A MULTIVARIATE DISCRIMINANT ANALYSIS OF THE RELATIONSHIP BETWEEN SELECTED CHARACTERISTICS OF ENTERING STUDENTS AND THEIR FINAL UNDERGRADUATE MAJORS

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This is to certify that the

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ABSTRACT

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Purpose

The purpose of this study was to investigate relationships which exist between students' characteristics, as measured by orientation data, and their final undergraduate majors. One major hypothesis was proposed: Undergraduate major fields can be differentiated on the basis of selected characteristics of entering freshman students who attain senior standing or graduate in each major.

Methodology

Forty-seven measures of ability/achievement, family and background experiences, self-ratings and interests, and educational/vocational preferences were selected as relevant student variables. The student sample was drawn from the first-time freshmen who entered Michigan State University during either Fall 1963 or Fall 1964 and had graduated or attained senior standing by Spring 1967. The major sample consisted of the undergraduate major fields represented in

the student sample which contained at least 40 students of one sex. A total of 909 men and 856 women in 27 groups representing 23 different major fields made up the final study sample from which a 20 percent random sample was drawn for cross-validation purposes.

The data were subjected to four treatments: (1) a discriminant analysis of the 27 major groups, (2) a separate discriminant analysis of the 14 male groups and the 13 female groups, (3) classification of a cross-validation sample based on the 27-group analysis, and (4) classification of male and female cross-validation samples based on the 14- and 13-group analyses, respectively.

Results

The 27-group discriminant analysis yielded 26 functions, of which 10 were significant at the .001 level, a rejection of the null hypothesis. Function one accounted for 51 percent of the dispersion among groups and split the majors into a verbal/humanistic group and a numerical/physical science/technical group. The verbal/humanistic group contained only female majors; the numerical/physical science/technical group contained all the male majors plus the mathematics women. Function two, interpreted as generalist to specialist in nature, accounted for 11 percent of the trace. The third function separated the major groups along an abstract to applied continuum and accounted for 10 percent of the dispersion. The fourth and fifth functions, each accounting for 4 percent of the trace, were interpreted but not labeled because the heterogeneous combination of high weight variables in each function did not lend themselves to a common interpretation. The remaining five significant functions were not interpreted.

The separate discriminant analyses of 14 male and 13 female majors each produced five significant functions which accounted for 80 and 76 percent of the dispersion, respectively, and which were interpreted in detail.

Three cluster analyses were performed using inter-centroid distances and a computational scheme suggested by Rao (1952). The 27-group case produced 6 multi-group clusters and two isolated majors. The results of the cluster formation supported the secondary hypothesis that men and women in the same major have different patterns of characteristics. For each analysis, clusters were compared on the first three significant functions by means of a three-dimensional plot of group centroids.

A maximum likelihood procedure based on function weights and discriminant scores was used to classify three 20 percent cross-validation samples into majors and clusters. Assignments were scored as hits (classification into correct major), near hits (classification into correct cluster), and misses. Results were significantly better than chance.

Thus, it would seem that, as Holland (1966a) suggests, there is a tendency for students to seek environments which permit them to exercise their skills and abilities, to take on agreeable problems and roles, and to avoid disagreeable ones. Results of this investigation demonstrated that it is possible to differentiate among major field environments on the basis of the dominant characteristics of members of each environment. Further, it appears that these characteristics are fairly stable over time.

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CHAPTER I

THE PROBLEM

Need

The Michigan State University Catalog lists over 150 programs of study (majors), available to the entering undergraduate student, administered by more than 80 departments in 13 colleges. Individual undergraduate courses offered during a term number in the hundreds and, in one academic year, well over 2,000 different courses are presented to students. Michigan State University is not atypical. A study (Saupe, 1966) of courses listed and taught at nine of the eleven universities which make up the Institutional Research Council of Eleven[1] gave the median number of undergraduate courses listed for a year as 2,108.

Michigan State University, recognizing the choice problems presented to entering freshmen by so vast a selection of courses and majors as indicated above, provides a liberal policy governing selection and change of major and makes available academic advisement and counseling services

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[1]The IRCE is composed of universities in the Big Ten Conference and The University of Chicago.

to assist students in making intelligent, appropriate, and satisfying decisions. Beginning freshman students attend a 3-day summer orientation and counseling session (called a "clinic"), during which they take academic aptitude and placement tests. Personal information is collected on a Counseling Center form, the Personal Information Inventory (PII), and through individual interviews. The PII is made available to clinic counselors, but not to academic advisers. Test results are stated as raw scores and percentiles and are used by clinic counselors, and later by academic advisers, to assist students in selecting a major field and planning an educational program.

Recent research results (Abe & Holland, 1965; Davis, 1965; Werts, 1966; among others) indicate that the factors influencing the career choices and selection of major field by college undergraduates are related to a need for what Davis calls "social homogeneity"--a tendency for "birds of a feather to flock together." According to Abe & Holland:

> When a student's characteristics resemble those of the typical student in his field, he is likely to feel at home and remain in his field. Conversely, incongruencies between a student and his field result in feelings of alienation and dissatisfaction and usually lead to a change of plans (p. 1).

There is further the implication that, in addition to the pull a student feels toward a field which contains others who are most like himself, particular fields of study and work attract certain kinds of people. This suggests that orientation data, in its most useful form, would permit comparisons of a student's pattern of abilities, interests, and past experiences with the patterns of successful students in a variety of majors within the University. But the information collected during summer orientation clinics, in its present format, sheds little light on the meaning of patterns of student characteristics and provides no insight into the relationship between student characteristics and academic majors.

Purpose

The purpose of this study is to investigate relationships which exist between students' characteristics, as measured by orientation data, and their final undergraduate majors, by identifying student variables which differentiate among major fields, and quantifying the differentiating relationships. From the results of the study, it should be possible to describe a variety of majors in terms of the kinds of students attracted to them, and to determine the probability of a student's completing his undergraduate study in a particular major.

Rationale

Guidelines for the selection or rejection of specific measures were sought from the body of theory and research dealing with vocational choice and development. Werts (1966) identified the problem of choosing the "right" variables in his introductory remarks to a National Merit Scholarship Corporation Research Report on the relationship of ability and social class to career patterns, where he said:

> It is easy to find statistically significant differences between persons sorted by occupation (or occupational aspiration), almost regardless of the type of sociological or psychological variables beind studied. . . . Briefly, the problem confronting career research today is one of relevance, of how to separate the theoretically meaningful from the many sources of artifact (p. 1).

John Holland's theoretical formulations appear to be most applicable to the purposes of this study. Holland's (1966b) theory of vocational choice rests on four assumptions.

1. Most persons in our culture can be categorized as one of six types, a type being defined as a complex cluster of personal attributes. Parents, social class, schools, and community play an important role in the development of the personality type.

2. Where people congregate, they create an environment that reflects the types they are. Thus, there are six kinds of environments, each dominated by a given type of personality.

3. People search for environments and vocations that will permit them to exercise their skills and abilities, to express their attitudes and values, to take on agreeable problems and roles, and to avoid disagreeable ones. Vocational decisions depend on a great range of student characteristics including interests, values, self-conceptions, competencies, achievements, range of experience, and family resources. To a lesser degree, environments also search for people through recruiting practices.

4. A person's behavior can be explained by the interaction of his personality pattern and his environment.

With regard to the fourth assumption, Holland says:

> In the present theory, a person's first and subsequent decisions are explained in terms of personality pattern and environmental model only. A more complete theory would incorporate economic and sociological influence (p. 12).

Although Holland stresses the importance of personality and interests as determinants of vocational choice, he does not ignore aptitude and intelligence. These latter characteristics are assumed to be differentially distributed among the six personality types and environments.

Four general categories of relevant variables seem to emerge from Holland's theoretical position. They are: (1) aptitude/achievement, (2) self-ratings and interests, (3) family and background experiences, and (4) educational and vocational preferences. Research by Tiedeman and his associates (Dunn, 1959; King, 1958; Tatsuoka, 1957; Tiedeman & Bryan, 1954) on choice of undergraduate major utilized variables which fell into the same four categories. The selection of specific measures for these studies appeared to be determined by what measures were available for the population to be studied, in contrast to Holland's research where, apparently, theory development and refinement of instrumentation have proceeded together.

At Michigan State University, information in each of the four categories is collected from students during orientation, but its usefulness is limited first, because of the treatment of the data and second, because even in its current form, the information is not made easily accessible to counselors and advisers. A consequence of the current study will be to re-organize the available data into a more meaningful form for use by students and their advisers in the selection of courses and the choice of a major field.

Research Hypotheses

The major hypothesis of this study is that undergraduate major fields can be differentiated on the basis of the multivariate discriminant analysis of aptitude, interest, educational-vocational preference, and family background measures of students who attain senior standing or have graduated in each major. A secondary hypothesis of the study is that male and female students in the same major will have substantially different patterns of characteristics.

To test the validity of the discriminant analysis results, group centroids for each major and for each sex will be used to predict membership in a major field for a cross-validation sample of seniors and graduates.

Overview

The value of investigating factors which influence undergraduate students in their selection of final major fields was discussed above, and some of the theoretical and research bases for such a study were delineated. In Chapter II, previous research relevant to the problem is critiqued.

Chapter III sets forth the design and methodology employed in the investigation. Results of the analysis are included in Chapter IV. The fifth chapter contains a descriptive summary of each of the majors included in the study. In Chapter VI, the materials presented in Chapters I through IV, the conclusions warranted by the findings, and some suggestions for related research are summarized.

CHAPTER II

REVIEW OF LITERATURE

The review of literature is limited to studies of the relationship between student characteristics and undergraduate college majors. Results of descriptive and predictive investigations of this topic are critically examined, and pertinent recommendations reported.

The Descriptive Studies

The first group of studies reported in this section deals in a general way with the identification of student characteristics unique to specific curricular groups or subgroups. The second set of studies concerns the relationship of student characteristics to change or persistence in major field.

The Research and Development Division of the American College Testing Program has published several descriptive studies of college-bound and undergraduate students, of which three are concerned with the relationship between student characteristics and undergraduate major fields.

Abe & Holland (1965) collected information on 117 student variables from 12,432 college freshmen at 31 institutions of higher education. The data-collection instrument contained 1,004 items covering student interests, attitudes, potential for various kinds of achievement, and other orientations. Students were grouped by sex and anticipated major field of study, which resulted in 79 male groups and 60 female groups. Each major field was described on the basis of its extreme characteristics, fields were grouped into 13 conventional academic areas, and the characteristics most descriptive of the major fields in each area were summarized. Four categories of characteristics emerged as differentiators: (1) occupational group preferences, (2) self-ratings of competencies, (3) self-ratings of traits and abilities, and (4) selection of important life goals and achievements. Abe & Holland concluded that measures of student interests and life goals are useful discriminators of major fields, but warned against a too-specific interpretation of results because of certain limitations imposed by the design of the study. They pointed out that: (1) their subjects were grouped on the basis of anticipated major field rather than actual major field, (2) the number of subjects in a major ranged from 10 to 1,353 making some characterizations more reliable than others, and (3) the use of extreme characteristics may have overly-accentuated existing differences. In addition, major fields were grouped a priori into 13 "conventional" academic areas and each area was then treated as if it were composed of homogeneous majors.

Baird (1967, No. 17; 1967, No. 19) reported on two ACT studies generated from data collected on the Student Profile Section of the ACT test battery administered to high school students during 1964-65. He selected a 3 percent representative sample which totaled 10,073 boys and 8,305 girls and, in the first study, grouped them by student-reported family income into nine categories. Income groups were compared in several areas including probable choice of major. Baird found that students from higher income families tended to move toward fields which he classified as administrative, political, or persuasive and away from social, religious, or educational areas, while lower income students were more likely to select the latter areas. In the second study, Baird (1967, No. 19) used differing educational goals to form student groups which he again compared in a variety of areas including probable major choice. He concluded that stated educational goals (reasons for coming to college) are closely related to educational plans and that, in general, different major fields tend to attract students with different educational goals. Baird's design suffered some of the same limitations described in the Abe & Holland study; that is, students were grouped on the basis of anticipated major field and major fields were classified a priori into supposedly homogeneous categories. He used student-reported family income as a classification variable in the first study without any reported evidence that the student-reported family income resembled the actual family income.

Smith (1967) compared 76 junior physical education majors (female) with 70 junior letters and science majors (female) on measures of ability, family background, and self-identification by sex, family role, and career choice. She found significant differences between the two majors on the following variables: (1) size of community and high school, (2) recreational pursuits of the father, (3) quality of relationship with father, (4) factors influencing choice of major, and (5) leadership and interest in extra-curricular activities.

Veldman, Peck, & Richek (1968) demonstrated a relationship among certain aspects of high school experience, personality measures, and the student teaching performance of a group of 192 female students who graduated from the University of Texas. The subjects were assigned to eight criterion groups defined by a high school characteristic, i.e., grade point average, class size, favorite high school subject, and the like. A varied set of measures were available on each subject: (1) nine variables of attitude toward self and others, (2) eight measures of personality, (3) six factor scores from a pupil observation instrument, (4) four factor scores from the California Psychological Inventory, (5) college grade point average during the senior year, and (6) an evaluation of student teaching effectiveness.

Results of the eight analyses of variance led Veldman *et al.* to conclude that measures of high school experience warrant further use and study as relevant variables in understanding college students' choice of field and career.

Korn (1962) compared a group of 1959 freshmen men majoring in the physical sciences (chemistry, mathematics, and physics), with engineering majors and general studies majors using their scores on the *California Psychological Inventory*, the *Strong Vocational Interest Blank*, and a biographical data sheet. Chi-square analyses of SVIB patterns comparing engineers with physical science majors, general studies with physical science majors, and general studies with engineering majors were carried out. Engineering and physical science majors shared an intense interest in the physical sciences, which differentiated them from the general studies group. In order to discriminate between engineering majors and physical science majors, Korn identified strong interest areas which were not shared and found a practical-theoretical polarization. Two of the *CPI* scales, Femininity and Responsibility, also distinguished among the three groups of men. A replication of the study using freshmen men who entered the same majors in 1960 produced substantially the same results.

Korn concluded that differences between similar majors can be better understood by considering more than one basis for classification of student characteristics. He emphasized the value of describing major groups in terms of their members' rejection of some interests as well as their attraction to others.

Each of the above studies utilized a large number and variety of measures to describe the students in the various majors and, thus, differentiate among the fields, but in all cases, the most useful variables for this purpose were nonintellective in nature. The following two studies demonstrate the efficacy of ability-achievement measures in accomplishing the purpose.

Voorhies (1966) selected a sample of undergraduate men majoring in business administration, industrial arts, and engineering to demonstrate a multivariate treatment of entrance data which would be of value in the academic advisement of male students at Middle Tennessee State College. Entrance test scores and high school grade point average were run through multiple regression analysis and discriminant function analysis. Voorhies computed a separate multiple R and discriminant function for each curricular group but, apparently, did not run a cross-validation study on the results. He recommended the inclusion of nonintellective measures in future studies of this type. Trends in the data also suggested to him that variables with negative discriminant weights and positive regression coefficients might be used to identify avoidance patterns for major fields. That is, students who scored high on such variables appeared more likely to change major field than those who had low scores on them, and changes seemed to be toward fields more compatible with student abilities or interests.

Cullum (1966) investigated the relationships between scores on the General Aptitude Test Battery, grade point average, and six undergraduate major fields. He was able to differentiate management, English, and physical education majors on aptitude scores, and found that students who expressed dissatisfaction with their major fields had aptitude scores which differed from the norms in their fields. The latter finding tends to support the Voorhies notion that avoidance patterns are discernible in such data, if researchers are alert to their possibility.

Interest measures alone have also been used successfully in discriminating among broadly defined curricular groups. Baggaley (1947) divided 185 Harvard students into two groups on the basis of their major fields at the end of the freshman year; Group A was a cluster of natural science majors and Group B was a cluster of social science and humanities majors. Using Kuder Preference scores, he computed a mean discriminant score for each group and got significant results using a *t*-test of mean differences. He also computed individual discriminant scores for visual inspection of group homogeneity. Baggaley suggested that students with extreme scores be singled out for additional educational-vocational guidance.

Matteson (1961) believed that student interests, as measured on the _Activity Check List_ (ACL), would differentiate among curriculum groups. Prior to their enrollment as freshmen at Michigan State University, 185 freshman men and 115 freshman women were given the _ACL_; 262 students indicated a specific choice of major and 38 had not yet selected a major. Students were grouped by college membership. An interest area was designated as characteristic of a college group if more than half the group had high or high-average scores in the area. Interest areas were distributed among the various colleges about as Matteson expected (i.e., Engineering = mechanical, computational, scientific; Business and Public Service = clerical and computational), and were combined differently for each college. He was also able to differentiate among colleges on the basis of the strength and diversity of student interests.

Although any student-linked variable could be described as a "personality" measure, the next four studies utilize scores from instruments designed to isolate various personality traits. Interestingly enough, results from these studies are not so clear cut as those obtained in studies which relied on simpler or more straightforward instrumentation.

Martoccia (1964) used a measure of authoritarianism to differentiate among 10 major groups of students. Significant results from an analysis of variance indicated that students in different majors do differ on degree of authoritarianism. However, the author suggested that, because there was a negative correlation between intelligence test scores and authoritarian scores, the group differences observed might also be related to intelligence.

Lundin & Lathrop (1963) investigated the relationship between personality adjustment as measured by the MMPI and choice of undergraduate major. Twenty Hamilton College junior and senior men in each of three majors (biology-chemistry, history, and English literature) were given the MMPI and results were analyzed by a one-way analysis of variance. No significant differences were found among the criterion groups on any of the scales. The authors suggested that students at Hamilton College are too homogeneous a group to exhibit adjustment differences based on major fields.

Elton & Rose (1967) studied all male freshman students who entered the University of Kentucky College of Engineering during 1963-65 and three semesters after entrance either were still in engineering or had transferred to commerce or arts and sciences. Six measures of student personality, scores on five factors derived from the Omnibus Personality Inventory (OPI) scales, and the ACT composite score were subjected to a stepwise discriminant analysis for the three criterion groups. One significant function emerged (Scholarly Orientation) which accounted for 73 percent of the variation among groups. Elton & Rose found that students who transferred into liberal arts had the highest mean score on this dimension. Those who transferred into commerce had the lowest mean discriminant score, and the group that remained in engineering had a mean score midway between the two transfer groups. Group separation was even more pronounced when group centroids were plotted in 2-discriminant space. The second function was not significant, however, and the authors gave it only limited attention in their discussion. They suggested that, with a larger sample, the second function might have reached significance, adding a valuable dimension to the interpretation of group differences.

