
t	5	2	A.S.M.D. Addition, Subtraction, Multiplication, Division Hancock, Holden, Lucas, O'Brien, Schneider Addison - Wesley '63
t	n	2	Mathematics at Work Van Tuyl American '51
t	n	2	Applied Mathematics Johnson Bruce '39
t	5	2	Review Arithmetic, 1 & 2 Buswell, Brownell, John Ginn Publishing Co., '55

Appendix K (continued)

t	n	2	Math in Life Schorling & Clark Harcourt, Brace and World '46
s	n	2	Mathematics, A Modern Approach Wilcox Ginn Publishing Co. '61
s	1	2	Introduction to Secondary Math Vol. 1 & 2 Haag, Dudley D. C. Heath '64
t	n	2	Arithmetic for High School Butler D. C. Heath '53
t	n	2	General Mathematics at Work Ewing, Hart D. C. Heath '50
t	5	2	Mathematics In Life, Bk II Fehr, Schult D. C. Heath '62
t	5	2	Investigating Mathematics Grossnickle, Brueckner, Merton,Reckzeh Holt, Rinehart and Winston '62
t	5	2	Moving Into Mathematics Grossnickle, Brueckner, Merton,Reckzeh Holt, Rinehart and Winston '56
t	5	2	The New Thinking With Numbers Brueckner, Merton, Grossnickle Holt, Rinehart and Winston '52
t	5	2	The New Knowing About Numbers Brueckner, Merton, Grossnickle Holt, Rinehart and Winston '52
s	1	2	Exploring Modern Mathematics Bk 2 Keedy, Jameson, Johnson Holt, Rinehart and Winston '63

Appendix K (continued)

s	5	2	Pre-Algebra Mathematics Nichols Holt, Rinehart and Winston '65
s	n	2	General Math I Nichols Holt, Rinehart and Winston '65
t	n	2	Fundamentals Math Miller Holt, Rinehart and Winston '57
t	n	2	Everyday Mathematics Douglass, C. E. Holt, Rinehart and Winston '51
t	n	2	New Practical Math Lennes MacMillan '49
t	5	2	Applying Arithmetic (The World of Numbers Series) Carpenter, Drake MacMillan Company '57
t	n	2	Making Mathematics Plain Rose & Weber McCormick-Mather '56
t	5	2	Using Mathematics Henderson, Pingry McGraw - Hill Book Company '55
s	3	2	Modern Mathematics - Topics and Problem Book I and II Aiken, Beseman McGraw - Hill Book Company '59
t	5	2	Arithmetic For Today, Book I and II Durell, Hagaman, Smith Charles E. Merrill Books, Inc. '62
t	n	2	Arithmetic Progress, Book 3, 4, 5, 6 Johnson Charles E. Merrill Books, Inc. '61

Appendix K (continued)

t	n	2	Basic Arithmetic Nelson Noble and Noble '50
t	5	2	Mathematics, First Course Brown, Gordey, Sward, Mayor Prentice - Hall, Inc. '60
t	5	2	Mathematics, Second Course Brown, Gordey, Swand, Mayor Prentice - Hall, Inc. '60
t	n	2	Arithmetic in Life & Work Lasley, Mudd Prentice - Hall, Inc. '52
s	1	2	Seeing Through Mathematics 2 Van Engen, Hartung, Trimble, Berger, Cleveland Scott, Foresman and Company '62
s	1	2	Seeing Through Arithmetic, Special Book B Hartung, Van Engen, Knowles Scott, Foresman and Company
t	5	2	Mathematics and Life, Book 2 Knight, Studebaker, Hawkins, Tate Scott, Foresman and Company '46
t	n	2	Your Mathematics Hawkins Scott, Foresman and Company '53
t	5	2	Functional Mathematics Grade 7 Gager, Kikomoor, Schuster, Echols, Johnson, Mahood, Madden Scribner Publishing Co. '53
s	1	2	Modern Mathematics Through Discovery Book I Rosskopf, Morton, Moredock, Gilbert Silver Burdett Company '61
s	5	2	Modern Basic Mathematics, Book I & II Skeen, Whitmore L. W. Singer '64

Appendix K (continued)

t	5	2	Modern Mathematics In Elementary and Junior High Schools Williams, Read, Williams L. W. Singer '61
t	5	2	Working With Numbers, Books 6, 7, 8 Benbrook, Foerster Steck-Vaughn Company '52
t	n	2	Fundamentals of Arithmetic Stein Van Nostrand '59
t	n	2	Mathematics for Daily Needs Osborn-Colstock Webster '60
t	n	2	Applied Mathematics Lankford and Clark World Book Co. '53
t	n	2	Basic Ideas of Mathematics Lankford and Clark World Book Co. '53
t	n	2	Essential Mathematics Lankford and Clark World Book Co. '61
t	n	2	Mathematics in Daily Use Landford and Clark World Book Co. '53
s	1	2	Introduction to Secondary School Mathematics, Vol. I and II SMSG Yale University Press '62
s	1	2	Mathematics for Junior High School Vol. I and II SMSG Yales University Press '61
s	3	3	Mathematics - A Liberal Arts Approach Dodes Hayden Book Company '64

Appendix K (continued)

t	5	3	Mathematics In Living Series (Book 1 Buying, Book 2 Wages and Budget, Book 3 Banking, Book 4 Insurance and Taxes) Weiland, Woytek Pruitt Press '64
s	3	3	Basic Mathematics ..A Problem-Solving Approach, Book 1 thru 5 O'Malley Addison - Wesley '63
s	1	3	Mathematics..A Modern Approach Wilcox, Yarnelle Addison - Wesley '63
t	5	3	Arithmetic in My World Stokes, Adams, Whiteley, Bauer, Kendall and others Allyn and Bacon, Inc. '59
tr	3	3	Basic Mathematics for High Schools Thordarson, Anderson Allyn and Bacon, Inc. '62
t	5	3	Refresher Arithmetic Stein Allyn and Bacon, Inc. '61
t	5	3	Basic Mathematics-Measurement Bobrow Encyclopedia Britannica Press '61
t	5	3	Arithmetic of Better Business McMarkin, Marsh, Baten Ginn Publishing Company '59
t	5	3	Everyday General Mathematics, Bk.I & II Betz, Miller, Miller, Mitchell, Taylor Ginn Publishing Company '49 '60
t	n	3	Useful Mathematics Dunn, Allen, Goldthwaite, Potter Ginn Publishing Company '42
t	n	3	Mathematics Everyday Potter & Beck Ginn Publishing Company '45

Appendix K (continued)

t	5	3	Mathematics To Use Potter, Dunn, Allen & Goldthwaite Ginn Publishing Company '59 '62
t	5	3	Mathematics for Success Potter, Neitzel, Root, Enright Ginn Publishing Company '60
t	5	3	Mathematics for The Consumer Lankford, Schorling, Clark Harcourt, Brace and World '53
t	5	3	Mathematics in Daily Use Hart, Schult, Irvin D. C. Heath '50
t	5	3	Essentials of Business Arithmetic Kanzer, Schaaf D. C. Heath '50
t	n	3	Practical Electrical Mathematics Rasch D. C. Heath '46
t	5	3	Mathematics We Use - Book 3 Brueckner, Grossnickle Holt, Rinehart and Winston '48
t	5	3	Trouble Shooting Mathematics Skills Bernstein, Wells Holt, Rinehart and Winston '63
s	3	3	Foundations of Mathematics Wiebe Holt, Rinehart and Winston '62
t	5	3	Holt General Mathematics Kinney, Ruble, Blythe Holt, Rinehart and Winston '60
t	5	3	Making Mathematics Work Nelson, Grimes Houghton-Mifflin Company '50
t	5	3	General Mathematics for The Shop Nelson, Moore, Hamburger Houghton-Mifflin Company '56

Appendix K (continued)

s	5	3	General Mathematics - Book one Brown, Simon, Snader, Montgomery, Williams Laidlaw Brothers '63
s	5	3	General Mathematics - Book Two Brown, Simon, Snader, Montgomery, Williams Laidlaw Brothers '63
s	9	3	Arithmetic..An Introduction to Mathematics Lay MacMillan Company '61
t	5	3	Arithmetic for Business + Everyday Use Huffman, Twiss, Whale McGraw - Hill Book Company '56
t	5	3	Business Mathematics ..Excercises, Problems + Tests Rosenberg McGraw - Hill Book Company '63
t	5	3	Foundation Mathematics Bartoo, Osborn McGraw - Hill Book Company '54
t	5	3	General Trade Math Van Leuven McGraw - Hill Book Company '52
t	5	3	Arithmetic for Business and Consumer Use Huffman, Twiss, Whale McGraw - Hill Book Company '62
t	5	3	Practical Mathematics Palmer, Bibb McGraw - Hill '52
t	5	3	Business Arithmetic McNelly, Adams Prentice - Hall, Inc. '53
t	5	3	The New Applied Mathematics Lasley, Mudd, Rogler Prentice - Hall, Inc. '58

Appendix K (continued)

t	5	3	Going Places with Mathematics Peters Prentice - Hall Inc. '57
t	5	3	General Mathematics Mallory, Skeen, Meserve L. W.Singer '60
t	5	3	Mathematics Skill Builder Briggs South-Western '57
t	5	3	Applied Business Mathematics Piper, Gruber South-Western '56
t	5	3	General Business (8th Ed.) Crabbe, Enterline, Debrum, Salsgiver South-Western '56
t	5	3	Applied Business Arithmetic Piper et al South-Western '59
t	5	3	The Mathematics of the Shops McMackin, Shaver Van Nostrand '47
t	5	3	Mathematics for Technical and Vocation-al Schools Slade, Margolis Wiley '46
s	1	4	Modern Algebra, First Course Johnson, Lendsey, Slesnick, Bates Addison - Wesley '61
s	1	4	Algebra 1 Brumfiel, Eicholz, Shanks Addison - Wesley '61
s	1	4	Algebra One Hayden, Finan Allyn and Bacon, Inc. '61
t	5	4	Elementary Algebra Edgerton, Carpenter, White Allyn and Bacon, Inc. '59

Appendix K (continued)

t	5	4	Algebra and Its Use - Book I Grove, Mullikin, Grove, Van Dyke American Book Company '56
tr	n	4	Basic Mathematics, Bk. I Grove American Book Company '61
t	5	4	Elementary Algebra Shute, Kline, Shirk, Willson American Book Company '56
tr	n	4	Algebra Accelerated, Book I Hills & Mazziotto Bennett '59
t	5	4	Algebra I Murphy Encyclopedia Britannica Press '61
t	5	4	Algebra For Today, First Year Betz Ginn Publishing Company '57
s	1	4	Modern Algebra, A Logical Approach Pearson, Allen Ginn Publishing Company '64
t	5	4	First Course in Algebra Weeks, Adkins Ginn Publishing Company '61
t	5	4	Algebra, Book One - Elementary Course Welchons, Krickenberger, Pearson Ginn Publishing Company '62
t	5	4	First-Year Algebra, Elementary Course Hawkes, Luby, Touton Ginn Publishing Company '46 '58
t	n	4	New First Course in Algebra Hawkes, Luby Touton Ginn Publishing Company '45
s	3	4	Contemporary Algebra..Book One Smith, Lankford, Payne Harcourt, Brace and World '62

Appendix K (continued)

t	5	4	Row-Peterson Algebra One Smith, Totten, Douglass Harper and Row '54
t	5	4	Algebra, First Course Fehr, Carnahan, Beberman D. C. Heath '62
t	5	4	Algebra, Course 1 Fehr, Carnahan, Beberman D. C. Heath '57
t	5	4	A First Course in Algebra Hart D. C. Heath '51
t	5	4	New First Algebra Hart, Schult, Briston D. C. Heath '62
t	5	4	First Year Algebra Hart, Schult, Swain D. C. Heath '57
t	n	4	Progressive First Algebra Hart D. C. Heath '43
s	1	4	High School Mathematics - Course 1 Units 1 - 4 (Univ. of Ill. Press) Beberman, Vaughn D. C. Heath '59
s	1	4	Exploring Modern Mathematics Book 3 Keedy, Jameson, Johnson Holt, Rinehart and Winston '64
s	1	4	Modern Elementary Algebra Nichols Holt, Rinehart and Winston '65
tr	3	4	Modern Elementary Algebra Nichols, Collins Holt, Rinehart and Winston '61
t	5	4	Algebra 1 Morgan, Paige Holt, Rinehart and Winston '58