A 20 percent sample of the entering freshmen at the University of Oregon was subdivided into five broad major fields (business, education, natural science, humanities, and social science) which were then compared and contrasted on the basis of <u>Poe Inventory of Values</u> (PIV) mean scores (Warnath & Fordyce, 1961). The <u>PIV</u> yields scores in eight areas of values: aesthetic, intellectual, material, power, social contact, religious, prestige, and humanitarian. Six of the eight scales discriminated among the five groups; social contact and prestige did not. Warnath & Fordyce used *t*-tests to establish differences between each pair of major groups on each of the six value scales, a total of 60 *t*-tests, and achieved significance in 19 instances. They also computed a D statistic, which revealed group profile differences between each pair of major groups.

Although the Warnath & Fordyce study displayed major group differences based on the values of group members, their interpretations must be viewed with some caution, because of the confounding effects produced by running 60 *t*-tests. Hays (1963) says:

> One is never really justified in carrying out all the $\binom{J}{2}$ different *t*-tests for differences among J groups, and then regarding this as some kind of substitute for the analysis of variance. Such *t*-tests carried out on all pairs of means must necessarily extract redundant, overlapping, information from the data, and as a result a complicated pattern of dependency must exist among the tests. Furthermore, the apparent levels of significance found from a set of such tests have neither a simple interpretation nor a simple connection with the hypothesis tested by the *F* test in the analysis of variance. . . . All in all, there is very little to recommend such a multiple *t*-test procedure (pp. 375-376).

On the assumption that students and faculty in a given field tend to have personal characteristics in common which differ from the common characteristics of students and faculty in other fields, Astin (1965) investigated the classroom environments of different college courses. Freshman students at 246 colleges completed a questionnaire in which 32 items provided information on the behavior and techniques of instructors, student behavior, and student-instructor interaction for the one course most closely related to the major fields. Nineteen different fields were represented in the sample. Differences among the 19 fields were evaluated by chi-square tests of the proportion of "yes" responses given to each of the 32 items. Astin found systematic differences among the various fields of study based on the behavior of the students and faculty in each field.

The approach-avoidance nature of choosing an undergraduate field is clarified somewhat in the following series of studies. In an attempt to determine why Michigan State University students change their majors, Pierson (1962) surveyed the 1958 seniors who were graduating in a major different from the one they had originally selected. He found that the primary reason given for major changes was a lack of information (about course content, the variety of majors actually available, and the vocational opportunities related to the original major).

The responses selected by these seniors suggested that changers were seeking major fields which were more compatible with their personal interests than their original majors had been, i.e., "the courses really didn't interest me," "future jobs related to my original major didn't appeal to me," "I learned about another major that suits me better."

Warren (1961) tested the hypothesis that changes in college major are likely to occur when a discrepancy exists between self concept and expected occupational role. His subjects were 525 males who were either National Merit Scholars or Certificate of Merit winners and who entered college as freshmen in 1956. Measures used in the study included 18 scale scores from the <u>Omnibus Personality

Inventory which was administered prior to college entrance, plus a measure of expected occupational role, taken near the end of the freshman year. A discrepancy score was computed for each subject. Also available were three declarations of major field, one taken before entrance and one each at the end of the freshman and sophomore year. Change in field was categorized as "No Change," "Minor Change," or "Major Change," and mean discrepancy scores were computed for each category. Contrary to expectations, the mean differences were not significant. A second hypothesis, that self-role discrepancy scores of those who changed field twice would be higher than for those who changed once, yielded significant differences. Additional manipulation of the original data to which were added College Board SAT total scores and freshman year grade point average led Warren to conclude that self-role discrepancies contribute to major field changes, but do not, by themselves, explain the phenomenon. Other factors may either act to inhibit change (financial considerations) where it would otherwise occur or encourage change (low grades).

Holland's theory of vocational choice hypothesizes that students select and remain in major fields where the environment (other students) is most compatible. Holland & Nichols (1964) tested this hypothesis in a study which drew on National Merit Finalists for the student sample and their answers to a National Merit Scholarship Corporation questionnaire for the variables. Students were assigned to one of six major field orientations, first on the basis of their preference as high school seniors and then, on the basis of their preference at the end of their freshman year in college. Changes in major were coded and weighted for degree of change. Results tended to confirm the hypothesis that students who leave a field are different from the typical student in that field. Holland & Nichols recommend that information used in the counseling of students who are in the process of choosing or changing majors be based on "a more comprehensive review of self-conceptions, achievements, and personality in addition to information from aptitude and interest inventories" (p. 242).

Super's vocational development theory suggested to Cole, Wilson, & Tiedeman (1964) that those who are alike choose alike and the more alike group members are, the longer they remain together. From this, they hypothesized that the students graduating in a particular major field would have more homogeneous test scores than the students who entered the same field four years ealier. Two studies were conducted, one at the University of Rochester and one at Harvard College, which, although not identical, were replicative.

The Rochester study was based on a sample of 759 men who entered between 1948 and 1951 and, subsequently, completed a degree. Fifteen variables, measured at matriculation, were included in the discriminant analysis of eight basic curricular groups. Centour scores were calculated for each group member and used to determine the degree of divergence from the centroid of each curricular group at graduation. Results showed that students tended to move out of fields where they were atypical and into fields more compatible with their abilities and interests. The incidence of change in field was higher for students whose original field was not the field of highest centour, thus supporting the hypotheses.

The Harvard study utilized freshman data on 774 students who entered the college between 1946 and 1949 and graduated on schedule. The sample represented 16 fields of concentration. Ten principal-component scores, based on 36 variables, were analyzed and their multivariate distributions used to compute centour scores for each student. Centour scores were used to determine the degree of divergence from the original curricular group. Results did not support the hypotheses.

Both studies showed that students are more likely to leave the natural sciences for the social sciences and humanities than to enter the natural sciences from other fields and that, in general, the holding power of the natural sciences is weaker than the holding power of the social sciences and humanities. Thistlethwaite (Mimeo., ca., 1960), on the other hand, found that although the natural sciences had greater holding power for males than any other field, net enrollment decreased because the field lost more men than it gained. It is possible that the movement of students out of natural science fields is a reflection of student interests and abilities, but the lack of movement into the natural sciences could be explained, at least in part, by the nature of the curriculum itself. The stringent sequencing of courses may well preclude transferring into the natural sciences after the freshman year.

Gamble (1962) investigated the pre-college, out-of-school, personal experiences associated with curriculum changes during the first three semesters of college. Experience variables included in the study were classed as home and family relationship, vocational, religious, peer group, community, co-curricular, or social and totaled 61. Data were collected on beginning students at The Pennsylvania State University and a random sample of 365 was selected from the 2,265 students still enrolled at the beginning of the third semester. They were grouped by sex and number of curriculum changes affected. Three variables were significantly related to the number of curriculum changes made by men. A favorable but not insistent attitude of parents toward attending college, greater age of the student, and certainty of vocational choice were linked to fewer curriculum changes. Several nonsignificant relationships were also found for men. Men whose mothers worked outside the home made more changes, as did men with no siblings. It was not possible, however, to relate the life history or experience variables included in the study to the number of curriculum changes made by women. Gamble used chi-square to establish significant relationships between change categories and experience variables which made it impossible to consider the interrelationships among variables.

Hasan (1966) demonstrated a relationship between pre-college extra-curricular participation and persistence in a major field; low aptitude test scores and change of major; and change of major and lower grade point averages. The study sample consisted of 727 students who entered Southern Illinois University during 1958-59 and subsequently graduated or left the institution. Hasan found that father's and/or mother's educational level did not differentiate among changers and persisters.

Augustine (1966) identified factors related to change and persistence in major field for a sample of engineering students at three large midwestern universities. Men who transferred out of engineering for nonacademic reasons were paired with men who remained in the field. Data were collected by questionnaires and personal interviews and included information on family background, high school experiences, factors influencing choice of major and vocation, and important life goals. Augustine found significant differences between persisters and changers on these variables.

Both criterion groups reported dissatisfaction with the highly structured curriculum, dislike of certain of the required mathematics courses, and the importance of peers in the decision to continue in or leave engineering.

Thistlethwaite (Mimeo., ca., 1960) investigated the relationship between changes in major field and level of training and the experiences of college students. He obtained information on the relative holding power of different fields of study and the characteristics of students and faculty in different fields. His sample was composed of 1,500 National Merit Scholars or Merit finalists who were completing their third year of college. Students reported their current major field of study and first college major and completed a modified version of the College Characteristics Index which yielded a faculty press index and a student press index. Fields of study were combined into five broad academic areas: (1) natural sciences, (2) biological sciences, (2) social sciences, (4) arts and humanities, and (5) other fields. Each student also described the faculty member who had the greatest influence upon his "desire to learn." Descriptions were based on the student's perception of the instructor's behavior in a course he taught. Analyses of the press indices and faculty descriptions led Thistlethwaite to conclude that students were attracted to and/or held in fields where they perceived compatible role models among the faculty. Deterrents to continued membership in an academic area were related to inappropriate student expectations for the area.

The Predictive Studies

In most of the following studies, the researchers were concerned with differentiating among undergraduate majors in order to apply the resulting information to the guidance and advisement of college students. Prediction, in these cases, was employed to demonstrate the validity of the analysis procedure and the accuracy of results, rather than as an end in itself.

Included in this section are designs utilizing a wide variety of measures and several different statistical treatments. The first four studies are examples of predictive research which rely on a single category of variable to differentiate among curricular groups. The remaining investigations employed two or more classes of variables.

In order to test the validity of the College Qualification Test (CQT) subscores for differential prediction, Juola (1961) selected six broad curriculum groups of first-term freshmen at Michigan State University and ran simple correlations between their subscores and first-term grade point averages (GPA). The three CQT subscores predicted GPA for the technical curricular group better than did the total CQT score, and as well as the total for two random groups and the nontechnical curricular group. Juola concluded that the CQT subtests show potential for differential prediction of achievement, and therefore, differential guidance of undergraduate students.

An early investigation of the value of student interest measures as predictors of major field was conducted at Harvard College by Tiedeman and Bryan (1954). They employed multivariate discriminant analysis of the nine dimensions of the Kuder-Vocational to predict the membership of sophomore students in one of five fields of concentration. Tiedeman and Bryan were primarily interested in demonstrating the effectiveness of multivariate discriminant analysis in the treatment of student variables to produce more meaningful information than did the original data.

Although satisfied with results, the authors emphasized that interests alone are not enough to fully account for differences among fields, and suggested that other variates be explored as potential predictors. They also believed it would be useful to introduce a success factor into the analysis, i.e., using field of concentration at graduation.

Harder (1959) used the MMPI clinical scales with three curricular groups of male undergraduates (business, education, and engineering) in an attempt to differentiate curricular groups in terms of personality characteristics. Results were not significant. He then identified MMPI items which distinguished among the groups and developed scoring keys for these items. Normalized T scores were computed for each subject and used to classify him into a criterion group. Classification results for the normative sample were significantly better than chance expectations. No cross-validation was performed.

The Kuder Preference Scientific scale, the Guilford-Zimmerman verbal comprehension and general reasoning subscores, and the ACE Psychological total score were selected by Stinson (1958) to discriminate among three groups of students who entered the Engineering School of Oklahoma State University as freshmen and subsequently graduated as engineers, graduated in a non-engineering major, or dropped out of the University. Tests were administered during the freshman year. Five years later, 30 members of each group were selected at random and from the four scores, a discriminant function was computed. Stinson used the mean discriminant score for each criterion group to establish three mutually exclusive critical regions that separated the groups from each other. Stinson recommended that counselors employ the technique as an aid in the academic advisement and counseling of succeeding freshman engineering classes.

Strong Vocational Interest Blank scores, socio-economic status of father's occupation, and Minnesota Scholastic Aptitude Test scores were compared for undergraduate men in pre-business, pre-law, pre-medicine, and engineering (Petrik, 1966). Petrik found that socio-economic status played an important part in the interpretation of SVIB scores. Lower class persisters in pre-medicine and pre-law had different SVIB patterns than their middle class counterparts. In the engineering and pre-business majors, socio-economic status had little effect on the predictive efficiency of the SVIB; the Strong predicted persistence equally well for both classes and was not predictive of persistence in engineering.

Mazak (1967) used stepwise discriminant analysis of 67 variables, (abilities, interests, and values), to distinguish among five criterion groups of students who, seven years earlier, had entered El Camino Community College as pre-engineering students. After completing the analysis with five groups, Mazak combined students into four groups and then, three groups for re-analysis and prediction of membership. As the number of groups decreased, the accuracy of classification increased.

The major findings reported by Mazak were: (1) high school achievement is the best predictor of success in engineering and related majors in the junior college, and (2) junior college achievement is the best predictor of transfer to and success in senior institutions. Mazak recommended the use of high school achievement records as a major factor in counseling and academic advising with pre-engineering students and suggested that future research of this type include measures of student commitment, motivation, personality, study habits, and attitudes.

A unique approach to clarifying the relationship between student personality and curricular choice was devised by Goldschmid (1966). Fifty-five academic disciplines were rated by 142 judges on two scales, a science continuum and a humanities continuum. Five personality measures provided the scores used in the regresssion analysis. Students were grouped by final undergraduate major; two-thirds of the sample was used in the analysis and one-third was reserved for cross-validation. Eleven of 16 regression equations produced significant cross-validation results. In addition, interpretation of the predictive equations indicated that the contributing variables described the "science personality" on different dimensions than were used to describe the "humanities personality."

Simono (1967) used performance, environmental, and activity indices to predict membership in one of two criterion groups (science and non-science) and one of six subgroups: (1) engineering; (2) pre-medicine, zoology and chemistry; (3) mathematics and physics; (4) social studies; (5) business administration; and (6) literature and language. The sample consisted of 215 academically-talented sophomore, junior, and senior college men for whom data were available on high school performance, family and school background, and extra-curricular activities. The activity index produced significant differences between science and non-science majors. Two variables in the index were especially strong differentiators: (1) reading preferences and (2) interest in tinkering with machines or building models. Simono concluded that, for superior students at least, measures of extra-curricular interests are meaningful variables to use in studying differences in academic majors.

To demonstrate the use and advantages of multiple discriminant analysis and related classification procedures, Cooley & Lohnes (1962) report on one phase of the Scientific Careers Study undertaken earlier by Cooley. In this study, senior engineering and science majors were given the Study of Values test, which measures six personality characteristics that Cooley believed would differentiate among three criterion groups. The criterion groups consisted of: (1) science and engineering majors who planned to engage in basic research after graduation, (2) those who planned to continue in applied science and engineering, and (3) those who planned to leave the field for work having more direct involvement with people. The analysis produced significant group differences, allowing Cooley to proceed with classification of a check sample of sophomore engineering and science majors drawn and tested at the same time as the senior sample. After graduation, members of the "sophomore" sample reported their career plans. If the classification procedure, based on the senior group centroids, assigned a check sample member to the criterion group he planned to enter, it was credited with a "hit." Approximately 50 percent hits were achieved, demonstrating that value measures are effective in differentiating among members of the same academic area whose career plans differ.

A concern for the curricular choice problems of undergraduates at Harvard College led King (1958) to a predictive study of the relationship between student characteristics and final undergraduate major. The purpose of the study was to provide analytic comparisons of student aptitudes and interests with various fields of study to replace the subjective comparisons then in use. Scores from the Aptitude Survey Test (a battery of 21 subtests), the Kuder Preference Record-Vocational, College Board SAT Verbal and Mathematical scores, predicted freshman grade average, Fall semester freshman rank, public-private secondary school attendance, and scholarship application constituted the 36 variables available for the study sample of men who graduated in the Classes of 1950 through 1953, as well as for the check sample of men who graduated in the Classes of 1954 and 1955. A total of 22 fields of concentration identified the criterion groups in the study. Multivariate discriminant analysis provided the information necessary for the computation of group centroids, individual centour scores, and distance measures, from which King was able to predict group membership for the check sample. Prediction results were significantly better than chance expectations. Noting the relatively large beta weights assigned by discriminant analysis to interest measures, King recommended a reduction in the number of aptitude-ability measures and an increase in the number of interest and attitude measures in subsequent investigations of this type.

The purpose of Dunn's (1959) study was to compare the relative effectiveness of multiple regression analysis and multiple discriminant analysis in the prediction of college major. The same data were subjected to both treatments and Dunn found that discriminant analysis was far superior for predicting choice of major. The sample consisted of 1,380 men and women representing 14 different major fields. The 13 variables included ability-achievement measures and basic demographic data. Two functions accounted for 86 percent of the variance and were used to predict membership for a cross-validation sample. Because the 14 major groups overlapped each other in the discriminant space, Dunn grouped them into six clusters and judged prediction results as "hits," "near hits," and "misses," "near hits" being predictions that fell in the right cluster but wrong major. She found it much easier to predict into clusters than into exact fields of study, and suggested that greater accuracy might result first, by adding interest and personality measures and second, by separating major groups by sex rather than including sex as an analysis variable.

Tatsuoka (1957) developed a joint probability model which combined discriminant and regression analysis to demonstrate a relationship among measures of aptitude; high school grades and rank in class; type of high school and geographic location; personality ratings; and final fields of concentration. The normative sample of M.I.T. freshmen was assigned to one of six curricular groups, depending on field of concentration at graduation. A seventh group consisted of the students who had withdrawn or been suspended for academic reasons. Multiple regression and multiple discriminant analyses were run, using 11 variables and seven criterion groups, resulting in seven multiple regression equations and one significant discriminant function. Tatsuoka used these to predict a joint probability of membership and success in one of the criterion groups for a check sample of the next year's graduates.