Appendix K (continued)

s	1	4	Discovering Structure In Algebra Grossnickle, Reckzeh, Bernhardt Holt, Rinehart and Winston '62
s	1	4	Modern Algebra..Structure and Method Dolciani, Berman, Freilich Houghton-Mifflin Company '62
t	5	4	Algebra For Problem Solving, Bk.1 Freilich, Berman, Johnson Houghton-Mifflin Company '52
t	5	4	First Course in Algebra Lennes, Maucker, Kinsella MacMillan Company '49
t	5	4	Algebra, Its Big Ideas and Basic Skills Aiken, Henderson, Pingry McGraw - Hill Book Company '53 '60
s	3	4	Foundations of Algebra, Book 1 Lancaster, Cardwell McGraw - Hill Book Company '65
s	1	4	Algebra..Its Elements and Structure Banks, Subel, Walsh McGraw - Hill Book Company '65
tr	5	4	Algebra One..A Modern Course Vannatta, Goodwin, Fawcett Charles E. Merrill Books, Inc. '62
tr	5	4	Contemporary Algebra..First Course Mayor, Wilcox Prentice - Hall, Inc. '65
tr	5	4	Algebra, First Course Mayor, Wilcox Prentice - Hall, Inc. '61
t	n	4	A First Course in Algebra Mallory Sanborn '43
s	n	4	First Course in Algebra Mallory, Skeen & Merserve L. W. Singer '61

Appendix K (continued)

s	1	4	Modern Mathematics..Algebra One Rosskopf, Morton, Hooten, Sitomer, Willoughby, Gilbert Silver Burdett Company '62
t	5	4	First Course in Algebra Mallory, Skeen, Meserve L. W. Singer '56
s	1	4	Algebra..A Modern Approach. Book 1 Peters, Schaaf Van Nostrand '63
t	5	4	Algebra In Easy Steps Stein Van Nostrand '56
t	5	4	Supplementary Units in Contemporary Arithmetic and Elementary Algebra Stein Van Nostrand '60
s	1	4	Introduction to Algebra Parts I and II SMSG Yale University Press '62
s	1	4	First Course in Algebra, Parts I and II SMSG Yale University Press '59 '61
s	1	4	Programmed First Course in Algebra Part I and Part II SMSG Yale University Press '62
t	n	4	Algebra One Smith & Landford World Book Company '55
t	n	4	Algebra: First Course Schorling, Smith & Clark World Book Co. '49
s	n	4	Introduction to Algebra Coursey McMahon '62

Appendix K (continued)

s	1	5	Geometry Moise, Downs Addison - Wesley '63
s	1	5	Geometry Brumfiel, Eicholz, Shanks Addison - Wesley '60
t	n	5	Refresher Geometry Stein Allyn '48
t	5	5	Plane Geometry Shute, Shirk, Porter American Book Company '60
t	5	5	Plane Geometry Curtis Encyclopedia Britannica Press '63
tr	5	5	High School Geometry Keniston, Tully Ginn Publishing Company '60
t	5	5	Plane Geometry Keniston, Tully Ginn Publishing Company '53
t	5	5	New Plane Geometry Welchons, Krickenberger Ginn Publishing Company '61
t	5	5	Plane Geometry, Revised Edition Welchons, Krickenberger Ginn Publishing Company '49
t	5	5	Text and Tests in Plane Geometry Smith, Reeve, Morss Ginn Publishing Company '49
t	5	5	Plane Geometry Smith, Ulrich, Clark Harcourt, Brace and World '57 '61
t	5	5	Modern-School Geometry Clark, Smith Schorling Harcourt, Brace and World '48 '54

Appendix K (continued)

t	5	5	Plane Geometry and Supplements Hart, Schult, Swain D. C. Heath '59
s	n	5	Modern Plane Geometry Hart, Schult, Swain D. C. Heath '61
s	n	5	New Plane Geometry and Supplements Hart, Schult, Swain D. C. Heath '64
t	n	5	Plane Geometry Hart D. C. Heath '50
t	n	5	Progressive Plane Geometry Wells & Hart D. C. Heath & Co. '43
tr	5	5	Geometry Fehr, Carnahan D. C. Heath '61
s	3	5	Contemporary Geometry Schacht, McLennan, Griswold Holt, Rinehart and Winston '61
t	5	5	Plane Geometry Schacht, McLennan Holt, Rinehart and Winston '57
t	5	5	Geometry..Meaning and Mastery Welkowitz, Sitomer, Snader Holt, Rinehart and Winston '50
s	1	5	Modern Geometry..Structure and Method Jurgensen, Donnelly Dolciani Houghton-Mifflin Company '63
t	5	5	Geometry For High Schools Seymour, et al MacMillan Company '58
t	5	5	Plane Geometry Seymour, Smith MacMillan Company '49

Appendix K (continued)

s	3	5	Modern Geometry, Its Structure and Function Henderson, Pingry, Robinson McGraw - Hill Book Company '62
t	n	5	Plane Geometry: A Clear Thinking Approach Schnell McGraw - Hill Book Company '53
t	n	5	Plane Geometry Heineman McGraw - Hill Book Company '56
s	5	5	Geometry..A Unified Course Goodwin, Vannatta, Fawcett Charles E. Merrill Books, Inc. '62
t	n	5	New Plane Geometry Mallory L. W. Singer '43
t	5	5	Dynamic Plane Geometry Skolnik, Hartley Van Nostrand '50
s	1	5	Geometry with Coordinates, Part I & II SMSG Yale University Press '63
s	1	5	Geometry Part 1 and 2 SMSG Yale University Press '59
s	1	6	Modern Algebra, Second Course Johnson, Lendsey, Slesnick, Bates Addison - Wesley '62
s	1	6	Pre-Calculus Mathematics Shanks, Brumfiel, Fleenor, Eicholz Addison - Wesley '65
t	5	6	Elements of Calculus and Analytical Geometry Thomas Addison - Wesley

Appendix K (continued)

s	1	6	Probability, A First Course Mosteller, Rourke, Thomas Addison - Wesley '61
s	1	6	Modern Algebra and Trigonometry Vance Addison - Wesley '62
s	3	6	An Introduction to Modern Mathematics Vance Addison - Wesley '60
t	n	6	Unified Algebra & Trigonometry Vance Addison - Wesley '55
s	n	6	Analytic Geometry: A Vector Approach Wexler Addison - Wesley '62
t	5	6	Trigonometry Vance Addison - Wesley '54
t	n	6	Analytic Geometry Fuller Addison - Wesley '51
tr	5	6	Calculus with Analytic Geometry A First Course Potter, Morrey Addison - Wesley '63
s	n	6	Elementary Mathematics Analysis Labarre Addison - Wesley '61
s	1	6	Algebra Two Hayden, Fischer Allyn and Bacon, Inc. '63
tr	5	6	Intermediate Algebra Edgerton, Carpenter, White Allyn and Bacon, Inc. '57
s	n	6	Intermediate Algebra White Allyn and Bacon, Inc. '61