Stahmann & Wallen (1966) incorporated several of the suggestions made by other investigators who employed multivariate discriminant analysis to predict undergraduate field. In their design, students were grouped by final undergraduate field, a separate discriminant analysis was run for men and women, and both achievement and interest measures were included. Scores on the Cooperative English, Mathematics, and Natural Science Tests and the Occupational Interest Inventory were obtained from the University of Utah freshman entrance examination battery for a selected sample of 1962, 1963, and 1964 graduates. Male subjects represented majors in engineering, business, pharmacy, and letters and sciences. Female subjects represented majors in nursing, elementary education, and letters and sciences. Subjects in majors with 50 or more members were randomly assigned to either an analysis sample or a cross-validation sample. Major groups with less than 50 members were included in the analysis sample only. Thus, the "cross-validation" sample of males contained no pharmacy majors and the "cross-validation" sample of females contained only elementary education majors. Mosier (1951) defined "cross-validation" as "weights determined on one sample and their effectiveness tested on a second, similarly drawn sample" (p. 8). Cooley & Lohnes (1962, p. 144) also use this definition. Because Stahmann and Wallen actually had a validity-generalization sample rather than a cross-validation sample, their results are difficult to interpret. They concluded that the freshman entrance battery was an effective predictor of major field at graduation and their predictions were better than chance for all majors except business. Actually, of 50 engineers in the check sample, 29 were classified correctly, of 39 business majors, 3 were classified correctly, of 50 letters and science majors 23 were classified correctly, and 22 men were assigned to pharmacy although there were no pharmacists in the check sample. The women's check sample contained 50 elementary majors and 32 were properly classified. Clearly, the business major was underassigned. Stahman & Wallen suggested that, because business students are a heterogeneous group, it might be necessary to use "variables other than achievement and interest measures to achieve adequate discrimination" (p. 444).

Cutting (1966) used 15 items from the Personal Information Inventory to predict field of concentration for a sample of Michigan State University students who entered as first-time freshmen in the Fall of 1963. Students were grouped by their Fall 1965 academic majors and majors with less than 30 members were combined into curriculum groups. The resulting 27 groups ranged in size from 40 to 257 students. A 25 percent random sample was set aside for cross-validation and the remaining 75 percent of the study population was used for multivariate discriminant analysis. The 15 variables were categorized by Cutting as self-concept measures and consisted of self-ratings of six abilities and preference rankings of nine occupational interest groups.

The analysis yielded 15 functions, 10 of which were significant. The first three functions, accounting for 75 percent of the trace, were used to identify 11 distinct groups and five clusters. Function one was interpreted as a masculine-feminine dimension, with high positive weights for verbal facility, interest in artistic occupations and social service occupations identifying the feminine characteristics and high negative weights for numerical ability and interest in physical science occupations identifying the masculine. Function two, a verbal-scientific dimension, had high positive loadings for interest in business detail and verbal-linguistic occupations and high negative loadings for biological science and mechanical-technical occupational interests. The third function showed high positive weights for self-ratings of general ability, verbal ability, reading ability, anticipated grade point average, and interest in verbal-linguistic occupations; high negative weights were attached to interests in business detail occupations and executive-managerial occupations.

From the positive and negative loadings, the most masculine majors should have fallen at the extreme negative end of the first function and the most feminine majors at the extreme positive end, but because the 15 variables were scaled with "0" or "1" as the high scores and "4" or "8" as the low scores, just the opposite occurred. Thus, on function one, a high self-rating of numerical ability (i.e., "0") was combined with the negative weighting associated with that variable to suppress the negative contribution to the discriminant score and indirectly increase the positive aspect, while a low self-rating of verbal facility (i.e., "4") was combined with the high positive weighting for that variable to increase the positive portion of the discriminant score.

Two cross-validation procedures were employed. In the first, a discriminant score was computed for each member of the check sample (N=567), for each of the 10 significant functions and each individual was assigned to the curricular group whose mean discriminant score was closest to his discriminant score. In other words, every individual in the check sample was assigned 10 times. Out of a possible, 5,760 assignments, 331 "hits" resulted. In the second, a maximum likelihood classification procedure was used, which took simultaneous account of all 10 significant functions and assigned each individual only once. With this technique, Cutting reported 137 "hits." He concluded that the variables and statistical treatment selected for the study were effective in predicting academic fields for incoming freshman students and suggested ways in which counselors could use such information with students.

The results of the study must be interpreted with some caution, however. Although not reported in the dissertation, a printing error on the 1963 form of the Personal Information Inventory made it impossible to score with certainty six of the nine occupational group rankings for each student. This, in turn, brings into question the meaning of the contribution made to each function by the nine occupational variables. In spite of this fact, the self-ratings and rankings of occupational interest groups did differentiate among the curricular groups analyzed, suggesting that these measures are somehow related to differences among major fields.

Summary

The foregoing review of literature emphasized descriptive and predictive studies of student characteristics associated with differing undergraduate major fields. The following conclusions represent the principal findings relevant to the current study.

1. Measures of student and/or faculty characteristics are effective in differentiating among a variety of undergraduate major fields.

2. A wide variety of characteristics has been examined and shown to be useful. Although interest and value measures appear to be particularly potent differentiators, researchers are fairly unanimous in recommending the use of a variety of measures, including ability/achievement, family background, high school background and experiences, and self-ratings, in addition to interests and values.

3. Student characteristics are useful not only in establishing major field <u>differences</u>, but in identifying <u>similarities</u> which cross department and college organizational lines.

4. Many investigators believe that more accurate distinctions result when <u>final</u> undergraduate majors are used to establish criterion groups than when <u>first</u> or <u>interim</u> majors are used. Accuracy and understanding are improved when criterion groups are controlled for sex.

5. Multivariate discriminant analysis is particularly well suited to research problems dealing with the establishment and explanation of group differences which are based on a variety of variables.

These conclusions, coupled with the rationale presented in Chapter I, suggested the following guidelines for the design of the present study.

1. Student characteristics should be measured as early as possible, preferably prior to first collegiate attendance. For information of the type which should result from this study to be applicable to the choice problems faced by freshman students and their advisers, the data on which it is based must be collected and processed for use during the first term of enrollment. The following studies, of those cited above, employed precollege measures to successfully differentiate among undergraduate majors; Baird, 1967, No. 17 & No. 19; Cutting, 1966; Gamble, 1962; Hassan, 1966; Juola, 1961; Simono, 1967; Stahmann & Wallen, 1966; Veldman et al., 1968; and Voorhies, 1966.

2. From the pre-college measures available, those selected for inclusion in the study should represent a variety of classes. Interest and preference measures receive strong emphasis in Holland's theoretical formulations (1966) as well as his research (Abe & Holland, 1965; Holland & Nichols, 1964). In addition, studies by Baggaley (1947), Matteson (1961), and Tiedeman & Bryan (1954) relied exclusively on interest variables and showed useful results. Similar evidence is available in support of measures of ability/achievement (Cullum, 1966; Dunn, 1959; Juola, 1961; and Voorhies, 1966), values (Baird, 1967, No. 19; Cooley &

Lohnes, 1962; and Warnath & Fordyce, 1961), family and high school background (Augustine, 1966; Baird, 1967, No. 17; Gamble, 1962; Smith, 1967; and Veldman et al., 1968), and self-ratings (Abe & Holland, 1965 and Cutting, 1966). Results of research studies using measures of adjustment and/or personality traits were less consistent (Elton & Rose, 1967; Harder, 1959; Lundin & Lathrop, 1963; and Martoccia, 1964). A number of studies were based on a combination of two or more classes of variables. The following researchers specifically recommended the inclusion of several categories in future investigations: Abe & Holland, 1965; Dunn, 1959; Holland & Nichols, 1964; King, 1958; Korn, 1962; Martoccia, 1964; Stahman & Wallen, 1966; Tiedeman & Bryan, 1954; and Voorhies, 1966.

3. In so far as possible, criterion groups should be kept "pure." Three considerations are relevant to this point. When are groups identified, what academic areas should be combined into criterion groups, and how should the sex variable be treated? Tiedeman & Bryan (1954) were the first to suggest that criterion groups include only those students who graduated in each field, but others have since made the same recommendation (Abe & Holland, 1965; Baird, 1967, No. 17 & No. 19; and Cutting, 1966). Interpretation of results has been clearer in those studies where clustering of major fields was based on initial findings, i.e., Dunn, 1959; and King, 1958. Considerations of sample size

have sometimes made it necessary to treat men and women in the same major as one criterion group. Other studies have been designed to include only men. Dunn (1959) used sex as an analysis variable, but recommended that it be used as a criterion variable so that separate analyses could be run. Again, clearer interpretations would undoubtedly result if criterion groups were controlled for sex.

Applications of these guidelines led to the design and methodology detailed in Chapter III.

CHAPTER III

DESIGN AND METHODOLOGY

The Sample

Selection of Students and Final Major Fields

The restricted population from which the study sample was drawn entered Michigan State University as first-time freshmen during either Fall 1963 or Fall 1964 and had attained senior standing (130 quarter credits or more), or had graduated from Michigan State University by Spring 1967. All students in this group who had earned more than 30 quarter credits from an institution other than Michigan State were eliminated. A total of 3,681 students, 1,934 males and 1,747 females, filtered through the first set of screens. A second set of restrictions was placed on the sample because of criteria established for the selection of final major fields.

A major field is defined as a program of study which is specifically identified by a college of the University, and which culminates in a bachelor's degree. The 3,681 students represented 127 majors in 10 colleges. Major groups containing less than 40 members of one sex were eliminated, leaving a total of 2,096 students in 23 majors from 9 colleges. Nine of these majors contained only females, ten contained only males, and each of the four remaining majors had both a male and a female group. The sample, thus, consisted of 27 groups representing 23 different final majors.

The last restriction on the sample, that all measures be available for all subjects, resulted in an initial loss of 130 students whose orientation test scores and/or Personal Information Inventory (PII) data were missing or incomplete, and a subsequent loss of 201 students whose PII forms were no longer on file at the Counseling Center.

The study sample consisted of 1,765 students, 909 males and 856 females, in 23 majors from 9 colleges. A 20 percent sample of each major group was drawn from the study sample and set aside for use in the cross-validation study, while the remaining 80 percent of each group became the analysis sample. The composition of the study sample, the analysis sample, and the cross-validation sample is shown in Table 1.

Instrumentation

The maximum number of variables which could have been included in the discriminant analysis, at the time the study was designed, was limited by computer capacity to 50. Only those variables which were measured before students

TABLE 1. COLLEGE AND MAJOR GROUPS INCLUDED IN STUDY: BY SEX AND SIZE OF STUDY SAMPLE, ANALYSIS SAMPLE, AND CHECK SAMPLE

	College	Major	Sex	Size of Study Sample	Size of Analysis Sample	Size of Cross-Validation Sample
1.	Agriculture	Packaging	M	81	65	16
2.	Business	Accounting	M	73	58	15
3.	Business	Gen. Bus. Admin.	M	94	75	19
4.	Business	Economics	M	42	34	8
5.	Business	Marketing	M	64	51	13
6.	Engineering	Electrical	M	70	56	14
7.	Engineering	Mechanical	M	44	35	9
8.	Natural Science	Zoology	M	46	37	9
9.	Natural Science	Mathematics	M	82	66	16
10.	Arts & Letters	History	M	62	50	12
11.	Social Science	Social Science	M	69	55	14
12.	Social Science	Pre-Law	M	42	34	8
13.	Social Science	Political Science	M	72	58	14
14.	Social Science	Psychology	M	68	54	14
	Total	14		909	728	181
15.	Home Economics	H. E. Teaching	F	48	38	10
16.	Home Economics	Rtl. Tex. & Cloth.	F	42	34	8
17.	Natural Science	Mathematics	F	51	41	10
18.	Natural Science	Nursing	F	46	37	9
19.	Education	Elementary	F	253	202	51
20.	Education	Special	F	46	37	9
21.	Communication Arts	Speech	F	40	32	8
22.	Arts & Letters	Art Practice	F	49	39	10
23.	Arts & Letters	English	F	90	72	18
24.	Arts & Letters	History	F	49	39	10
25.	Social Science	Social Science	F	44	35	9
26.	Social Science	Psychology	F	44	35	9
27.	Social Science	Social Work	F	54	43	11
	Total	13		856	684	172

began formal course work at Michigan State were admissable. Within this framework, the theoretical considerations set forth in Chapter I and the results of previous research cited in Chapter II provided the rationale for selecting, from the orientation data available, the specific variables which were included in the study. As previously noted, the most meaningful measures for predicting membership in an academic field appeared to fall into four categories: (1) aptitude/achievement measures, (2) interest and self-rating measures, (3) family and background measures, and (4) educational and vocational preference measures.

Aptitude/Achievement Measures

Raw scores on the following tests were used as measures of academic aptitude and achievement.

1. The College Qualification Test (CQT)

    a. Verbal
    b. Information
    c. Numerical

2. MSU Orientation Tests

    a. English
    b. Reading

The College Qualification Test (Bennett, G. K., Bennett, M. G., Wallace, W. L., & Wesman, A. G., 1957) is a 200-item battery of three tests: (1) a test of verbal facility, (2) a test of numerical ability, and (3) a test of general information. A total of 75 vocabulary items provides the verbal score. Included in the numerical test are 50 items measuring conceptual skills necessary in the study of arithmetic, algebra, and geometry. The 75-item information test deals with general knowledge in the physical, biological, and social sciences.

The *Michigan State University English Test* and *Reading Test* were developed by the Office of Evaluation Services of Michigan State University. The former test consists of 38 items representing many aspects of English usage and was designed to be especially discriminating at lower ability levels. The reading test contains 50 questions based on a series of reading passages from the four general education areas in which University College courses are offered. This test provides supplementary information for the selection of low-ability students who need remedial work as well as for selection of high-ability students who are eligible for honors sections (Office of Evaluation Services, 1964).

High school grade point average had to be eliminated as a measure of ability/achievement because the form in which it is recorded on the *Student Master Record* does not distinguish among high school grading scales based on differing point systems.

Measures of Interest, Family Background, and Educational and Vocational Preference

The size of high school graduating class and location of the high school (in- or out-of-state), were taken from the *Student Master Record* which is compiled by the

Office of the Registrar. All other measures described below came from the Personal Information Inventory which is filed in each student's record at the Counseling Center.

The PII was developed by the Michigan State University Counseling Center and was first administered to students during the 1963 summer orientation clinics. The 1964 PII is a revision of the 1963 instrument. All of the PII information used in the analysis had to be re-scaled, either to accomodate differences in the two forms of the Inventory or to convert qualitative information into quantitative measures suitable for the analysis. The PII items included in the study, the original coding, and the re-scaling are presented in Appendix A.

Interest and self-rating measures. Four classes of variables were included in the interest and self-rating measures.

1. Reading preferences for novels, technical books, mystery books, biography/history, and literary classics;

2. Rating of enjoyment of high school courses in fine and applied arts and letters, science and mathematics, social studies, and non-academic subjects;

3. Self-rating of general ability, numerical reasoning, verbal reasoning, reading skill, and anticipated college grade point average (GPA) in comparison to other students entering MSU; and

4. Ranking of interest in three of nine occupational groups.

Family and background measures. Ten variables were included in this categroy.

1. Educational level of father;
2. Educational level of mother;
3. Occupational status of father;
4. Employment of mother;
5. Marital status of parents;
6. Number of older siblings;
7. Number of younger siblings;
8. Size of high school graduating class;
9. Location of high school in- or out-of-state; and
10. Sources of financial support for college.

Educational and vocational preference measures. Four classes of variables were included in this category.

1. Strength of first major choice;
2. Certainty of vocational choice;
3. Factors influencing vocational choice; and
4. Reasons for coming to college.

Summary of Instrumentation and Variables Used

All variables came from one of three sources: (1) the Student Master Record, (2) the Office of Evaluation Services test record, or (3) the Personal Information Inventory. The measurements selected fell into four categories: (1) ability/achievement, (2) interest and self-ratings,

(3) family and background experiences, and (4) educational and vocational preferences. The variables included in the analysis are enumerated in Table 2.

TABLE 2. VARIABLES INCLUDED IN THE DISCRIMINANT ANALYSIS

Ability/Achievement Measures
1. CQT Verbal
2. CQT Information
3. CQT Numerical
4. MSU English
5. MSU Reading

Reading Preferences
6. Novels
7. Technical books
8. Mystery books
9. Biography and History
10. Literary classics

High School Courses
11. Fine and applied Arts and Letters
12. Science and Mathematics
13. Social studies
14. Non-academics

Self-Ratings
15. General capacity
16. Numerical reasoning
17. Verbal reasoning
18. Reading skill
19. Anticipated college GPA

Occupational Interest Groups
20. Artistic
21. Physical science
22. Biological science
23. Mechanical and technical
24. Social service
25. Business detail
26. Business contact
27. Verbal and linguistic
28. Executive and managerial

Family and Background Experiences
29. Educational level of father
30. Educational level of mother
31. Occupational level of father
32. Employment of mother
33. Marital status of parents
34. Number of older siblings
35. Number of younger siblings
36. Size of high school graduating class
37. High school in- or out-of-state
38. Sources of financial support

Educational and Vocational Preferences
39. Strength of first major choice
40. Certainty of vocational choice

Factors influencing vocational choice:
41. Family and significant others
42. High school experience
43. Personal interests and needs

Reasons for coming to college:
44. Educational/vocational needs
45. Social needs
46. Family influence
47. Status needs

The Statistical Model

Multivariate discriminant analysis was selected as the appropriate statistical treatment to accomplish the purposes of this study. Saupe (1965) has presented a concise description of the technique.

> The data consist of several variables or measures for individuals in a number of groups. Let M be the number of measures and let G be the number of groups.
>
> The analysis of this type of data with the multiple-discriminant model requires the calculation of two matrices. A is the M x M matrix of among-groups sums of products. Each entry in A is calculated in the same manner as an among-groups sum of squares in an analysis-of-variance problem or a sum of cross-products in an analysis-of-covariance problem. It is an expression of the dispersion among group means. W is the matrix, also M x M, of within-groups sums of products. The entries in W are calculated in the same way as are within-groups sums of squares and cross-products in analysis-of-variance or -covariance problems. It is an expression of within-groups dispersion.
>
> Matrices A and W are then used in the basic matrix equation,
>
> $$(A-\lambda W)\nu = 0$$
>
> which is solved for λ, a scalar, and v, a column matrix of M elements. The resulting λ's and v's are the principal results of the basic analysis. Some characteristics of these results follow:
>
> 1. In general, there is more than one solution; that is, unique vector v and associated scalar λ. As a matter of fact, because the rank of matrix A is the smaller of G-1 and M, this is the exact number of nonzero solutions to be expected.
>
> 2. The solution for which λ is largest is said to define the first discriminant function; the solution with the next largest λ, to define the second discriminant function; and so forth. The first discriminant function defines that linear

combination of the M measures that maximizes the ratio of among-groups dispersion to within-groups dispersion. The second discriminant function maximizes the ratio of among- to within-groups dispersion for that component of the among-groups dispersion that is not accounted for by the first discriminant function, and so forth.

3. Each solution or function is orthogonal to (that is, uncorrelated with) all the other functions of the analysis.

4. The λ's can be interpreted in relation to their sum as proportions of the dispersion among groups accounted for by the respective functions.