Appendix K (continued)

t	5	6	Solid Geometry Avery, Stone Allyn and Bacon, Inc. '51
s	5	6	Functional Trigonometry Hillman, Alexanderson Allyn and Bacon, Inc. '61
t	n	6	Fundamentals of Mathematics Stein Allyn and Bacon, Inc. '64
t	n	6	College Algebra Morgan, American Book Company '43
t	5	6	Intermediate Algebra Shute, Kline, Shirk, Willson American Book Company '60
t	5	6	Solid Geometry Shute, Shirk, Porter American Book Company '57
t	5	6	Plane and Spherican Trigonometry with Tables Morgan American Book Company '51
t	n	6	Fundamentals of Solid Geometry Nyberg American Book Company '47
t	5	6	Algebra II Titiev Encyclopedia Britannica Press '61
t	5	6	Solid Geometry Luckman Encyclopedia Britannica Press '62
t	5	6	Trigonometry Luckman Encyclopedia Britannica Press '61
s	3	6	Analytic Trigonometry Luckman Encyclopedia Britannica Press '62

Appendix K (continued)

t	n	6	Plane Trigonometry Brink Appleton Century '40
t	n	6	Solid Geometry Sigley Dryden '56
s	n	6	Introductory Calculus Bobrow Encyclopedia Britannica Press '61
s	n	6	Analytic Geometry Luckman Encyclopedia Britannica Press '62
s	5	6	Language of Algebra Lawvere Encyclopedia Britannica Press '62
s	1	6	Topics In Modern Mathematics (An Introduction to Sets and The Structure of Algebra) Krickenberger and Pearson Ginn Publishing Company '58
t	n	6	Solid Geometry McCormack Ginn Publishing Company '31
t	5	6	Brief Analytic Geometry Mason, Hazard Ginn Publishing Company '57
t	5	6	New Analytic Geometry Smith, Gale, Neelley Ginn Publishing Company '58
t	5	6	Second Course in Algebra - With Trigonometry Weeks, Adkins Ginn Publishing Company '62
t	5	6	Algebra, Book Two, Second Course Welchons, Krickenberger Ginn Publishing Company '60

Appendix K (continued)

s	n	6	Algebra, Book 2, Modern edition Welchons, Krickenberger, Pearson Ginn Publishing Company '62
t	5	6	Algebra For Today, Second Course Betz Ginn Publishing Company '51
t	5	6	Second-Year Algebra, Intermediate and Advanced Course Hawkes, Luby, Touton Ginn Publishing Company '56
tr	5	6	Analytic Geometry Steen, Ballou Ginn Publishing Company '63
t	5	6	Essentials of Solid Geometry, Including Spherical Geometry Welchons, Krickenberger, Pearson Ginn Publishing Company '59
t	5	6	Solid Geometry Welchons, Krickenberger, Pearson Ginn Publishing Company '55
tr	n	6	A Course in Plane and Solid Geometry Weeks, Adkins Ginn Publishing Company '61
t	5	6	Solid Geometry, Revised Edition Welchons, Krickenberger Ginn Publishing Company '50
tr	5	6	Modern Trigonometry Welchons, Krickenberger, Pearson Ginn Publishing Company '62
t	5	6	Trigonometry With Tables Welchons, Krickenberger Ginn Publishing Company '60
t	5	6	Plane Trigonometry and Tables Granville, Smith, Mikesh Ginn Publishing Company '52

Appendix K (continued)

t	5	6	Plane and Spherical Trigonometry with Tables Wentworth, Smith Ginn Publishing Company '51
t	5	6	Plane Trigonometry and Tables Wentworth, Smith Ginn Publishing Company '51
t	n	6	Trigonometry Welchons, Douglas Ginn Publishing Company '54
t	5	6	Essentials of Plane Trigonometry with Tables Rosenbach, Whitman, Moskovitz Ginn Publishing Company '43 '61
t	5	6	Plane Trigonometry with Tables Ballou, Steen Ginn Publishing Company '53
t	5	6	Plane and Spherical Trigonometry with Tables Ballou, Steen Ginn Publishing Company '53
t	5	6	Introductory College Mathematics Milne, Davis Ginn Publishing Company '62
t	n	6	Elements of the Differential and Integral Calculus Granville Ginn Publishing Company '57
t	n	6	Modern School Solid Geometry Schorling, Clark, Smith Harcourt, Brace and World '48 '54
t	n	6	Plane Trigonometry with Tables Weeks Ginn Publishing Company '53
t	n	6	Second Year Algebra Schorling Harcourt, Brace and World '50

Appendix K (continued)

t	5	6	Trigonometry Smith, Hanson Harcourt, Brace and World '57
t	5	6	Solid Geometry Smith, Ulrich Harcourt, Brace and World '57
t	5	6	Row-Peterson Algebra Two Smith, Totten, Doublass Harper and Row '61
s	1	6	UICSM Preliminary Edition (Probability and Statistical Inference) Beberman, Vaughn D. C. Heath '59
t	5	6	Trigonometry For Secondary Schools Butler, Wren D. C. Heath '57
t	5	6	Algebra, Course 2 Fehr, Carnahan, Beberman D. C. Heath '55
t	5	6	New Second Algebra Hart, Schult, Briston D. C. Heath '62
t	5	6	A Second Course in Algebra Hart D. C. Heath '51
t	5	6	Second Year Algebra Hart, Schult, Swain D. C. Heath '57
t	n	6	Essentials of Algebra Hart D. C. Heath '43
s	3	6	Elementary Mathematical Analysis Herberg, Bristol D. C. Heath '62
t	5	6	Trigonometry Hart D. C. Heath '54

Appendix K (continued)

t	5	6	Analytic Geometry Wilson, Tracey D. C. Heath '15
t	5	6	College Algebra Hart D. C. Heath '53
t	5	6	Mathematical Analysis Camp D. C. Heath '56
t	5	6	Modern Higher Algebra Wells, Hart D. C. Heath '33
t	5	6	Modern Plane Trigonometry Hart, W. L. D. C. Heath '61
t	n	6	Progressive Solid Geometry Hart, W. L. D. C. Heath '43
t	n	6	Solid Geometry Hart, W. W. D. C. Heath '52
t	n	6	Analytic Geometry and Calculus Hart, W. L. D. C. Heath '57 '63
s	1	6	Introductory Calculus with Analytic Geometry Begle Holt, Rinehart and Winston '61
t	5	6	Brief Units in Solid Geometry Schact, McLennan Holt, Rinehart and Winston '59
s	n	6	Elementary Concept of Sets Woodward and McLennon Holt, Rinehart and Winston '59
t	5	6	Modern Trigonometry Brixey, Andree Holt, Rinehart and Winston '55