5. If the data are the product of random sampling from multivariate normal populations with homogeneous dispersion matrices, hypotheses about group differences can be tested. The hypothesis of overall group differences can be tested by means of Wilks' Λ criterion, and hypotheses concerning the differences associated with individual discriminant functions and combinations thereof can be examined by means of a χ^2 approximation based upon the λ's (Rao, 1952).

6. The vector v of each solution consists of coefficients that can be applied to the set of measures for an individual to produce a discriminant score for the individual. An individual has as many discriminant scores as there are discriminant functions. Discriminant scores are usually not computed for nonsignificant functions.

7. A significant discriminant function is interpreted by examining the magnitudes of the standardized coefficients for the various measures and examining the mean discriminant scores for the several groups.

8. With the resulting discriminant functions, a set of discriminant scores can be computed for an unclassified individual for whom there are scores on the involved measures and he can be classified into the group that has mean discriminant scores closest to his discriminant scores (pp. 175-177).

As stated in Saupe's fifth characteristic, significance tests based on multivariate discriminant analysis assumes that the within group distributions of raw data are multivariate normal with equal variance and covariance matrices. The problems associated with testing these assumptions were discussed by Ikenberry (1960). A letter from Dr. David Tiedeman, which is quoted by Ikenberry, states:

> I don't know of a simple, direct test of the multivariate normal assumption. There are no tables of which I am aware which specify the expected frequencies under the assumed multivariate normality. . . . We usually test the normality of the discriminant scores rather than that of the original scores (in Ikenberry, 1960; p. 72).

A perusal of the within group frequency distribution showed that several of the variables, as originally scaled, were bimodal or J-shaped, while others had a more nearly normal appearance. It was decided to rescale the bimodal and J-shaped variables in such a way as to increase the normalcy of the distributions without destroying the trends originally present. In general, the scales affected were constructed a priori to retain as much information from the primary sources as possible so that a posteriori adjustments could be made with a minimum loss of data. Appendix B contains the original and subsequent frequency distributions of the variables which were rescaled.

The use of discriminant scores to classify an individual whose group identity is unknown, Saupe's eighth point, assumes multivariate normal distribution of the discriminant scores.

The data were analyzed by computer utilizing the multivariate discriminant analysis program available from the Michigan State University Computer Institute for Social Science Research (CISSR Technical Report 33).

Summary

The student sample for this study was drawn from the first-time freshmen who entered Michigan State University during either Fall 1963 or Fall 1964 and had graduated or attained senior standing by Spring 1967, having earned no more than 30 quarter credits from another institution. The major sample consisted of the undergraduate major fields represented in the student sample which contained at least 40 students of one sex. A total of 1,765 students, 909 men and 856 women, in 23 different majors made up the final study sample from which was drawn a 20 percent random sample for cross-validation purposes.

Data were collected from three sources: (1) the Student Master Record, (2) the Office of Evaluation Services test records, and (3) the Personal Information Inventory. A total of 47 variables was analyzed using multivariate discriminant analysis. The results of the analysis are presented in Chapter IV.

CHAPTER IV

ANALYSIS OF DATA

The data were subjected to four treatments: (1) a discriminant analysis of the 27 major groups, (2) a separate discriminant analysis of the 14 male groups and the 13 female groups, (3) classification of a cross-validation sample based on the 27-group analysis, and (4) classification of male and female cross-validation samples based on the 14- and 13-group analyses, respectively.

As Saupe (1965) pointed out, multivariate discriminant analysis provides a number of nonzero solutions (functions) equal to one less than the number of groups; each function is orthogonal to all the other functions in the analysis; and a function is interpreted by examining the size and sign of the standardized coefficients (weights) for the variables in concert with the mean discriminant scores (group centroids) for the various groups.

Discriminant Analysis of Twenty-Seven Criterion Groups

The major hypothesis of the study was that undergraduate major fields can be differentiated on the basis of selected characteristics of the students who attain senior standing or have graduated in each major. Stated in null form:

> No differences exist among undergraduate major fields on the basis of the abilities/achievements, interests, educational-vocational preferences, or family and high school backgrounds of their student members.

To test this hypothesis, 47 measures of aptitude, interest, family and high school background, and educational-vocational preference were collected on a student sample representing 23 different undergraduate majors. (Nine fields contained only females, ten contained only males, and each of four fields had both a male and a female group, making a total of 27 criterion groups.) A multivariate discriminant analysis of the data produced 26 discriminant functions, 10 of which were significant (Rao's χ^2) at the .001 level, a rejection of the null hypothesis. As shown in Table 3, the first three functions accounted for 71 percent of the dispersion among groups (trace), the addition of functions four and five increased the percent of trace to 79, and the remaining five significant functions accounted for an additional 11 percent of the trace. The 16 nonsignificant functions explained less than 10 percent of the variation among groups.

A secondary hypothesis of the study was that male and female students in the same major have substantially different patterns of characteristics. Although there is no direct statistical test for this hypothesis, Rao (1952) offers an application of the Mahalanobis $\underline{D}^2$ statistic which

TABLE 3. PERCENT OF TRACE, DEGREES OF FREEDOM, AND STATISTICAL SIGNIFICANCE LEVELS FOR FIRST TEN DISCRIMINANT FUNCTIONS OF THE TWENTY-SEVEN GROUP ANALYSIS

Function Number	Percent of Trace		df	Tabled X^2 Values $\alpha = .001$	Computed X^2 Values
	Individual	Cumulative			
1	50.78	...	72	114.8	1,608.5
2	10.89	61.67	70	112.3	535.7
3	9.58	71.25	68	109.8	481.4
4	4.08	75.33	66	107.3	226.0
5	3.99	79.32	64	104.7	221.2
6	2.88	82.20	62	102.2	163.4
7	2.35	84.55	60	99.6	134.7
8	2.14	86.69	58	97.0	122.9
9	1.94	88.63	56	94.5	111.8
10	1.66	90.29	54	91.9	96.5

provides relevant descriptive information. The treatment is based on the concept of "clusters." A cluster is defined as two or more groups which fall close together in the discriminant space. Restating the second hypothesis in terms of the cluster concept: Males and females in the same major form two groups which fall into mutually exclusive clusters. In null form the hypothesis becomes:

> Males and females in the same major form two groups which fall into the same cluster.

Rao (1952) explains the computational procedures thus:

> No formal rules can be laid down for finding the clusters because a cluster is not a well-defined term. The only criterion appears to be that any two groups belonging to the same cluster should at least on the average show a smaller $\underline{D}^2$ than those belonging to two different clusters. A simple device suggested by K. D. Tocher is to start with two closely associated groups and find a third group which has the smallest average $\underline{D}^2$ from the first two. Similarly, the fourth is chosen to have the smallest average $\underline{D}^2$ from the first three, and so on. If at any stage the average $\underline{D}^2$ of a group from those already listed appears to be high, then this group does not fit in with the former groups and is therefore taken to be outside the former cluster. The groups of the first cluster are then omitted, and the rest are treated similarly (pp. 362-363).

The clusters shown in Tables 4 and 5 were formed using intercentroid distances and Rao's computational scheme. The computations are included in Appendix C. The four fields which contained both a male and a female group were mathematics (Groups 9 and 17), history (Groups 10 and 24), social science (Groups 11 and 25), and psychology (Groups 14 and 26). They are underlined in the tables. It can be seen that none of the pairs fell in the same cluster, and none fell in the next nearest cluster. The male groups were closest to other male groups, and with the exception of women mathematics majors, the female groups were closest to other female groups. The mathematics women were closer to Cluster D (male zoology and psychology majors) than any other cluster and closer to psychology women than any other major. These results suggested that, for the study sample, male and female members of the same major had substantially

TABLE 4. FORMATION OF CLUSTERS USING INTERCENTROID DISTANCES FROM TWENTY-SEVEN GROUP ANALYSIS

Cluster	Majors Included in Each Cluster	Average Intra-Cluster Distance	Average Inter-Cluster Distance							
			A	B	C	D	E	F	G	H
A	6-7-9	.85	....	1.42	1.54	1.23	2.26	2.37	1.53	2.11
B	1-2-3-5	.86		....	1.34	1.42	2.17	2.02	1.86	1.92
C	4-10-11-12-13	.91			....	1.18	1.63	1.86	1.68	1.86
D	8-14	.98				....	1.65	1.88	1.28	1.64
E	23-24-25-26	.92					....	1.26	1.51	1.38
F	15-16-19-20-21-22-27	.97						....	1.82	1.14
G	17	...							....	1.53
H	18	...								....

TABLE 5. INTER-CLUSTER RELATIONSHIPS FOR TWENTY-SEVEN GROUP ANALYSIS

Cluster	Majors Included in Cluster	Nearest Cluster	Majors in Nearest Cluster	Farthest Cluster	Majors in Farthest Cluster
A	6-7-<u>9</u>	D	8-14	F	15-16-19-20-21-22-27
B	1-2-3-5	C	4-10-11-12-13	E	23-24-25-26
C	4-<u>10</u>-<u>11</u>-12-13	D	8-14	F & H	15-16-19-20-21-22-27 & 18
D	8-<u>14</u>	C	4-10-11-12-13	F	15-16-19-20-21 22-27
E	23-<u>24</u>-<u>25</u>-<u>26</u>	F	15-16-19-20-21-22-27	A	6-7-9
F	15-16-19-20-21-22-27	H	18	A	6-7-9
G	<u>17</u>	D	8-14	B	1-2-3-5
H	18	F	15-16-19-20-21-22-27	A	6-7-9

different patterns of characteristics and resembled other criterion groups more than they resembled each other.

Interpretation of the Discriminant Functions

Although the analysis produced ten significant functions, the first five functions accounted for 79.32 percent of the trace, while the last five significant functions accounted for only 10.97 percent of the variation among groups. Consequently, only the first five functions were interpreted in detail. Table 6 identifies variables by name and number and should be used in conjunction with Tables 7 through 25 in which variables are designated by number only.

The first function accounted for 50.78 percent of the variation among groups. The standardized weights assigned to the 47 variables for this function are shown in Table 7. It was decided to consider, for interpretive purposes, those variables assigned an absolute weight of 10.00 or more.

Four positive and six negative weights reached this magnitude in function one. High positive loadings were assigned to the MSU English test score, reading preference for literary classics, preference for fine and applied arts and letters in high school, and interest in social service occupations, while high negative loadings were assigned to CQT Information and Numerical test scores; interest in physical science occupations, mechanical-technical occupations,

TABLE 6. VARIABLES INCLUDED IN TABLES 7 THROUGH 25

Ability/Achievement Measures

1. CQT Verbal
2. CQT Information
3. CQT Numerical
4. MSU English
5. MSU Reading

Reading Preferences

6. Novels
7. Technical books
8. Mystery books
9. Biography and History
10. Literary classics

High School Courses

11. Fine and applied Arts and Letters
12. Science and Mathematics
13. Social studies
14. Non-academics

Self-Ratings

15. General capacity
16. Numerical reasoning
17. Verbal reasoning
18. Reading skill
19. Anticipated college GPA

Occupational Interest Groups

20. Artistic
21. Physical science
22. Biological science
23. Mechanical and technical
24. Social service
25. Business detail
26. Business contact
27. Verbal and linguistic
28. Executive and managerial

Family and Background Experiences

29. Educational level of father
30. Educational level of mother
31. Occupational level of father
32. Employment of mother
33. Marital status of parents
34. Number of older siblings
35. Number of younger siblings
36. Size of high school graduating class
37. High school in- or out-of-state
38. Sources of financial support

Educational and Vocational Preferences

39. Strength of first major choice
40. Certainty of vocational choice

Factors influencing vocational choice:

41. Family and significant others
42. High school experience
43. Personal interests and needs

Reasons for coming to college:

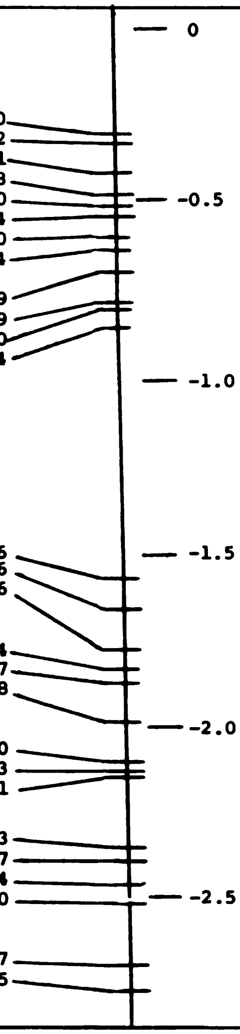
44. Educational/vocational needs
45. Social needs
46. Family influence
47. Status needs

TABLE 7. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR TWENTY-SEVEN MAJOR GROUPS ON FUNCTION ONE

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -
1	8.09		
2	-23.25		x
3	-26.83		x
4	16.67	x	
5	5.77		
6	3.67		
7	- 2.84		
8	- 2.48		
9	- 2.95		
10	11.71	x	
11	12.33	x	
12	- 0.39		
13	- 1.51		
14	- 0.63		
15	- 1.42		
16	- 9.13		
17	- 1.92		
18	- 0.75		
19	- 3.11		
20	7.87		
21	-22.46		x
22	- 1.37		
23	-16.09		x
24	17.03	x	
25	- 4.83		
26	- 8.33		
27	- 1.97		
28	-19.84		x
29	- 1.42		
30	7.44		
31	- 2.49		
32	- 1.35		
33	0.34		
34	1.12		
35	4.30		
36	3.23		
37	4.51		
38	0.83		
39	1.29		
40	- 3.97		
41	3.48		
42	- 4.09		
43	- 2.25		
44	0.28		
45	4.18		
46	- 2.13		
47	-12.60		x

Major Group	Group Centroid
21. Speech	-0.30
22. Art Practice	-0.32
23. English	-0.41
19. Elem. Educ.	-0.48
20. Special Educ.	-0.50
27. Social Work	-0.54
16. Ret., Tex. & Clo.	-0.60
25. Soc. Sci. (F)	-0.64
24. History (F)	-0.69
18. Nursing	-0.79
15. Home Ec. Tchg.	-0.80
26. Psychology (F)	-0.84
17. Mathematics (F)	-1.56
10. History (M)	-1.66
11. Social Sci. (M)	-1.76
13. Political Sci.	-1.84
14. Psychology (M)	-1.87
12. Pre-Law	-1.98
8. Zoology	-2.10
5. Marketing	-2.13
3. Gen. Bus. Adm.	-2.11
2. Accounting	-2.33
4. Economics	-2.37
9. Mathematics (M)	-2.44
1. Packaging	-2.50
6. Electrical Eng.	-2.67
7. Mechanical Eng.	-2.75

Plot of Group Centroids on this Function



and executive-managerial occupations; and coming to college to fulfill status needs. Function one was interpreted as a verbal/humanistic versus numerical/technical dimension.

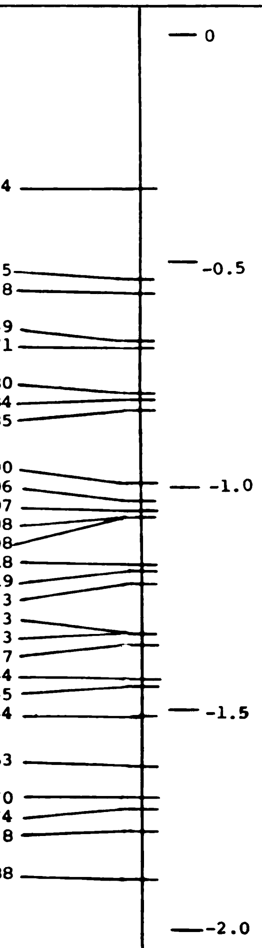
A plot of the major group centroids on this function (Table 7) gave further support to the verbal/humanistic versus numerical/technical dichotomy. Majors at the extreme end of the numerical/technical area included mechanical engineering, electrical engineering, packaging, and mathematics. Majors at the extreme end of the verbal/humanistic area included speech, art practice, and English. The fact that all the male majors spread out along the high negative end of the ordinate and the women's majors (with the exception of the mathematic's women) huddled at the low negative end suggested that the first function reflected a sex-related difference among the criterion groups. This led to the decision to run separate discriminant analyses of the male majors and the female majors, the results of which are described later in the chapter.

Function two (Table 8) accounted for approximately 11 percent of the difference among groups. High positive weights were assigned to six variables (CQT Information test scores; biography and history reading preferences; interest in social studies in high school; and preferences for business contact, verbal and linguistic, and executive and managerial occupations) and high negative weights were assigned to four variables (MSU English and Reading test scores;

TABLE 8. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR TWENTY-SEVEN MAJOR GROUPS ON FUNCTION TWO

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid
1	9.81				
2	14.62	x			
3	4.12				
4	-13.74		x		
5	-17.57		x		
6	- 5.02				
7	- 4.73				
8	- 3.91				
9	10.85	x		13. Political Sci.	-0.34
10	- 1.69				
11	- 8.10				
12	- 5.23				
13	13.38	x		10. History (M)	-0.55
14	5.01			12. Pre-Law	-0.58
15	1.04				
16	- 9.13			4. Economics	-0.69
17	5.23			3. Gen. Bus. Admin.	-0.71
18	3.15				
19	- 5.57			11. Soc. Sci. (M)	-0.80
20	- 9.06			5. Marketing	-0.84
21	-21.09		x	25. Soc. Sci. (F)	-0.85
22	- 7.03				
23	- 6.84				
24	- 4.49			24. History (F)	-1.00
25	1.16			15. Home Ec. Tchg.	-1.06
26	11.55	x		2. Accounting	-1.07
27	20.02	x		16. Ret., Tex. & Clo..	-1.08
28	15.15	x		23. English	-1.08
29	- 1.31			27. Social Work	-1.18
30	5.84			14. Psychology (M)	-1.19
31	6.64			19. Elem. Educ.	-1.23
32	1.44			20. Special Educ.	-1.33
33	1.66			21. Speech	-1.33
34	2.43			26. Psychology (F)	-1.37
35	0.22			1. Packaging	-1.44
36	- 3.81			8. Zoology	-1.45
37	- 5.18			22. Art Practice	-1.54
38	- 6.49				
39	- 8.04			7. Mechanical Eng.	-1.63
40	- 9.37				
41	- 3.06			18. Nursing	-1.70
42	-10.12		x	9. Mathematics (M)	-1.74
43	- 6.68			6. Electrical Eng.	-1.78
44	- 7.39				
45	- 5.30			17. Mathematics (F)	-1.88
46	- 4.79				
47	- 6.05				

Plot of Group Centroids on this Function



preference for physical science occupations, and the importance of high school experiences in the selection of a vocation). Although the nature of the second function was less clear-cut than function one, the positively-weighted variables suggested a generalist orientation and the negatively-weighted variables a specialist orientation.