Appendix K (continued)

t	5	6	Algebra 2 Morgan, Paige Holt, Rinehart and Winston '58
s	1	6	Contemporary Second-Year Algebra Keedy, Griswold, Schacht Holt, Rinehart and Winston '63
t	n	6	Senior Mathematics Douglas, Kinney Holt, Rinehart and Winston '45
t	n	6	Algebra: Meaning and Mastery Bk. II Snader Holt, Rinehart and Winston '50
s	3	6	A Modern Course in Trigonometry Hooper, Griswold Holt, Rinehart and Winston '59
s	1	6	Fundamentals for Advanced Mathematics Glicksman, Ruderman Holt, Rinehart and Winston '64
tr	5	6	Fundamentals of College Mathematics Brixey, Andree Holt, Rinehart and Winston '61
t	5	6	Analytic Geometry and Calculus Schwartz Holt, Rinehart and Winston '60
t	5	6	Algebra For Problem Solving Freilich, Berman, Johnson Houghton-Mifflin Company '57
s	1	6	Modern Algebra and Trigonometry.. Structure and Method, Book 2 Dolciani, Berman, Wooton Houghton-Mifflin Company '63
s	1	6	Modern Introductory Analysis Dolciani, Beckenbach, Donnelly, Jurgensen, Wooton Houghton-Mifflin Company '64

Appendix K (continued)

t	5	6	Solid Geometry Morgan, Beckenridge Houghton-Mifflin Company '57
s	n	6	Elementary Functions Dolciani Houghton-Mifflin Company '65
t	5	6	Second Course in Algebra Lennes MacMillan '50
t	n	6	Geometry - Plane and Solid Brown and Montgomery Laidlaw Bros. '60
t	5	6	Solid Geometry Seymour, Smith MacMillan Company '49
s	1	6	Algebra..Its Elements and Structure, Book 2 Banks, Sobel, Walsh McGraw - Hill Book Company '64
t	n	6	Solid and Spherical Trigonometry Seymour MacMillan Company '49
s	n	6	Arithmetic for College Larson MacMillan Company '58
s	1	6	Fundamentals of Freshman Mathematics Allendoerfer, Oakley McGraw - Hill Book Company '59
s	1	6	Principles of Mathematics Allendoerfer, Oakley McGraw - Hill Book Company '63
t	5	6	Plane Trigonometry with Tables Heineman McGraw - Hill Book Company '56
t	5	6	Plane and Spherical Trigonometry Kells, Kern, Bland McGraw - Hill Book Company '51

Appendix K (continued)

t	5	6	Trigonometry For Today Brooks, Schock, Oliver McGraw - Hill Book Company '59
t	5	6	Algebra and Trigonometry Rees, Sparks McGraw - Hill Book Company '62
s	3	6	Algebra Two..A Modern Course Vannetta, Goodwin, Fawcett Charles E. Merrill Books, Inc. '62
tr	5	6	Advanced High School Mathematics Vannatta, Carnahan, Fawcett Charles E. Merrill Books, Inc. '63
t	n	6	Solid Geometry Bartoo, Osborn McGraw - Hill Book Company '40
t	n	6	Basic Mathematical Analysis Ayre, H. Glenn McGraw - Hill Book Company '50
t	5	6	Contemporary Algebra..Second Course Mayor, Wilcox Prentice - Hall, Inc. '65
t	5	6	Algebra, Second Course Mayor, Wilcox Prentice - Hall, Inc. '61
t	5	6	Trigonometry Rees, Rees Prentice - Hall, Inc. '59
s	1	6	Analytic Geometry and an Introduction to Calculus Schock, Warshaw Prentice - Hall, Inc. '61
t	5	6	Calculus with Analytic Geometry Taylor Prentice - Hall, Inc. '56
t	5	6	College Algebra Richardson Prentice - Hall, Inc. '58

Appendix K (continued)

t	n	6	A Second Course in Algebra Stone and Mallory Sanborn '37
s	1	6	Introduction to Finite Mathematics Kemeny, Snell, Thompson Prentice - Hall, Inc. '57
t	n	6	New Trigonometry Including Elements of Spherical Trigonometry Mallory Sanborn '55
s	1	6	Modern Mathematics..Algebra Two and Trigonometry Rosskepf, Willoughby, Vogeli Silver Burdett Company '64
t	5	6	Senior Mathematics Mallory, Fehr L. W. Singer '55
t	5	6	Second Course in Algebra Mallory, Meserve, Skeen L. W. Singer '61
s	1	6	Principles of Advanced Mathematics Meserve, Pettofrezzo, Meserve L. W. Singer '64
t	n	6	New Solid Geometry Mallory, V. S. L. W. Singer '43
t	n	6	New Trigonometry Essentials of Solid Geometry Mallory L. W. Singer '55
t	5	6	Plane Trigonometry Weeks, Funkhouser Van Nostrand '53
t	5	6	Calculus and Analytic Geometry Randolph Wadsworth '61

Appendix K (continued)

t	5	6	Basic Mathematics for Science and Engineering Andres, Miser, Reingold Wiley '55
t	n	6	Essentials of Trigonometry Rosenbach Van Nostrand '50
t	n	6	Dynamic Solid Geometry Skolnik and Hartley Van Nostrand '52
t	n	6	Solid Mensuration Kern Wiley '38
t	n	6	Solid Mensuration With Proofs Kern, Bland Wiley '54
s	n	6	An Introduction to Balgol Oakford and Gere Wadsworth Publishing Company '61
s	1	6	Intermediate Mathematics, Parts I & II SMSG Yale University Press '61
s	1	6	Elementary Functions SMSG Yale University Press '61
s	1	6	Introduction to Matrix Algebra SMSG Yale University Press '61
s	1	6	Analytic Geometry, Parts I and II SMSG Yale University Press '63
t	n	3	Economic Mathematics: Business Arithmetic for the Consumer Lennes and Sutton Allyn and Bacon '50

Appendix K (continued)

t	n	3	Mathematics in Business Hendle - Feldman Allyn and Bacon '63
t	n	3	Shop Mathematics Felker, C. A. Bruce '58
t	n	3	Sheet Metal Mathematics New York State Vocational Association Delmar '47
t	n	3	Money Makes Sense Kahn Fearon '60
t	n	3	Using Dollars and Cents Kahn Fearon '64
t	n	3	Vocational Mathematics Vol. I and II Schumacher Goodheart-Willcox '54
t	n	3	Vocational Mathematics, Shop Arith. Schumacher Goodheart '61
t	n	3	Arithmetic for Business Use Hanna and Marshall Harper-Row '52
t	n	3	Basic Mathematics for Electronics Cooke McGraw-Hill Book Company '64
t	n	3	General Business for Everyday Living Price, Musselman, Weeks McGraw - Hill Book Company '60
t	n	3	Technical Mathematics Rice and Knight McGraw - Hill Book Company '63
t	n	3	Consumer Economics Wilhelms McGraw - Hill Book Company '59