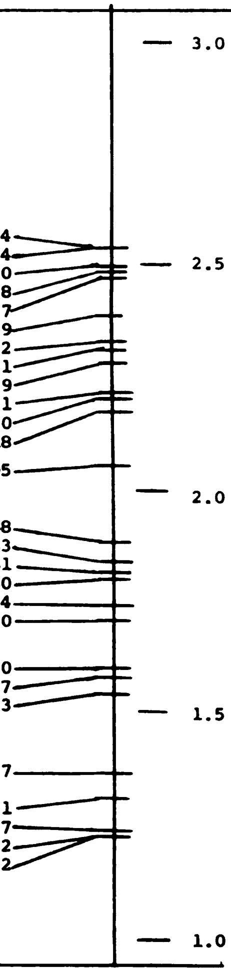
The distribution of group centroids tended to confirm the generalist-specialist dichotomy. The five majors at the specialist end of the scale were mathematics (women), electrical engineering, mathematics (men), nursing, and mechanical engineering, while the five majors at the other extreme were political science, history (men), pre-law, economics, and general business administration.

The third function (Table 9) was interpreted as an abstract versus applied orientation. High positive loadings on CQT Verbal and Information test scores, MSU Reading score, anticipated college GPA, and interests in physical science, social service, and verbal/linguistic occupations were associated with high positive group centroids for social science (women), psychology (men and women), English, and mathematics (women) majors. Variables with high negative weights included preference for non-academic subjects in high school, interest in business detail occupations, high school in Michigan, certainty of vocational choice, family influence in decision to come to college as well as in choice of vocation, and the status value of a college education. Majors

TABLE 9. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR TWENTY-SEVEN MAJOR GROUPS ON FUNCTION THREE

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid
1	20.89	x			
2	10.04	x			
3	- 3.45				
4	0.70				
5	14.02	x			
6	- 7.09				
7	7.01				
8	1.52				
9	4.86				
10	4.54				
11	4.38				
12	0.42			14. Psychology (M)	2.54
13	6.42			25. Soc. Sci. (F)	2.54
14	-10.07		x	26. Psychology (F)	2.50
15	7.84			23. English	2.48
16	- 8.09			17. Mathematics (F)	2.47
17	- 4.85			13. Political Sci.	2.39
18	4.77			24. History (F)	2.32
19	14.96	x		9. Mathematics (M)	2.31
20	- 3.47			12. Pre-Law	2.29
21	22.34	x		10. History (M)	2.21
22	9.52			6. Electrical Eng.	2.20
23	- 2.95			4. Economics	2.18
24	18.91	x		8. Zoology	2.05
25	-10.98		x		
26	4.74				
27	15.90	x		20. Special Educ.	1.88
28	- 3.53			15. Home Ec. Tchg.	1.83
29	1.19			7. Mechanical Eng.	1.81
30	- 2.70			11. Soc. Sci. (M)	1.80
31	4.07			27. Social Work	1.74
32	1.15			18. Nursing	1.70
33	- 5.92				
34	8.55				
35	3.65			21. Speech	1.60
36	1.05			19. Elem. Educ.	1.57
37	-10.89		x	16. Ret., Tex. & Clo.	1.53
38	- 0.62				
39	- 3.32				
40	-13.74		x	22. Art Practice	1.37
41	-14.28		x		
42	- 8.88			1. Packaging	1.31
43	- 1.81			3. Gen. Bus. Admin.	1.27
44	- 2.23			2. Accounting	1.22
45	3.36			5. Marketing	1.22
46	-13.28		x		
47	-12.41		x		

Plot of Group Centroids on this Function



with low positive group centroids on function three were marketing, accounting, general business administration, packaging, and art practice.

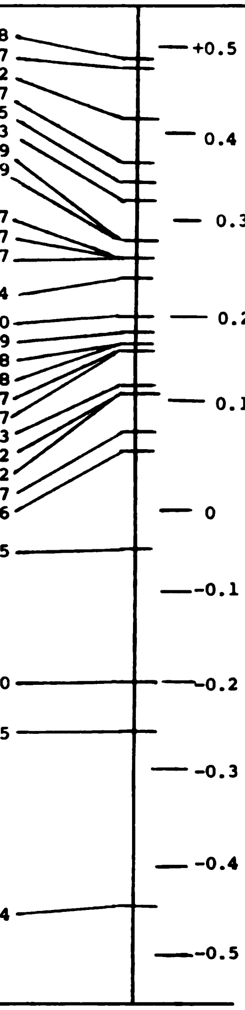
Seven variables were assigned high negative weights in function four. They were: CQT Verbal score; preference for reading literary classics; interest in artistic, physical science, mechanical/technical, and executive managerial occupations; and, vocational choice influenced by high school experiences. This combination of variables was labeled artistic/technical. The high positive variables (MSU Reading score, interest in social service occupations, and educational level of mother) suggested a conventional feminine orientation. From such a polarization, it was not surprising to find that the women's majors were separated much more than the men's majors (Table 10). Group centroids at the artistic/technical pole were art practice, speech, retailing of textiles and clothing, and English. Majors at the conventional feminine end of the scale included nursing, home economics teaching, social work, and elementary education.

The high-weight variables in function five shared no obvious common qualities. Positive weights were assigned to self-rating of numerical reasoning; interest in social service, business detail, and artistic occupations; and family influence of vocational choice. Major groups with high positive centroids included accounting, mathematics (men and

TABLE 10. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR TWENTY-SEVEN MAJOR GROUPS ON FUNCTION FOUR

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid
1	-15.04		x	18. Nursing	0.48
2	- 0.74			15. Home Ec. Tchg.	0.47
3	9.44			27. Social Work	0.42
4	- 9.06			19. Elem. Educ.	0.37
5	14.27	x		8. Zoology	0.35
6	- 4.86			20. Special Educ.	0.33
7	- 3.58			2. Accounting	0.29
8	- 2.54			26. Psychology (F)	0.29
9	3.69				
10	-10.45		x	12. Pre-Law	0.27
11	0.62			17. Mathematics (F)	0.27
12	6.05			24. History (F)	0.27
13	3.13				
14	1.41			9. Mathematics (M)	0.24
15	- 1.74				
16	7.32			5. Marketing	0.20
17	- 3.05			13. Political Science	0.19
18	1.16			3. Gen. Bus. Admin.	0.18
19	2.58			7. Mechanical Eng.	0.18
20	-27.23		x	4. Economics	0.17
21	-10.66		x	10. History (M)	0.17
22	9.28			25. Social Sci. (F)	0.13
23	-11.91		x	11. Social Sci. (M)	0.12
24	12.96	x		14. Psychology (M)	0.12
25	1.52			6. Electrical Eng.	0.07
26	- 9.09			1. Packaging	0.06
27	- 8.98				
28	-13.37		x	23. English	-0.05
29	- 0.10				
30	10.87	x			
31	2.09				
32	2.38				
33	- 1.03				
34	- 0.67				
35	5.44			16. Ret., Tex. & Clo.	-0.20
36	- 0.30				
37	- 1.87			21. Speech	-0.25
38	1.29				
39	- 6.00				
40	6.44				
41	1.00				
42	-15.32		x		
43	- 5.78				
44	- 5.34				
45	- 2.45				
46	- 1.68				
47	- 3.11			22. Art Practice	-0.44

Plot of Group Centroids on this Function



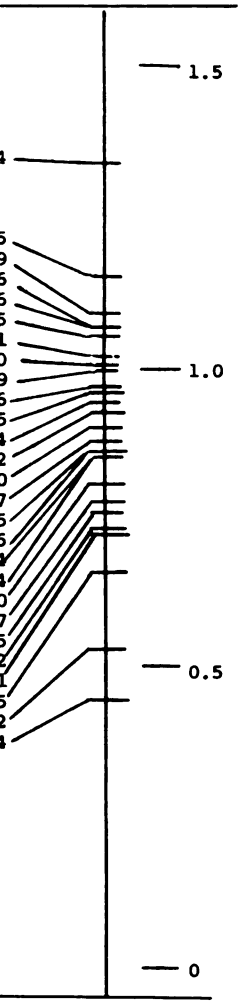
women), economics, retailing of textiles and clothing, and social science women. High negative weights were assigned to self-rating of reading skill, interest in biological science occupations, and reasons for coming to college. Majors with low positive group centroids included nursing, zoology, and social science men (Table 11).

A comparison of group clusters on functions one (numerical/technical-verbal/humanistic), two (generalist-specialist), and three (abstract-applied) highlighted the separation achieved by the discriminant analysis. Cluster A (electrical engineers, male mathematicians, and mechanical engineers) fell into the abstract-specialist-highly numerical/technical category, although mechanical engineers were lower on the abstract scale than were the other two majors in the cluster. Cluster B (packaging, accounting, general business administration, and marketing) was characterized as applied-generalist-highly numerical/technical. Packaging and accounting were higher on the numerical/technical scale and lower on the generalist scale than were general business administration and marketing. Cluster C (economics, history, social science men, pre-law, and political science) was characterized as abstract-generalist-numerical/technical. Within the cluster, economics majors were higher on numerical/technical, and social science men were less abstract than the rest. Cluster D (zoology and psychology men) was clearly in the numerical/technical category, but zoology

TABLE 11. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR TWENTY-SEVEN MAJOR GROUPS ON FUNCTION FIVE

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid
1	6.78				
2	3.16				
3	- 3.16				
4	4.74				
5	- 5.26				
6	- 6.29				
7	- 1.49			2. Accounting	1.34
8	- 4.31				
9	0.41				
10	- 1.10				
11	- 5.96			9. Mathematics (M)	1.15
12	0.46			17. Mathematics (F)	1.09
13	6.67			4. Economics	1.06
14	- 1.55			16. Ret., Tex. & Clo.	1.06
15	- 4.43			25. Social Sci. (F)	1.05
16	21.35	x		19. Elem. Educ.	1.01
17	6.28			15. Home Ec. Tchg.	1.00
18	-12.42		x	23. English	0.99
19	7.69			10. History (M)	0.96
20	11.51	x		6. Electrical Eng.	0.95
21	4.75			24. History (F)	0.94
22	-17.42		x	3. Gen. Bus. Admin.	0.92
23	2.26			7. Mechanical Eng.	0.90
24	21.85	x		22. Art Practice	0.87
25	24.70	x		13. Political Sci.	0.85
26	5.44			20. Special Educ.	0.85
27	6.13			5. Marketing	0.84
28	1.25			26. Psychology (F)	0.84
29	4.26			21. Speech	0.80
30	- 5.29			12. Pre-Law	0.77
31	- 3.98			14. Psychology (M)	0.75
32	- 1.88			27. Social Work	0.72
33	3.79			1. Packaging	0.71
34	- 0.16			11. Social Sci. (M)	0.65
35	7.60			8. Zoology	0.52
36	1.78			18. Nursing	0.44
37	0.64				
38	- 5.17				
39	3.31				
40	0.96				
41	12.33	x			
42	9.24				
43	7.60				
44	-20.33		x		
45	- 8.26				
46	-11.32		x		
47	-17.24		x		

Plot of Group Centroids on this Function



majors were less abstract than the psychology men and slightly more specialist. The first female cluster, E, was abstract--more generalist than specialist-verbal/humanistic. The psychology women were the least verbal/humanistic and generalist of the four majors in Cluster E, which also included English, history, and social science. Cluster F (home economics teaching, retailing of textiles and clothing, elementary education, speech, art practice, and social work) was more applied than abstract--more specialist than generalist-verbal/humanistic. Home economics teaching majors, special education majors, and social work majors were more abstract than the other four majors and the art practice group was higher on the specialist function than the rest. Mathematics women and nursing majors were not clustered with any other major groups. Mathematics women fell into an abstract-specialist-numerical/technical category, the only female group classified as abstract-specialist and the only female group not classified within the verbal/humanistic segment of function one. Nursing was flanked by Cluster F, but more specialist than any of the seven Cluster F-majors and more abstract than four of them (Figure 1).

The results of the 27-group analysis not only demonstrated that undergraduate major fields could be differentiated on the basis of their members' characteristics, but that the most pronounced difference among criterion groups was sex-related. For this reason, separate discriminant

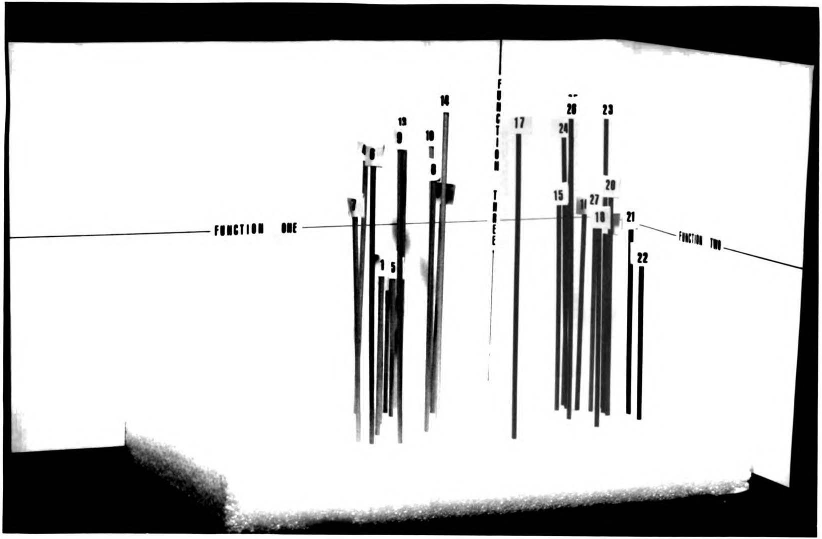


FIGURE 1. THREE DIMENSIONAL PLOT OF GROUP CENTROIDS ON FIRST THREE SIGNIFICANT FUNCTIONS OF TWENTY-SEVEN GROUP ANALYSIS.

analyses were carried out for the 14 male majors and the 13 female majors.

Discriminant Analysis of Fourteen Male Criterion Groups

The 14-group analysis produced 13 discriminant functions, of which five were significant at the .001 level. The five significant functions accounted for 79.85 percent of the variation among groups (Table 12).

TABLE 12. PERCENT OF TRACE, DEGREES OF FREEDOM, AND STATISTICAL SIGNIFICANCE LEVELS FOR FIRST FIVE DISCRIMINANT FUNCTIONS OF THE FOURTEEN-GROUP ANALYSIS

Function Number	Percent of Trace		df	Tabled X^2 Values $\alpha = .001$	Computed X^2 Values
	Individual	Cumulative			
1	33.26	...	59	98.3	415.6
2	21.90	55.16	57	95.8	299.6
3	11.38	66.54	55	93.2	171.6
4	7.53	74.07	53	90.6	118.1
5	5.78	79.85	51	88.0	92.3

The first function, numerical/physical science versus verbal/social science, assigned high positive weights to the CQT Numerical score, self-rating of numerical reasoning, interests in physical science and mechanical/technical occupations, and certainty of vocational choice; high negative weights were attached to the <u>CQT Verbal</u> score, preference for social studies courses in high school, and interest in verbal/linguistic occupations. High positive group centroids were associated with electrical engineering, mathematics, mechanical engineering, and packaging while low positive group centroids were associated with political science, history, pre-law, and social science. Function one explained 33 percent of the group variation (Table 13).

Function two, applied versus abstract, closely resembled the third function of the 27-group analysis; high positive weights were attached to the <u>CQT Numerical</u> score, preference for novels, preference for nonacademic high school courses, self-rating of verbal reasoning, interest in business detail occupations, and the importance of family influence and status needs in the decision to come to college and the choice of vocation. Majors at the positive end of the continuum were accounting, marketing, general business administration, and packaging. Negative loadings were associated with <u>CQT Verbal</u> and <u>Information</u> scores, the <u>MSU Reading</u> score, anticipated college GPA, and interests in physical science, biological science, and social service occupations. Majors grouped at the abstract pole included psychology, electrical engineering, mathematics, and political science, followed closely by pre-law, zoology, and history (Table 14).