Appendix K (continued)

t	n	3	Carpentry Mathematics Wilson & Rogers McGraw - Hill Book Company '49
t	n	3	Elementary Technical Mathematics Juszli Prentice Hall '62
t	n	3	General Clerical Procedures Kirk, John and others Prentice-Hall, Inc. '51
t	n	3	Everyday Business Lawson Scholastic '64
t	n	3	Business Mathematics, Principles and Practices Rosenberg South-Western '53
t	n	3	Money Management Library Household Finance Household Finance Corp. '63
t	n	3	Teaching Taxes Program Internal Revenue Service Internal Revenue Service '63
s	n	4	Primer of Statistics for Non-statisticians Franzblau Harcourt Brace and World '59
tr	n	4	Introduction to Probability and Statistics Alder and Roessler Freeman '62
t	n	6	Computing Tables Barker Ginn Publishing Co. '41
t	n	6	Programming the 650 Computer Andree, Richard V. Holt, Rinehart and Winston '58

Appendix K (continued)

t	n	6	Handbook of Mathematics, Tables and Formulas Burington, Richard S. McGraw-Hill Book Company '65
t	n	6	College Entrance Reviews in Intermediate Mathematics Shapiro and Tapper Educational Advisory Center '58
t	n	6	College Entrance Reviews in Mathematics Aptitude Shapiro and Tapper Educational Publishing Service '60
t	n	6	The Consumer and The Law Getz, S. George N. E. A. '58
t	n	6	Physics, Fundamentals and Frontiers Stollberg, Hill Houghton Mifflin '65
t	n	6	Basic Electronics Grob, Bernard McGraw-Hill Book Company '59

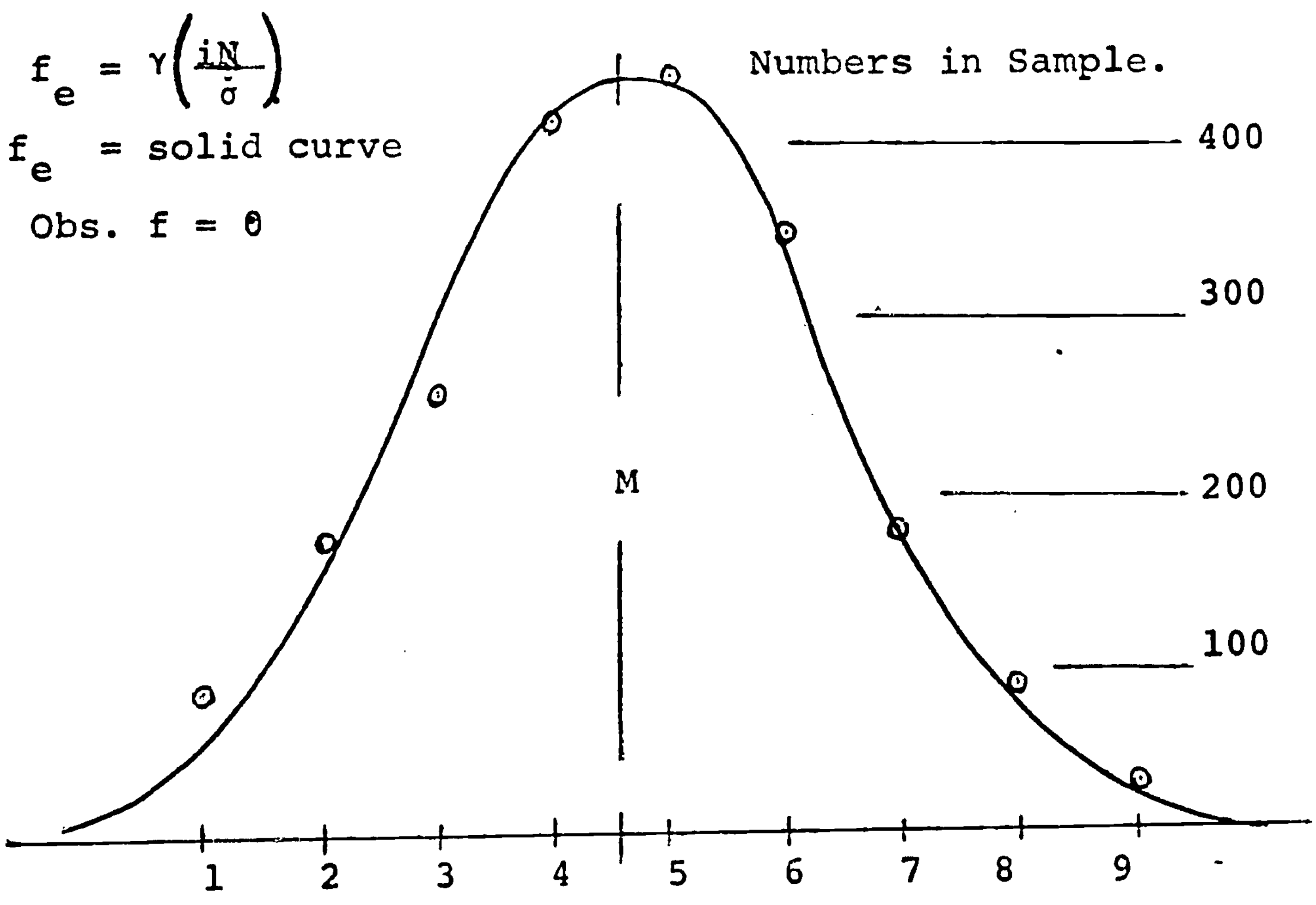
Appendix L: The Development of the Sample - Sources and Levels of Attrition.

	Total Cards	To Age 23	Bay Area H.S.	No Ed. Beyond 12th	Less Not Tested	Less "Non part." Dist.	Less Incom-plete Records	In Sample	
								Male	Female
a. Manufacturing Durable Goods	1,536	820	606	483	378	371	162	108	54
b. Manufacturing Non-Durable Goods	1,682	909	659	562	536	529	217	161	56
c. Utilities	10,024	4,164	2,431	1,844	1,844	1,650	791	194	597
d. Wholesale Retail Trade	600	542	508	379	379	372	150	110	40
e. Finance	1,512	538	538	538	538	355	94	10	84
f. Government	1,492	1,012	931	883	868	798	517	43	474
g. Transportation	304	147	106	67	67	58	19	3	16
h. Services	680	348	338	264	239	236	68	50	18
Totals	17,835	8,480	6,117	5,020	4,849	4,369	2,018	679	1,339

Appendix M: Evidence of "Normality" for the sample. Based on expected frequencies for academic aptitude versus observed frequencies.