TABLE 13. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR FOURTEEN GROUPS ON FUNCTION ONE

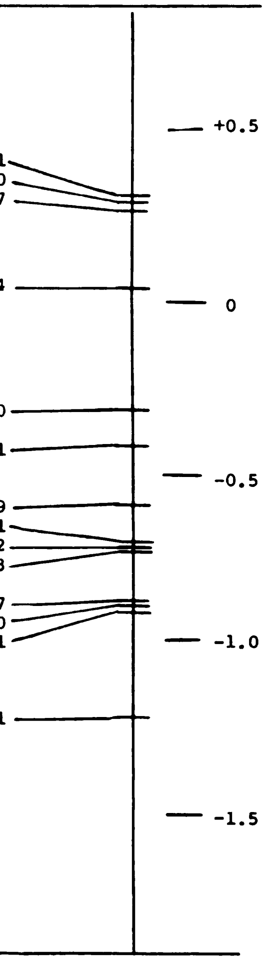
Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid	Plot of Group Centroids on this Function
1	-14.38		x			
2	2.13					
3	13.68	x				
4	4.03					
5	9.45					
6	0.88					
7	4.32					
8	5.88					
9	- 9.34					
10	- 7.31					
11	- 2.24			6. Electrical Eng.	2.52	
12	5.27			7. Mechanical Eng.	2.46	2.5
13	-12.08		x			
14	- 4.20			9. Mathematics	2.37	
15	- 1.04					
16	15.58	x				
17	- 3.98					
18	- 4.05			1. Packaging	2.14	
19	8.88					
20	7.21					
21	22.36	x				2.0
22	5.61					
23	17.91	x		2. Accounting	1.88	
24	0.69			8. Zoology	1.88	
25	6.36					
26	- 2.37					
27	-19.60		x			
28	3.00			5. Marketing	1.49	
29	0.53			4. Economics	1.48	
30	- 8.79			14. Psychology	1.48	1.5
31	- 6.99			3. Gen. Bus. Admin.	1.40	
32	- 1.15					
33	- 0.36					
34	- 1.18					
35	2.01					
36	1.07			11. Social Science	1.14	
37	3.70			12. Pre-Law	1.08	
38	5.72					1.0
39	7.53					
40	11.33	x		10. History	0.91	
41	1.02					
42	8.21			13. Political Science	0.79	
43	3.39					
44	- 8.33					
45	- 0.67					
46	- 0.36					
47	1.78					0.5

TABLE 14. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR FOURTEEN GROUPS ON FUNCTION TWO

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -
1	-11.98		x
2	-14.64		x
3	23.54	x	
4	- 9.54		
5	-18.78		x
6	10.29	x	
7	- 8.29		
8	0.63		
9	1.31		
10	- 4.73		
11	- 2.35		
12	0.28		
13	- 1.43		
14	12.49	x	
15	- 6.98		
16	8.81		
17	13.78	x	
18	- 7.17		
19	-26.23		x
20	- 1.39		
21	-19.15		x
22	-12.46		x
23	1.13		
24	-14.62		x
25	18.90	x	
26	- 3.50		
27	0.14		
28	4.94		
29	- 3.08		
30	5.57		
31	0.87		
32	- 3.06		
33	1.06		
34	- 3.26		
35	0.30		
36	- 7.14		
37	8.44		
38	- 0.83		
39	4.39		
40	4.97		
41	27.17	x	
42	19.26	x	
43	6.96		
44	9.21		
45	- 1.37		
46	13.97	x	
47	16.25	x	

Major Group	Group Centroid
2. Accounting	0.31
5. Marketing	0.30
3. Gen. Bus. Admin.	0.27
1. Packaging	0.04
11. Social Science	-0.30
7. Mechanical Eng.	-0.41
4. Economics	-0.59
10. History	-0.71
12. Pre-Law	-0.72
8. Zoology	-0.73
13. Political Science	-0.87
9. Mathematics	-0.90
6. Electrical Eng.	-0.91
14. Psychology	-1.21

Plot of Group Centroids on this Function



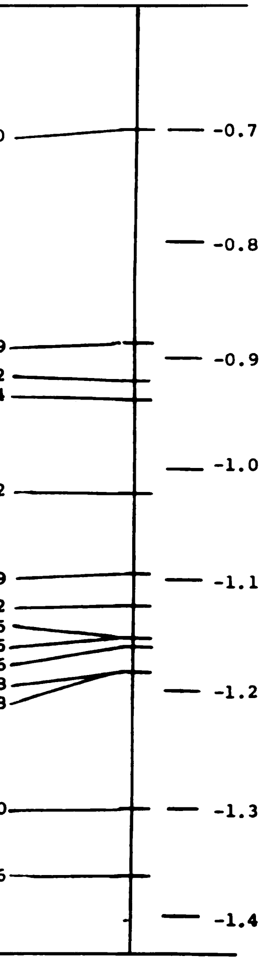
The third function assigned high weights to only two classes of variables: reasons for coming to college and occupational preference groups. High positive weights were associated with the former and high negative weights with the latter, suggesting an educational-to-vocational spread. The group separations, however, were not great. All group centroids were negative and covered less than a one-point range (from -.70 through -1.36). The function accounted for 11.38 percent of the trace. Economics and accounting had the highest negative centroids and zoology had the lowest negative centroid (Table 15). The remaining eleven criterion groups fell within three-tenths of a point of each other.

In function four, high negative loadings were attached to preference for high school science and mathematics courses, educational level of mother, coming to college for status reasons, occupational level of father, and number of older siblings. Mechanical engineering, prelaw, and economics majors had the highest negative centroids. Positive weights were attached to preference for business detail, social service, and biological science occupations; self-rating of numerical reasoning ability; vocational choice influenced by family and significant others; the MSU Reading score; and preference for literary classics. Accounting had the lowest negative centroid on this function.

TABLE 15. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR FOURTEEN GROUPS ON FUNCTION THREE

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid
1	- 5.10				
2	- 0.40				
3	1.53				
4	2.84				
5	0.58				
6	5.97			8. Zoology	-0.70
7	1.33				
8	3.69				
9	- 6.75				
10	8.48				
11	6.87				
12	- 3.44				
13	- 6.42				
14	- 1.38				
15	2.91				
16	- 7.79				
17	- 4.65			1. Packaging	-0.89
18	5.90				
19	- 8.42			11. Social Science	-0.92
20	- 5.04			14. Psychology	-0.94
21	-12.26		x		
22	4.09				
23	-12.77		x		
24	-16.47		x		
25	-20.28		x	5. Marketing	-1.02
26	-12.77		x		
27	-15.70		x		
28	-13.23		x		
29	0.53			3. Gen. Bus. Admin.	-1.09
30	- 2.15				
31	0.11			12. Pre-Law	-1.12
32	2.41			7. Mechanical Eng.	-1.15
33	- 0.58			10. History	-1.15
34	- 4.25			6. Electrical Eng.	-1.16
35	- 3.97			9. Mathematics	-1.18
36	- 0.15			13. Political Science	-1.18
37	0.73				
38	5.38				
39	- 2.99				
40	- 3.57				
41	4.54			2. Accounting	-1.30
42	4.37				
43	3.43				
44	13.70	x			
45	4.82			4. Economics	-1.36
46	6.01				
47	10.89	x			

Plot of Group Centroids on this Function



Psychology, mathematics, history, and zoology majors were also at the low negative end of the scale (Table 16). The high negative variables suggested a socio-economic status factor, while the high positive variables were too mixed to allow a single interpretation. Business detail occupations and self-rating of numerical ability carried the highest positive weights, which, combined with group means on these variables, explained the position of accounting and mathematics. Psychology, history, and zoology were more strongly affected by the positive weights assigned to social service and biological science occupational interests.

The high negative variables in function five (Table 17) also suggested a socio-economic status factor; self-rating of numerical reasoning, number of older and younger siblings, occupational level of father, and sources of financial support for college were important in separating zoology and pre-law majors from the rest of the groups. Three of the four College of Business majors (marketing, economics, and general business administration) also had negative group centroids. The high positive variables were heterogeneous in character. Interest in mechanical/technical, physical science, social service, verbal/linguistic, and executive/managerial occupations as well as the CQT Verbal score and the employment of the mother outside the home were assigned positive weights over 10.00. Packaging

TABLE 16. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR FOURTEEN GROUPS ON FUNCTION FOUR

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid
1	1.44				
2	0.55				
3	- 8.18				
4	- 2.78			2. Accounting	-0.78
5	10.61	x			
6	1.52				
7	5.94				
8	0.30				
9	- 4.85				
10	10.28	x			
11	0.42				
12	-15.04		x	14. Psychology	-0.92
13	2.01				
14	- 1.39			9. Mathematics	-0.96
15	- 6.01				
16	20.35	x		10. History	-0.98
17	- 3.20				
18	- 7.07			8. Zoology	-1.02
19	4.65				
20	7.00				
21	- 5.49				
22	13.80	x			
23	- 2.00				
24	16.21	x			
25	25.48	x		13. Political Science	-1.15
26	1.03				
27	- 1.18			3. Gen. Bus. Admin.	-1.17
28	- 0.59			5. Marketing	-1.17
29	6.58			1. Packaging	-1.19
30	-15.08		x	11. Social Science	-1.20
31	-12.65		x		
32	6.16				
33	- 1.30			6. Electrical Eng.	-1.27
34	-12.72		x		
35	- 4.63				
36	3.33				
37	2.20				
38	- 2.63				
39	- 2.72				
40	- 2.97			4. Economics	-1.40
41	10.03	x			
42	6.28			12. Pre-Law	-1.43
43	7.26				
44	- 3.08			7. Mechanical Eng.	-1.45
45	- 9.57				
46	- 9.68				
47	-13.68		x		

Plot of Group Centroids on this Function

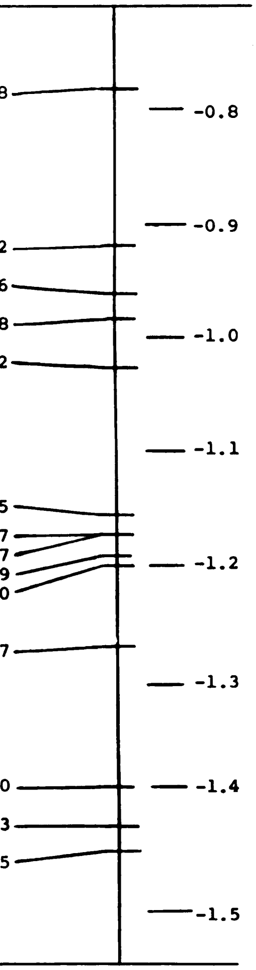
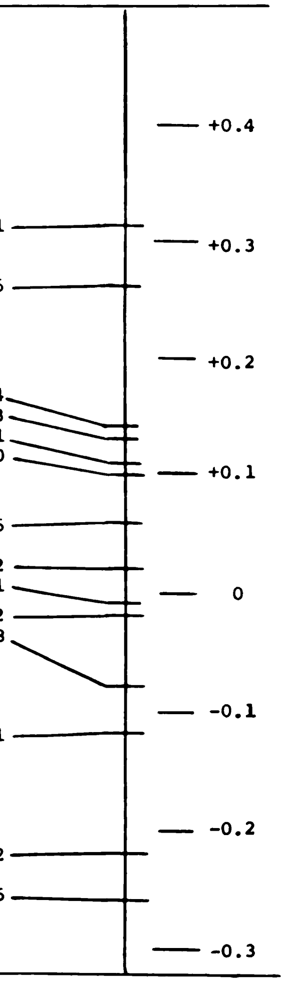


TABLE 17. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR FOURTEEN GROUPS ON FUNCTION FIVE

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -
1	12.01	x	
2	2.06		
3	3.03		
4	5.91		
5	- 5.85		
6	0.82		
7	2.87		
8	1.09		
9	- 1.74		
10	- 2.31		
11	2.48		
12	- 6.29		
13	4.83		
14	7.75		
15	- 9.44		
16	-14.08		x
17	0.50		
18	- 4.84		
19	1.70		
20	9.62		
21	19.35	x	
22	2.86		
23	25.16	x	
24	11.82	x	
25	- 2.75		
26	9.22		
27	11.03	x	
28	10.96	x	
29	0.84		
30	- 3.79		
31	-11.27		x
32	10.49	x	
33	2.42		
34	-13.08		x
35	-12.80		x
36	9.63		
37	1.54		
38	-11.01		x
39	- 2.45		
40	7.76		
41	- 7.68		
42	- 1.44		
43	- 7.75		
44	7.01		
45	4.12		
46	3.90		
47	9.19		

Major Group	Group Centroid
1. Packaging	0.31
10. History	0.26
6. Electrical Eng.	0.14
14. Psychology	0.13
7. Mechanical Eng.	0.11
13. Political Science	0.10
11. Social Science	0.06
2. Accounting	0.02
3. Gen Bus. Admin.	-0.01
4. Economics	-0.02
5. Marketing	-0.08
9. Mathematics	-0.11
12. Pre-Law	-0.22
8. Zoology	-0.26

Plot of Group Centroids on this Function



and history had the highest positive centroids for function five.

Using the same computational scheme employed in the 27-group case, the fourteen majors formed four clusters (A' through D') identical to the original clusters (A through D). Clusters A' through D', intra- and inter-cluster distances, and nearest cluster are shown in Tables 18 and 19. Computations are shown in Appendix D.

Comparing the plot of Clusters A' through D' on the first three functions with the previous plot of Clusters A through D revealed certain differences in their relative positions. Economics, history, and pre-law were less abstract on the 14-group analysis, making Cluster B' less abstract than Cluster B. Cluster B' was clearly verbal/ social science in the second analysis, in contrast to its position on function one of the 27-group analysis, where it was at the low end of the numerical/technical segment. Zoology shifted toward the numerical/physical science end of function one on the 14-group analysis, appearing more like accounting and packaging than in the 27-group analysis. Thus, the absence of the female majors resulted in greater clarification of the differences among the male groups.

TABLE 18. FORMATION OF CLUSTERS USING INTERCENTROID DISTANCES FROM FOURTEEN GROUP ANALYSIS

Cluster	Majors Included in Cluster	Average Intra-Cluster Distance	Average Inter-Cluster Distance A'	B'	C'	D'
A'	6-7-9	.69	....	1.36	1.51	1.09
B'	1-2-3-5	.76		....	1.28	1.39
C'	4-10-11-12-13	.79			...	1.06
D'	8-14	.87				....

TABLE 19. INTER-CLUSTER RELATIONSHIPS FOR FOURTEEN GROUP ANALYSIS

Cluster	Majors Included in Cluster	Nearest Cluster	Majors in Nearest Cluster	Farthest Cluster	Majors in Farthest Cluster
A'	6-7-9	D'	8-14	C'	4-10-11-12-13
B'	1-2-3-5	C'	4-10-11-12-13	D'	8-14
C'	4-10-11-12-13	D'	8-14	A'	6-7-9
D'	8-14	C'	4-10-11-12-13	B'	1-2-3-5

Discriminant Analysis of Thirteen Female Criterion Groups

The 13-group analysis produced 12 discriminant functions, of which five were significant at the .001 level and accounted for 76.34 percent of the variation among groups (Table 20).

TABLE 20. PERCENT OF TRACE, DEGREES OF FREEDOM, AND STATISTICAL SIGNIFICANCE LEVELS FOR FIRST FIVE DISCRIMINANT FUNCTIONS OF THE THIRTEEN-GROUP ANALYSIS

Function Number	Percent of Trace: Individual	Percent of Trace: Cumulative	df	Tabled X^2 Values α = .001	Computed X^2 Values
1	25.76	....	58	97.0	299.8
2	18.21	43.97	56	94.5	225.2
3	15.04	59.01	54	91.9	191.2
4	9.31	68.32	52	89.3	124.7
5	8.02	76.34	50	86.7	108.8

Almost 26 percent of the trace was accounted for by the first function. All weights of 10.00 or more were positive and were assigned to the following variables: interest in physical science occupations, the CQT Numerical score, the MSU Reading score, factors influencing vocational choices, and coming to college for educational and vocational reasons. This combination of variables suggested a scientific orientation for those majors with high positive group centroids as contrasted with a nonscience orientation of the majors with low positive group centroids. Majors in the former category included mathematics, psychology, nursing, history, social science, and English. As shown in Table 21, the mathematics women were much higher than any of the other groups, the psychology women occupied a second, separate and distinct position on the continuum, and the next four majors grouped together near the midpoint of the distribution. The four majors at the low positive end of the plot were retailing of textiles and clothing, elementary education, speech, and art practice. The prime differentiator, then, appeared to be an interest in science coupled with numerical ability.

The second function separated the majors on the strength of their verbal orientations. High positive loadings were associated with the CQT Verbal score, interests in verbal and linguistic as well as social service occupations, and self-rating of verbal reasoning ability. Negative weights were attached to certainty of first vocational choice, MSU Reading score, and self-rating of numerical reasoning ability. The combination of positive and negative loadings assigned the highest positive centroids to social science and English majors (Table 22), followed by history and psychology. The lowest centroids were assigned to nursing and mathematics.

TABLE 21. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR THIRTEEN GROUPS ON FUNCTION ONE

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid
1	2.58				
2	4.07				
3	18.62	x			
4	- 4.78				
5	13.28	x		17. Mathematics	4.25
6	0.23				
7	0.25				
8	6.63				
9	2.42				
10	- 1.86				
11	- 0.79				
12	4.06				
13	0.06				
14	- 1.83				
15	5.20				
16	3.29				
17	- 1.50				
18	- 0.80				
19	0.08				
20	- 4.02				
21	32.95	x			
22	5.13				
23	0.69				
24	- 3.33			26. Psychology	3.48
25	0.65				
26	- 0.42				
27	4.02				
28	- 2.84				
29	3.55				
30	- 5.21				
31	5.38				
32	- 1.32			18. Nursing	3.13
33	- 7.09			24. History	3.08
34	1.70			25. Social Science	3.07
35	- 1.64			23. English	3.01
36	- 4.05				
37	- 5.85				
38	5.53			20. Special Educ.	2.89
39	4.84			15. Home Ec. Tchg.	2.85
40	- 1.81				
41	10.35	x		27. Social Work	2.76
42	20.90	x		16. Ret., Tex. & Clo.	2.70
43	15.63	x		19. Elem. Educ.	2.67
44	11.16	x		21. Speech	2.63
45	5.05			22. Art Practice	2.60
46	1.30				
47	7.98				

Plot of Group Centroids on this Function

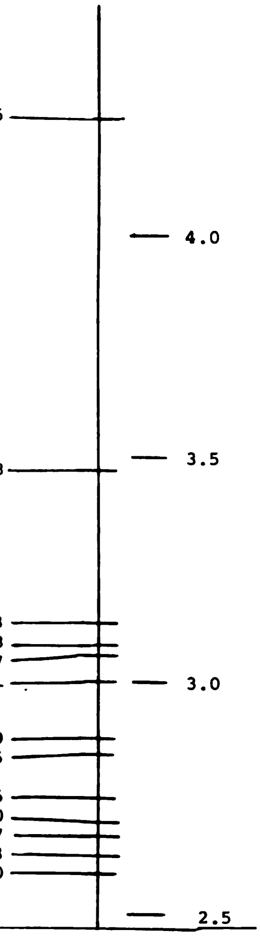


TABLE 22. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR THIRTEEN GROUPS ON FUNCTION TWO

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid	Plot of Group Centroids on this Function
1	23.65	x				
2	9.79					
3	3.38			25. Social Science	1.38	
4	1.38					
5	-13.51		x			
6	- 2.12			23. English	1.25	
7	6.07					
8	3.46					
9	- 1.92					
10	9.88					
11	0.19					
12	- 6.65					+1.0
13	6.13			24. History	0.95	
14	- 4.80			26. Psychology	0.94	
15	0.99					
16	-11.14		x			
17	11.88	x				
18	0.39					
19	1.68			16. Ret., Tex. & Clo.	0.73	
20	5.03					
21	- 7.65			21. Speech	0.66	
22	- 9.62			20. Special Education	0.57	
23	- 4.91			22. Art Practice	0.55	
24	12.79	x		19. Elementary Educ.	0.54	+0.5
25	0.69			27. Social Work	0.54	
26	7.10			15. Home Ec. Tchg.	0.53	
27	17.52	x				
28	6.36			17. Mathematics	0.34	
29	- 3.68					
30	- 1.99					
31	6.05					
32	- 0.75					
33	- 1.59					
34	6.50					
35	6.98					
36	1.56			18. Nursing	-0.009	0
37	- 6.44					
38	- 2.84					
39	- 0.62					
40	-21.30		x			
41	4.05					
42	4.16					
43	0.92					
44	- 3.22					
45	3.66					
46	- 7.17					
47	- 7.20					
						-0.5

Function three produced a small fine arts-creative cluster of majors at the high negative end of the scale and a large cluster of service-oriented majors at the low negative end of the scale (Table 23). Highest negative weights were assigned to preference for artistic occupations, vocational choice influenced by personal needs and experiences, the MSU English score, strength of first major choice, preference for literary classics, and the importance of a college education for its own sake. Art practice, speech, and retailing of textiles and clothing had high negative centroids. Nursing, English, and mathematics majors fell in the middle of the plot and the remaining seven criterion groups were close together at the low negative end. The positively-weighted variables were interest in social service occupations, the CQT Numerical score, education level of mother, and interest in biological sciences.