X	X-M	z	γ	f_e	Obs.f.	% diff.
9	4.4	2.44	.0198	22.28	39	0.83
8	3.4	1.89	.0656	73.81	80	0.31
7	2.4	1.33	.1670	187.91	184	-0.19
6	1.4	0.78	.2969	334.07	345	0.54
5	0.4	0.22	.3894	438.16	439	0.04
4	-0.6	0.33	.3776	424.88	411	-0.69
3	-1.6	0.89	.2756	310.11	255	-2.74
2	-2.6	1.44	.1415	159.22	167	0.39
1	-3.6	2.00	.0540	60.76	93	1.60

N = 2013
M = 4.659
σ = 1.789 (Sheppard's correction applied)
σ^2= 3.201 (Sheppard's correction applied)



Academic Aptitude Stanines (from standardized tests)

Appendix N: Chi-square Tests of Matched Groups
Structured(S) vs Traditional College Preparatory(T) Mathematics.

Socio - Economic Levels:

	High		+ Average		- Average		Composite	
Male:	S	T	S	T	S	T	S	T
N-Matched	9	9	38	38	37	37	84	84
Pass	6	5	29	21	33	19	68	45
Avg. Yrs. H. S.	4	4	3.8	4.0	3.9	3.9	3.9	3.9
Avg. Sem. Math.	6.6	6.0	5.9	5.7	5.9	5.6	5.9	5.7
χ^2	0.234		3.742		13.946		14.299	
Level Sig.	$.70>\varepsilon>.50$		$.10>\varepsilon>.05$		$.001>\varepsilon$		$.001>\varepsilon$	
H_o	accept		accept		reject		reject	
Female:								
N-Matched	12	12	59	59	67	67	138	138
Pass	9	9	48	39	50	41	107	89
Avg. Yrs. H. S.	3.8	3.7	4.0	3.9	3.9	3.9	3.9	3.9
Avg. Sem. Math.	5.3	4.3	4.2	4.3	4.6	4.6	4.5	4.4
χ^2		0	3.544		2.773		5.703	
Level Sig.		0	$.10>\varepsilon>.05$		$.10>\varepsilon>.05$		$.02>\varepsilon>.01$	
H_o	accept		accept		accept		reject	
M + F: N-Matched	222	222	χ^2= 17.892					
Pass	175	134	Level $.001>\varepsilon$		H_o reject			

Appendix N: (continued)
Structured(S) vs Occupational(O) Mathematics

Socio - Economic Levels:

	High		+ Average		- Average		Composite	
Male:	S	O	S	O	S	O	S	O
N-Matched	too few		17	17	36	36	53	53
Pass			13	11	25	13	38	24
Avg. Yrs. H. S.			3.8	3.9	3.9	3.9	3.9	3.9
Avg. Sem. Math.			5.4	5.4	5.6	5.5	5.5	5.5
χ^2			0.566		8.025		7.615	
Level Sig.			$.50>\varepsilon>.30$		$.01>\varepsilon>.001$		$.01>\varepsilon>.001$	
H_o			accept		reject		reject	
Female:								
N-Matched	too few		51	51	77	77	128	128
Pass			31	17	42	26	73	43
Avg. Yrs. H. S.			4.0	3.9	3.9	3.9	3.9	3.9
Avg. Sem. Math.			4.1	3.8	4.7	3.8	4.4	3.8
χ^2			7.713		6.741		14.187	
Level Sig.			$.01>\varepsilon>.001$		$.01>\varepsilon>.001$		$.001>\varepsilon$	
H_o			reject		reject		reject	
M + F: N-Matched	181	181	χ^2= 32.388					
Pass	111	57	Level $.001>\varepsilon$		H_o reject			

Appendix N: (continued)
Structured(S) vs General(G) Mathematics.

Socio - Economic Levels:

	High		+ Average		- Average		Composite	
	S	G	S	G	S	G	S	G
Male:								
N-Matched	too few		23	23	32	32	55	55
Pass			18	12	22	20	40	32
Avg. Yrs. H. S.			3.7	3.7	3.9	3.7	3.8	3.7
Avg. Sem. Math.			5.1	4.5	5.8	3.9	5.5	4.2
χ^2			3.450		0.277		2.573	
Level Sig.			$.10>\varepsilon>.05$		$.70>\varepsilon>.50$		$.20>\varepsilon>.10$	
H_o			accept		accept		accept	
Females:								
N-Matched	14	14	41	41	62	62	117	117
Pass	10	7	26	21	25	14	61	42
Avg. Yrs. H. S.	3.8	3.8	3.9	3.9	3.9	3.9	3.9	3.9
Avg. Sem. Math.	5.5	4.7	4.2	3.9	4.4	4.2	4.5	4.2
χ^2	1.348		1.246		4.526		6.261	
Level Sig.	$.30>\varepsilon>.20$		$.30>\varepsilon>.20$		$.05>\varepsilon>.02$		$.02>\varepsilon>.01$	
H_o	accept		accept		accept		reject	
M + F: N-Matched	172	172	χ^2= 8.479					
Pass	101	74	Level $.01>\varepsilon>.001$ H_o reject					

Appendix N: (continued)
Traditional College Prep(T) vs General(G) Mathematics

Socio - Economic Levels:

	High		+ Average		- Average		Composite	
Male:	T	G	T	G	T	G	T	G
N-Matched	too few		25	25	26	26	51	51
Pass			14	23	12	14	26	26
Avg. Yrs. H. S.			3.9	3.6	3.9	3.8	3.9	3.7
Avg. Sem. Math.			5.2	3.8	5.0	3.7	5.1	3.8
χ^2			0.321		0.308		zero	
Level Sig.			$.70>\varepsilon>.50$		$.70>\varepsilon>.50$		$\varepsilon>.99$	
H_o			accept		accept		accept	
Female:								
N-Matched	10	10	34	34	34	34	78	78
Pass	7	5	17	17	13	11	37	33
Avg. Yrs. H. S.	3.5	4.2	3.9	4.0	3.9	3.9	3.8	3.9
Avg. Sem. Math.	4.6	4.0	4.2	4.0	4.9	4.8	4.6	4.4
χ^2	0.833		zero		0.257		0.415	
Level Sig.	$.50>\varepsilon>.30$		$\varepsilon>.99$		$.70>\varepsilon>.50$		$.70>\varepsilon>.50$	
H_o	accept		accept		accept		accept	

M + F: N-Matched	129	129	$\chi^2= 0.249$
Pass	63	59	Level $.70>\varepsilon>.50$ H_o accept

Appendix O: Chi-square Test of Variance of Characteristics (7 variables, each compared with job test pass/fail) Stanford Computer Center Run. Program BMDO8D - cross tabulation with variable stacking.