Function four (Table 24) produced very little overall spread among the majors. Mathematics had the highest positive centroid (2.31), and psychology had the lowest (1.79), a difference of only .52 points. Examination of the high-weight variables suggested no clear explanation of the nature of the difference.

Function five assigned high positive weights to eleven variables and high negative weights to five variables (Table 25). Nursing received the highest positive centroid on the function and home economics teaching and retailing of

TABLE 23. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR THIRTEEN GROUPS ON FUNCTION THREE

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -
1	- 3.21		
2	8.02		
3	11.33	x	
4	-13.23		x
5	1.09		
6	- 9.26		
7	1.27		
8	- 2.43		
9	4.56		
10	-11.48		x
11	- 1.45		
12	2.38		
13	8.43		
14	- 1.14		
15	- 5.23		
16	- 1.49		
17	0.61		
18	- 0.72		
19	5.04		
20	-20.04		x
21	- 3.66		
22	10.69	x	
23	- 3.57		
24	23.35	x	
25	0.29		
26	- 3.22		
27	1.92		
28	- 6.75		
29	- 0.44		
30	11.06	x	
31	3.04		
32	2.70		
33	- 2.76		
34	- 1.41		
35	5.82		
36	1.73		
37	- 5.83		
38	- 0.76		
39	-12.79		x
40	5.76		
41	- 4.61		
42	-19.04		x
43	-10.25		x
44	-12.55		x
45	- 1.54		
46	- 5.70		
47	- 1.22		

Major Group	Group Centroid
15. Home Ec. Tchg.	-0.21
24. History	-0.25
27. Social Work	-0.31
19. Elementary Educ.	-0.35
20. Special Educ.	-0.37
26. Psychology	-0.39
25. Social Science	-0.40
18. Nursing	-0.49
23. English	-0.59
17. Mathematics	-0.69
16. Ret., Tex. & Clo.	-0.94
21. Speech	-1.06
22. Art Practice	-1.16

Plot of Group Centroids on this Function

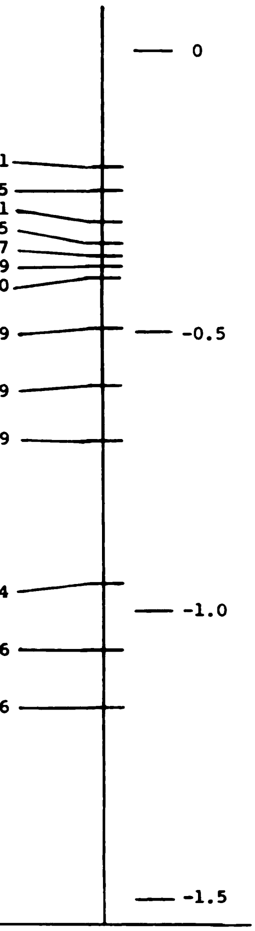


TABLE 24. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR THIRTEEN GROUPS ON FUNCTION FOUR

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -
1	-14.19		x
2	15.78	x	
3	- 0.94		
4	8.01		
5	- 6.79		
6	- 4.00		
7	- 5.82		
8	-12.53		x
9	- 0.16		
10	- 0.05		
11	4.38		
12	- 1.71		
13	- 3.36		
14	- 6.16		
15	- 2.18		
16	10.17	x	
17	4.10		
18	- 1.47		
19	- 5.33		
20	3.01		
21	7.21		
22	-12.28		x
23	- 6.16		
24	3.23		
25	7.61		
26	0.26		
27	0.64		
28	- 0.51		
29	1.20		
30	0.89		
31	6.05		
32	0.23		
33	6.61		
34	- 1.75		
35	2.20		
36	15.07	x	
37	6.53		
38	0.91		
39	1.06		
40	- 2.00		
41	17.26	x	
42	9.07		
43	10.13	x	
44	1.02		
45	4.70		
46	- 3.79		
47	9.91		

Major Group	Group Centroid
17. Mathematics	2.31
19. Elementary Educ.	2.24
25. Social Science	2.16
22. Art Practice	2.11
24. History	2.09
23. English	2.08
21. Speech	2.01
27. Social Work	2.00
16. Ret., Tex. & Clo.	1.97
20. Special Education	1.95
18. Nursing	1.84
15. Home. Ec. Tchg.	1.83
26. Psychology	1.79

Plot of Group Centroids on this Function

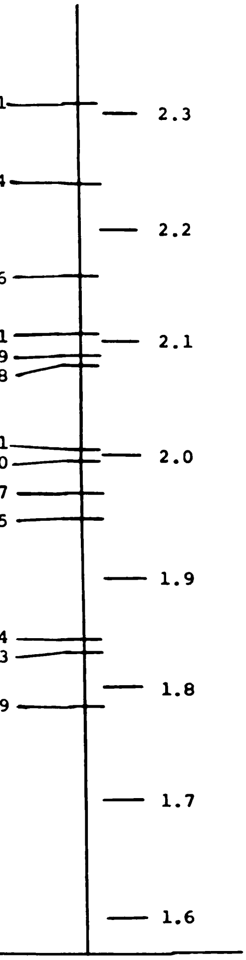
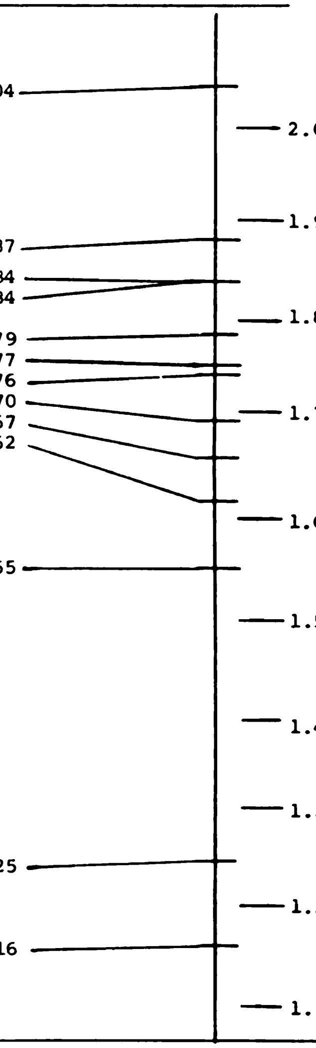


TABLE 25. STANDARDIZED WEIGHTS, GROUP CENTROIDS, AND PLOT OF GROUP CENTROIDS FOR THIRTEEN GROUPS ON FUNCTION FIVE

Variable	Standardized Weight (X 100)	High-Weight Variables +	High-Weight Variables -	Major Group	Group Centroid
1	-13.66		x		
2	- 9.50				
3	0.27				
4	17.90	x		18. Nursing	2.04
5	13.16	x			
6	- 2.15				
7	6.71				
8	0.28				
9	0.52				
10	1.37				
11	16.40	x			
12	- 4.76			23. English	1.87
13	-10.54		x	26. Psychology	1.84
14	-11.76		x	27. Social Work	1.84
15	- 6.36				
16	-13.92		x	20. Special Educ.	1.79
17	8.22			22. Art Practice	1.77
18	7.78			21. Speech	1.76
19	- 7.36			19. Elem. Educ.	1.70
20	- 5.34			24. History	1.67
21	2.07			25. Social Science	1.62
22	19.47	x			
23	4.60				
24	2.96				
25	- 5.72				
26	-15.10		x		
27	3.12			17. Mathematics	1.55
28	- 0.32				
29	- 9.39				
30	13.91	x			
31	6.50				
32	- 1.11				
33	- 3.92				
34	6.21				
35	0.73				
36	13.46	x			
37	5.39				
38	10.10	x			
39	0.99				
40	- 0.01				
41	- 7.60			16. Ret., Tex. & Clo.	1.25
42	- 7.04				
43	- 9.39				
44	26.35	x			
45	17.66	x		15. Home Ec. Tchg.	1.16
46	10.09	x			
47	23.27	x			

Plot of Group Centroids on this Function



textiles and clothing the lowest, with the remaining ten majors closely grouped in the center. The highest positive variables were the educational and status advantages of a college education, preference for biological science occupations, and the MSU English score. High negative variables included preference for business contact occupations, self-rating of numerical ability, the CQT Verbal score, and a preference for social studies and non-academic subjects in high school.

The clusters which were formed using intercentroid distances from the 13-group analysis and the same computational procedure employed in the 27- and 14-group cases were slightly different in composition and character from the original 27-group clusters E through H (Tables 26 and 27). Computations are shown in Appendix E.

The seven majors of the original Cluster F formed two clusters, E' and F'. Cluster E' contained home economics teaching, elementary education, special education, and social work majors. Cluster F' contained retailing of textiles and clothing, speech, and art practice majors. Cluster E' was more social-service oriented and less artistic/creative than F' and more closely knit than any of the other clusters. Cluster F' was the least science-oriented of all the clusters. Again, English, history, social science, and psychology formed a cluster and mathematics and nursing majors were isolates.

TABLE 26. FORMATION OF CLUSTERS USING INTERCENTROID DISTANCES FROM THIRTEEN GROUP ANALYSIS

Cluster	Majors Included in Cluster	Average Intra-Cluster Distance	Average Inter-Cluster Distance E'	F'	G'	H'	I'
E'	15-19-20-27	.64	....	0.96	0.96	0.96	1.61
F'	16-21-22	.71		....	1.16	1.22	1.75
G'	23-24-25-26	.80			....	1.31	1.50
H'	18	...				....	1.41
I'	17	...					....

TABLE 27. INTER-CLUSTER RELATIONSHIPS FOR THIRTEEN GROUP ANALYSIS

Cluster	Majors Included in Cluster	Nearest Cluster	Majors in Nearest Cluster	Farthest Cluster	Majors in Farthest Cluster
E'	15-19-20-27	F',G',H'	All but 17	I'	17
F'	16-21-22	E'	15-19-20-27	I'	17
G'	23-24-25-26	E'	15-19-20-27	I'	17
H'	18	E'	15-19-20-27	I'	17
I'	17	H'	18	F'	16-21-22

As a result of analyzing the female criterion groups separately from the male criterion groups, greater discrimination among the majors was possible (Figures 2 and 3). In the 27-group treatment, the greatest difference among groups (function one) was a numerical/technical versus verbal/humanistic split, with the male criterion groups at one end and all the female groups except mathematics at the other. The 14-group analysis also identified a numerical-verbal dichotomy as the primary difference, but those male majors which at first had to be described as "less numerical/technical" were subsequently shown to be verbal/social science. Similarly, the 13-group analysis emphasized the scientific, numerical, and verbal measures in accounting for the major portion of the variation among the female majors, but, because the first function dealt with scientific/numerical characteristics and the second function dealt with verbal characteristics, it was possible to describe the female criterion groups more exactly. Thus, the psychology women, who appeared to be neither highly verbal/humanistic nor numerical/technical in the 27-group analysis, were shown to be both scientific/numerical and verbal in the 13-group analysis.

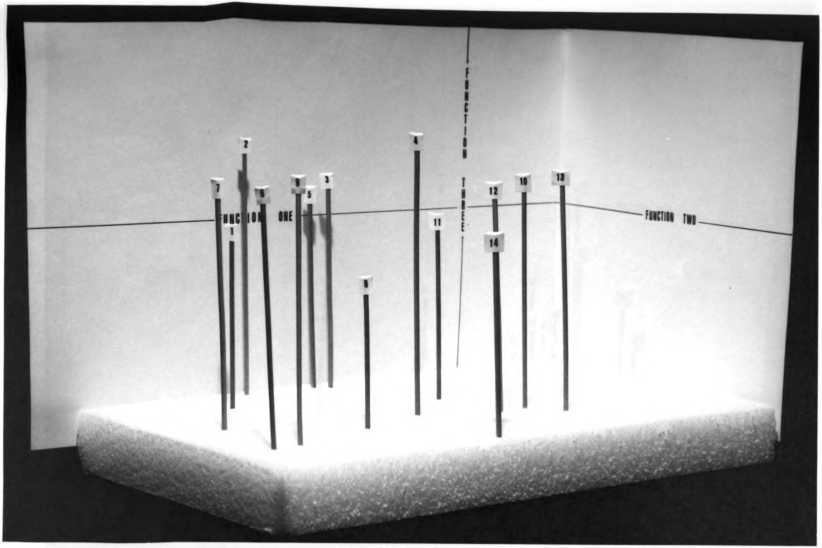


FIGURE 2. THREE DIMENSIONAL PLOT OF GROUP CENTROIDS ON FIRST THREE SIGNIFICANT FUNCTIONS OF FOURTEEN GROUP ANALYSIS.

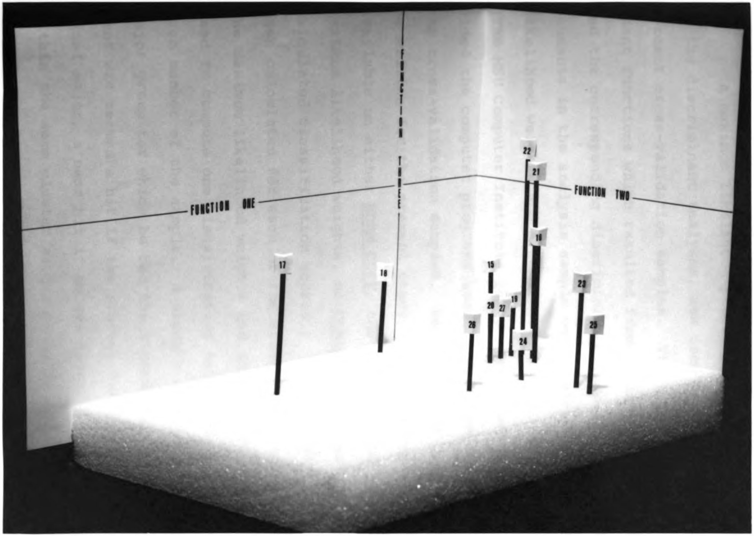


FIGURE 3. THREE DIMENSIONAL PLOT OF GROUP CENTROIDS ON FIRST THREE SIGNIFICANT FUNCTIONS OF THIRTEEN GROUP ANALYSIS.

Classification of the Cross-Validation Samples

A maximum likelihood procedure, based on the results of the discriminant analyses, was used to classify three 20 percent cross-validation samples. The significant discriminant functions which resulted from a discriminant analysis and the corresponding discriminant scores for each of the students in the analysis sample were used to compute maximum likelihood weights and a constant for each major group. (The MSU Computer Institute for Social Science Research provided the computer programs used in the classification of the cross-validation samples. Because these programs had to be written for the present study, technical reports were not available on either NORM CURV, the program which computed maximum likelihood weights, or CLASS, the program which calculated classification scores.) Discriminant scores were then calculated for each of the students in the check sample. The maximum likelihood weights and discriminant scores were used to compute one classification score per major group for each member of the sample. A student was assigned to the major group for which he had the highest score. An assignment was termed a hit if the student was classified into his final major, a near hit if he was classified into a major within the same cluster as his final major, and a miss if he was classified into a major outside the cluster which contained his final major.

Results of the Twenty-Seven Group Classification

The cross-validation sample for the 27-group classification contained 353 students, 181 men and 172 women. Ten significant functions and the corresponding 10 discriminant scores were used in developing the maximum likelihood weights and classification scores. The results of the classification are shown in Table 28.

Of the 353 students in the check sample, 62 (18 percent) were assigned to the correct major (hits), a rate significantly better than chance ($p < .001$). This finding gave additional support to the major research hypothesis of the study. An additional 107 students were assigned to the correct cluster (near hits). Combining hits and near hits gave a 48 percent accuracy rate.

The classification results also supported the secondary hypothesis of the study (that men and women in the same major have substantially different patterns of characteristics). The four major fields with both a male and a female group are mathematics (9 and 17), history (10 and 24), social science (11 and 25), and psychology (14 and 26). These groups are circled in Table 28. Of the five mathematics men assigned to women's majors, one was classified in mathematics and, of the six mathematics women assigned to men's fields, two were classified in mathematics. Of the seven psychology men assigned to women's majors, two were

TABLE 28. CLASSIFICATION OF CROSS-VALIDATION SAMPLE FOR TWENTY-SEVEN GROUP CASE SHOWING HITS, NEAR HITS, AND MISSES

Actual Major &	Cluster	Major and Cluster Assignment A 6	7	9	B 1	2	3	5	C 4	10	11	12	13	D 8	14	E 23	24	25	26	F 15	16	19	20	21	22	27	G 17	H 18	Size of Sample	Direct Hits N	%	Near Hits N	%	Cluster Total Hits & Near Hits N	Cluster	%
	6	2	.	3	3	1	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	3	.	14	2	14	3	21		A	
A	7	2	.	1	2	1	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	9	0	..	3	33			
	9	3	2	.	1	.	.	.	1	1	.	1	.	.	2	.	.	1	2	1	.	.	.	.	.	.	(1)	.	16	0	..	5	31	13		33
	1	1	1	.	4	.	.	1	1	.	.	1	.	2	.	.	.	.	1	.	1	.	.	.	.	1	.	2	16	4	25	1	6		B	
B	2	.	1	.	1	8	.	2	.	.	.	.	.	1	.	.	.	.	.	.	2	.	.	.	.	.	.	.	15	8	53	3	20			
	3	.	1	.	1	4	5	1	.	.	2	.	.	2	1	.	.	.	.	1	1	.	.	.	.	.	.	.	19	5	26	6	32			
	5	.	.	.	1	3	3	.	.	.	.	1	1	2	.	.	.	.	.	1	.	.	.	.	.	1	.	.	13	0	..	7	54	34		54
	4	1	.	.	.	1	1	.	.	1	.	1	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	8	0	..	2	25		C	
	10	.	.	1	.	.	.	1	1	1	1	1	2	.	2	1	(.)	.	.	.	.	1	.	.	.	.	.	.	12	1	8	5	42			
C	11	.	.	1	1	.	.	1	1	1	.	2	2	.	.	.	1	(.)	2	.	.	.	.	1	.	.	1	.	14	0	..	6	43			
	12	.	.	1	.	.	.	.	1	.	.	1	.	1	.	.	.	1	.	1	1	1	.	.	.	.	.	.	8	1	12	1	12			
	13	1	.	1	.	.	1	.	.	1	3	2	2	.	.	.	.	1	.	1	.	.	.	.	.	.	1	.	14	2	14	6	43	24		43
D	8	.	1	1	.	.	1	.	.	.	1	.	.	4	.	.	.	.	.	1	.	.	.	.	.	.	.	.	9	4	44	0	..		D	
	14	1	.	.	1	.	.	.	1	.	1	.	.	2	1	.	.	1	(2)	1	1	.	.	.	.	.	1	1	14	1	7	2	14	7		30
	23	.	.	.	.	.	.	.	.	1	.	1	.	1	.	5	1	1	1	.	1	.	1	1	3	1	.	.	18	5	28	3	17		E	
E	24	.	.	.	.	.	.	.	.	(.)	1	.	.	.	.	1	3	.	1	1	1	.	.	2	.	.	.	.	10	3	30	2	20			
	25	.	.	.	.	1	.	.	.	.	(.)	.	.	.	.	.	.	1	1	2	.	1	.	2	1	.	.	.	9	1	11	1	11			
	26	.	.	1	.	.	.	.	.	.	.	.	.	.	(.)	3	2	.	.	.	.	.	.	1	.	1	1	.	9	0	..	5	55	20		43
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	.	.	2	1	2	1	10	1	10	6	60		F	
	16	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	1	1	.	.	1	8	4	50	2	25			
	19	.	.	.	.	2	.	.	.	.	.	.	.	1	.	2	6	1	3	7	4	11	1	.	1	7	2	3	51	11	22	20	39			
F	20	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	1	3	.	.	.	.	1	.	.	2	9	0	..	4	44			
	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	.	.	.	.	1	1	1	.	1	.	.	8	1	12	3	37			
	22	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	.	.	3	1	.	.	.	10	1	10	8	80			
	27	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	2	1	3	.	.	.	.	.	1	.	1	11	1	9	3	27	65		61
G	17	.	1	(2)	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	3	.	10	3	30	NA	..	3	G	30
H	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	1	.	.	.	1	3	9	3	33	NA	..	3	H	33
Totals		12	7	12	16	23	12	6	7	6	10	11	7	18	11	15	16	9	17	28	21	18	4	12	10	14	17	14	353	62	18	107	30	169		48

assigned to psychology. For the remaining five groups, no cases were assigned to the opposite-sex major group.