Name Variable	χ^2	Degrees Freedom	Level of Significance
MALES:			
Highest Grade Completed	2.47945	3	$.50>\varepsilon>.30$
Type of Mathematics	41.25324	4	$.001>\varepsilon$
No. Yrs. High School	0.98341	2	$.70>\varepsilon>.50$
Semesters Mathematics	15.52998	8	$.05>\varepsilon>.02$
Family Income	4.58026	2	$.20>\varepsilon>.10$
Head of Household	0.86789	2	$.70>\varepsilon>.50$
Type of Job, Hd. Hshld.	3.210	6	$.80>\varepsilon>.70$
FEMALES:			
Highest Grade Completed	0.3809	3	$.95>\varepsilon>.90$
Type of Mathematics	94.45852	4	$.001>\varepsilon$
No. Yrs. High School	1.17981	2	$.70>\varepsilon>.50$
Semesters Mathematics	17.18998	8	$.05>\varepsilon>.02$
Family Income	50.78789	2	$.001>\varepsilon$
Head of Household	4.39808	2	$.20>\varepsilon>.10$
Type of Job, Hd. Hshld.	10.064	6	$.20>\varepsilon>.10$

Appendix P: Correlations Matrices for "Within-Groups" Variance -- mathematics types versus standardized test and job test results. Smallest negative correlation shows highest true correlation: see text. Stanford Computer Center Run -- program BMDO7M: Step-wise Discriminant Analysis.

Legend:

Academic Aptitude	1	No Mathematics in H. S.	W
Reading	2	Traditional College Prep	T
Mathematics	3	Structured	S
Job Test pass/fail	4	Occupational	O
N = number cases		General	G

FEMALE:

	Total:N=1339			W:N=17			T:N=225			S:N=306			O:N=392			G:N=399		
	2.	3.	4.	2.	3.	4.	2.	3.	4.	2.	3.	4.	2.	3.	4.	2.	3.	4.
1.	65	59	-34	33	35	-56	59	49	-24	76	73	-45	60	58	-25	62	52	-38
2.		55	-34		61	10		50	-34		61	-43		55	-23		51	-37
3.			-29			-02			-02			-39			-19			-36

MALE:

	Total:N=679			W:N=2			T:N=147			S:N=214			O:N=79			G:N=237		
	2.	3.	4.	2.	3.	4.	2.	3.	4.	2.	3.	4.	2.	3.	4.	2.	3.	4.
1.	66	56	-28	Dropped			67	50	-24	73	63	-22	51	45	-29	61	54	-37
2.		56	-21					59	-19		56	-17		54	-32		55	-22
3.			-21						-14			-27			-21			-19

Appendix Q: Fisher's "t" - test on the Adjusted Means, an additional check on the hypotheses. The data is drawn from the Covariance Analysis of Variance Run, Stanford Computer Center.

Legend:			
No mathematics in H.S.	W	Occupational	O
Traditional College Prep.	T	General	G
Structured	S	Common or Total	C

Data on Job Test pass/fail.

Females:

N=1339	W	T	S	O	G	C
Raw Score Means	2.765	2.444	2.408	2.643	2.719	2.580
Adjusted Means	2.609	2.548	2.506	2.623	2.612	2.580
s	.437	.498	.492	.480	.450	.476
s^2	.191	.248	.242	.230	.203	.227
N	17	225	306	392	399	1339

Males:

N=679	W	T	S	O	G	C
Raw Score Means	Drop.	2.450	2.318	2.544	2.603	2.473
Adjusted Means		2.518	2.399	2.500	2.502	2.473
s		.499	.467	.501	.490	.485
s^2		.249	.218	.251	.240	.235
N	2	147	214	79	237	677

continued.

Appendix Q: (continued)

"t"-test results

Females:

Traditional vs.	W	T	O	G
t	0.489	---	1.836	1.637
Level Sig.	$\varepsilon > .05$	---	$\varepsilon > .05$	$\varepsilon > .05$
df	240	---	615	622

Structured vs.	W	T	O	G
t	0.842	0.964	3.158	2.970
Level Sig.	$\varepsilon > .05$	$\varepsilon > .05$	$.01 > \varepsilon$	$.01 > \varepsilon$
df	321	529	696	703

Males:

Traditional vs.	T	O	G
t	---	1.427	0.308
Level Sig.	---	$\varepsilon > .05$	$\varepsilon > .70$
df	---	224	382

Structured vs.	T	O	G
t	2.308	1.605	2.394
Level Sig.	$.05 > \varepsilon$	$\varepsilon > .05$	$.05 > \varepsilon$
df	359	293	451

Appendix R: Significance Test for Difference Between Variances of Two Samples. An F-test on the variances of mathematics types. Data drawn from Covariance Analysis of Variance Run, Stanford Computer Center; tables in Appendix Q.

Females:

		= 0.05	n_1	n_2
$s_c^2 = .227$				
$s_w^2 = .263$	$F_{cw} = 1.118$	1.96	1339	17
$s_t^2 = .249$	$F_{ct} = 1.096$	1.19	1339	225
$s_s^2 = .243$	$F_{cs} = 1.070$	1.19	1339	306
$s_o^2 = .230$	$F_{co} = 1.013$	1.13	1339	392
$s_g^2 = .203$	$F_{cg} = 1.118$	1.13	1339	399

Males:

		= 0.05	n_1	n_2
$s_c^2 = .235$				
$s_t^2 = .251$	$F_{ct} = 1.068$	1.25	679	147
$s_s^2 = .219$	$F_{cs} = 1.073$	1.22	679	214
$s_o^2 = .254$	$F_{co} = 1.081$	1.35	679	79
$s_g^2 = .241$	$F_{cg} = 1.026$	1.22	679	237

Appendix S: A Comparison of "Pass-Fail" Ratios on Employer's Tests with The Means of Academic Aptitude Stanines.

	Means	
	Pass	Fail
Manufacturing: Durable Goods	5.453	4.561
Manufacturing: Non-Durable Goods	4.957	3.172
Utilities	5.737	3.978
Retail Sales	5.467	4.076
Finance	4.750	4.481
Civil Service (all levels)	6.052	4.170
Transportation	4.428	3.833
Services	4.557	3.143
Grand Means	5.252	4.027
Total Group Mean	4.659	