In general, men were more often misclassified into women's majors than were women misclassified into men's majors. Forty-three men were assigned to women's majors, while only 20 women were assigned to men's majors. The most "popular" women's majors for men were home economics teaching (eight men assigned), mathematics (eight men assigned), psychology (seven men assigned), and retailing of textiles and clothing (six men assigned). Five women were assigned to accounting, the only men's group to receive a substantial number of women. At least one member of each male group was assigned to a female group; the extreme example was psychology, in which half the men were assigned to women's majors. Three of the female groups (home economics teaching, speech, and nursing) had no members assigned to male groups. Over half of the mathematics women, however, were assigned to male majors. Apparently, psychology men have important characteristics in common with a number of female majors, and mathematics women share important characteristics with a number of male majors.

Results of the Fourteen-Group Classification

Five significant functions and the corresponding five discriminant scores from the fourteen-group discriminant analysis formed the basis for a maximum likelihood classification of the 181 men in the cross-validation sample. Twenty percent of the men were correctly assigned to their final majors and, when hits were combined with near hits, 52 percent of the check sample fell into the correct clusters (Table 29). This was an increase of 5 percent and 9 percent respectively, when compared to the accuracy achieved in classifying the men in the 27-group case. As to where the increase came from, the 43 men who, in the 27-group classification, had been assigned to female groups, were now forced into male groups. Twenty-five were still misses, but ten of them were assigned to the correct majors and eight were put into the correct clusters. In general, it was these additional hits and near hits which accounted for the increase in accuracy.

Sixty percent of the twenty-five misses were now found in Cluster D', nine in the psychology group and six in zoology, a second indication that the characteristics associated with the male psychology majors in this study are highly compatible with the characteristics of a variety of female majors.

Results of the Thirteen-Group Analysis

The cross-validation sample contained 172 women who were classified on the basis of the five significant functions produced by the 13-group discriminant analysis. Forty-four assignments were direct hits (26 percent), an increase

TABLE 29. CLASSIFICATION OF CROSS-VALIDATION SAMPLE FOR FOURTEEN-GROUP CASE SHOWING HITS, NEAR HITS, AND MISSES

Actual Major &	Cluster	Major and Cluster Assignment														Size of Sample	Direct Hits		Near Hits		Cluster Total Hits and Near Hits		
		C'			B'				C'					D'									
		6	7	9	1	2	3	5	4	10	11	12	13	8	14		N	%	N	%	N	Cluster	%
	6	3	1	2	2	1	..	..	1	..	..	..	..	3	1	14	3	21	3	21		A'	
A'	7	..	1	..	3	1	..	..	3	..	..	..	..	1	..	9	1	11	0	..			
	9	1	2	4	2	..	..	..	2	1	..	1	1	..	2	16	4	25	3	19	14		36
	1	2	2	..	4	2	..	..	..	..	..	..	..	4	2	16	4	25	2	12		B'	
B'	2	..	2	..	..	10	1	..	..	..	1	..	..	1	..	15	10	67	1	10			
	3	..	2	..	1	5	..	4	1	1	2	1	..	..	2	19	0	..	10	53			
	5	..	..	..	1	3	3	2	..	..	..	1	1	2	..	13	2	15	7	54	36		57
	4	1	..	..	..	1	1	..	1	2	..	1	..	1	..	8	1	12	3	37		C'	
	10	..	..	1	..	..	1	..	1	2	..	1	3	1	2	12	2	17	5	42			
C'	11	..	..	..	1	..	2	..	2	1	1	1	2	..	4	14	1	7	6	43			
	12	..	..	1	..	..	..	1	1	1	..	2	1	1	..	8	2	25	3	37			
	13	1	..	1	..	..	..	..	1	3	3	3	1	..	1	14	1	7	10	71	34		61
D'	8	..	..	1	2	..	..	1	..	..	..	..	..	3	2	9	3	33	2	22		D'	
	14	..	1	3	1	..	..	..	..	..	2	..	1	3	3	14	3	21	3	21	11		48
Totals		8	11	13	17	23	8	8	13	11	9	11	10	20	19	181	37	20	58	32	95		52

of 6 percent over the 27-group result. Accuracy of the cluster assignments was not directly comparable because, as described earlier in the chapter, the clusters formed from the 27-group analysis were not identical to the clusters formed from the 13-group analysis. The latter analysis produced five clusters instead of four. Even with the more rigorous test of the discriminatory power of the analysis, however, accuracy increased to 55 percent correct cluster assignments (Table 30).

Twenty women had been assigned to men's majors in the 27-group classification. Nine of them were direct hits in the 13-group classification and three were assigned to the correct clusters. Seventy-five percent of the misses were found in the mathematics group, and this, taken with the fact that 90 percent of the mathematics women were direct hits after the male groups were eliminated, provides further support for the conclusion that mathematics women share more important characteristics with the men in the study than the women.

Summary

The major hypothesis of the study was that undergraduate major fields can be differentiated on the basis of selected characteristics of their students. Results of the 27-group discriminant analysis permitted rejection of the null hypothesis:

TABLE 30. CLASSIFICATION OF CROSS-VALIDATION SAMPLE FOR THIRTEEN-GROUP CASE SHOWING HITS, NEAR HITS, AND MISSES

Actual Major &	Cluster	Major and Cluster Assignment													Size of Sample	Direct Hits		Near Hits		Cluster Total Hits and Near Hits		
		E'				F'			G'				H'	I'								
		15	19	20	27	16	21	22	23	24	25	26	18	17		N	%	N	%	N	Cluster	%
E'	15	2	2	..	2	..	2	..	..	..	..	..	1	1	10	2	20	4	40		E'	
	19	11	11	..	9	5	1	..	1	2	2	2	2	5	51	11	22	20	39			
	20	4	..	..	1	..	..	..	..	..	..	1	3	..	9	0	..	5	55			
	27	2	..	1	1	..	..	..	..	2	1	2	1	1	11	1	9	3	27	46		57
F'	16	..	..	1	..	5	1	1	..	..	..	..	..	..	8	5	62	2	25		F'	
	21	..	..	..	2	..	1	..	3	..	2	..	..	..	8	1	12	0	..			
	22	..	..	..	..	4	..	1	2	..	..	..	2	1	10	1	10	4	40	13		50
G'	23	..	1	..	..	2	..	2	6	1	2	2	..	2	18	6	33	5	28		G'	
	24	..	..	..	1	3	..	1	..	2	1	2	..	..	10	2	20	3	30			
	25	2	..	..	..	1	1	1	..	..	2	1	..	1	9	2	22	1	11			
	26	..	..	..	..	..	1	..	3	1	..	2	..	2	9	2	22	4	44	25		54
H'	18	2	1	..	..	1	..	..	..	..	..	1	2	2	9	2	22	NA	..	2	H'	22
I'	17	..	..	..	..	..	..	..	..	..	1	..	..	9	10	9	90	NA	..	9	I'	90
Totals		23	15	2	16	21	7	6	15	8	11	13	11	24	172	44	26	51	30	95		55

> No differences exist among undergraduate fields on the basis of the abilities, interests, educational-vocational preferences, or family and high school backgrounds of their student members.

It was, therefore, concluded that undergraduate major fields were different with respect to the kinds of students who persist in them.

A multivariate discriminant analysis of 47 variables for 27 major-sex groups produced 26 functions, 10 of which were significant beyond the .001 level. The first five significant functions accounted for 79 percent of the variation among groups and were analyzed in detail.

There was a marked separation of majors into two distinct groupings on the first function, a verbal/humanistic versus numerical/technical split. The verbal/humanistic grouping contained only female majors; the numerical/technical grouping contained all the male majors and the mathematics women. The differences identified by function one accounted for 51 percent of the total variation among groups and appeared to be heavily influenced by the sex differences measured by the variables.

The high-weight variables in function two were interpreted as generalist to specialist in nature and spread the majors along the continuum in gradual steps. Mathematics, engineering, and nursing were closest to the specialist end of the scale and political science, history men, and prelaw were at the extreme generalist end.

Function three identified a set of variables which appeared to differentiate between abstract fields and applied fields.

The fourth and fifth functions were difficult to interpret. They each accounted for about 4 percent of the trace, and although they were significant, they were greatly overshadowed by the first three functions.

The combined effects of the first three functions were demonstrated in a three-dimensional plot of group centroids. Common characteristics cut across college lines. Majors fell into more or less distinct clusters which shared similar interest and ability patterns. The greatest differences, of course, were the sex-related ones defined by the first function. This finding led to the decision to run separate discriminant analyses on the 14 male groups and the 13 female groups.

The general effect of separating the sexes was to clarify the nature of the differences among major fields. For example, all the male majors were originally described as numerical/technical and all the female majors (except mathematics) were described as verbal/humanistic. The separate analyses positioned all majors on both qualities.

To test the validity of the discriminant analyses, discriminant weights and scores were used to compute maximum likelihood weights from which cross-validation samples were classified. Separate classifications were performed for the

27-, 14-, and 13-group cases. Results in each case were significantly better than chance.

A secondary hypothesis of the study was that male and female students in the same major had substantially different patterns of characteristics. No direct statistical test of this hypothesis was possible. Descriptive information was available, however, and it was proposed that, if men and women in the same major were substantially the same, their groups would fall close together in the discriminant space defined by the 27-group analysis. In fact, none of the four pairs (mathematics, history, social science, and psychology) were together in discriminant space.

In Chapter V, a brief description of each of the 27 major groups is provided.

CHAPTER V

SUMMARY DESCRIPTIONS OF THE TWENTY-SEVEN MAJOR GROUPS

In this chapter, the raw data and the results of the appropriate discriminant analyses and maximum likelihood classifications are drawn together in a descriptive summary for each major group. Specifically mentioned are mean scores on variables (Appendix F), discriminant analysis and classification outcomes cited in Chapter IV, intercentroid distances and cluster formations (Appendices C, D, and E), and frequency distributions of raw data not previously included.

A few of the variables had distributions which demonstrated sex-related trends. Women's majors generally scored higher on the CQT Verbal and MSU Reading tests than men's groups. Women also tended to give higher ratings than did men to the following: literary classics, biography, and history books; fine and applied arts and letters courses in high school; social service, artistic, and biological science occupations; and the importance of family influence and the social aspects of a college education in their decision to attend college. Parents of women in the sample generally had higher mean educational levels than did parents of men in the sample. Men's majors generally scored higher on the CQT Information and Numerical tests than women's groups. They also tended to give higher ratings than did women to the following: technical and mystery books; high school science and mathematics courses; physical science and mechanical-technical occupations; and the importance of the prestige of a college education in their decision to attend college.

The Majors

1. Packaging. Men in this major scored somewhat below the mean for men on the ability/achievement measures and tended to rate themselves even lower. They preferred science, mathematics, and nonacademic subjects in high school and were more likely than most groups to read technical books for pleasure. Highest occupational preference was given to physical science and mechanical-technical professions; they tended to turn away from social service and verbal-linguistic occupations. Their parents had less education than most of the other major groups and father's occupational level was lower. Most of them were in-state students who planned to be partially self-supporting during college. They were more certain of their vocational choice prior to entering college than many groups, but a majority of them changed majors at least once before graduating. They were least likely of all groups to come to college for

educational reasons and most likely to come to college for the status and prestige of a college education.

This combination of characteristics placed packaging in the cluster of majors which included accounting, general business, and marketing, although they were also close to the engineering-mathematics cluster in discriminant space. Their interests and occupational preferences were similar to the latter cluster, but their scores on the ability/achievement measures and their self-ratings of ability were considerably lower. They appeared to be a group whose occupational aspirations outdistanced their abilities.

2. Accounting. Accounting majors scored below average on the CQT tests and MSU English and Reading tests and their self-ratings reflected their scores except for numerical reasoning, where they overrated their ability. They liked social studies and nonacademics in high school. Business detail occupations were very popular with these men; executive and managerial occupations ranked second. Of least interest were artistic occupations. Their parents had the lowest educational level of all groups and father's occupational level was also the lowest in the study. They came primarily from Michigan high schools and expected to work for a part of their college expenses.

The accounting majors most resembled packaging, general business, and marketing majors, and were somewhat close to zoology and mathematics men in discriminant space.

Nevertheless, they were different enough from all other groups to produce classification rates of 53 and 67 percent.

3. General business administration. Although their test scores were very low in comparison with other male groups, the general business administration majors rated their abilities as average or slightly above. Their occupational preferences were varied, although executive-managerial and business detail occupations were selected by more of the group than any others. They had no strong likes or dislikes among high school subjects, but showed a slight preference for social studies. Mean educational level of father was the highest of all male majors; mean level of mother was slightly lower. Father's occupational level was second highest of all groups, male and female. A high proportion of these men were in-state students. They were uncertain about choice of major and vocation prior to college entrance, and were more likely to be influenced in these decisions by family and significant others than most of the male groups.

The general business administration major was characterized in the discriminant analysis as generalist-applied. The members of this major appeared to be diverse and hetergeneous in their characteristics, suggesting that they might fit comfortably into any of several environments. The results of the classification supported this view. General business males were assigned to all clusters and to almost all majors in the 14-group case.

4. Economics. Economics majors scored above the mean on all five ability measures and rated themselves above average in all categories. They preferred physical science and executive-managerial occupations. Their parents had higher than average educational levels. The father's occupational level was high and in general, the mother did not work outside the home. A substantial minority of the group came from out-of-state high schools, a higher proportion than for any other male group. These men came to college primarily for educational reasons, but they were also motivated by social and status needs.

Economics was the only major from the College of Business which fell outside the "business" cluster in discriminant space. It was closer to the male majors from the College of Social Science than to the majors from the College of Business. This was apparently due to their consistently higher abilities and greater interest in abstract concepts.

5. Marketing. Marketing majors, like general business administration majors, had very low mean scores on the orientation tests, but rated their abilities as average and above. They tended to come from larger high schools in Michigan; they liked nonacademic subjects best and arts and

letters least. As a group, they were uncertain about a vocational choice. This uncertainty was reflected in the range of occupational interest expressed by them. Most popular were occupations of the executive-managerial type, but seven of the remaining eight occupational groups were selected by at least 20 percent of these men. Only artistic occupations were unpopular. They viewed a college education as important for its own sake, but, like packaging majors, they were more likely to value a college education for prestige and status reasons than most groups. A majority of their parents had continued their education beyond high school. Fathers were likely to be in supervisory or managerial positions and mothers were generally not employed outside the home. Their major source of financial support for college was their parents.

Marketing majors were most like general business administration majors. In both the 27-group discriminant analysis and the 14-group analysis, these two groups remained closer together in discriminant space than any other two major groups in the study. In both groups, there were few strong distinguishing characteristics, and consequently, it was difficult to classify them into the correct major. Assignment to the right cluster was much more likely.

6. Electrical engineering. Electrical engineers, of all male groups, had the highest mean scores on the CQT Verbal and Information Tests and the MSU Reading Test and

were second on _CQT Numerical_ and _MSU English_. Their self-ratings of ability were lower than one-third of the male groups. Science and mathematics were highly favored subjects in high school. Almost 40 percent of the group came from out-of-state. They were generally sure of their major and vocational choices and few changed majors during their four years. All of the men in this group selected physical science occupations; it was the first choice of all but three of them. Mechanical-technical and biological science occupations were their next preferences. Educational level of parents was about average for the male groups. Father's occupational level was somewhat below the male groups' average. The mother tended not to work outside the home.

Electrical engineers were characterized in the discriminant analyses as strongly attracted to the physical sciences and mathematics with specialized, abstract interests, placing them close to mathematics men and mechanical engineers.

7. _Mechanical engineers_. This group scored well above average on the _CQT Numerical_, above average on the _CQT Information_, and about average on the other three tests. Their self-ratings were realistic. Just as with electrical engineers, the mechanical engineers selected the physical science occupations first and mechanical-technical occupations second, but more of the latter group selected executive-managerial occupations as their third choice. They

were very sure that engineering was the correct major and vocation, decisions reached with the help of family and high school experiences. These men had very positive feelings about their high school experiences and, although science and mathematics were their favorite high school subjects, they tended to enjoy the other academic areas too. Three-quarters of them came from Michigan high schools. A college education was valued by this group as a way of getting desired prestige and position.

The discriminant analyses showed these men to be physical science-numerical-technical in interests and abilities. Their interests were specialized and they were more concerned with application of their specialty than with the theoretical aspects of it. Thus, they appeared to fall between electrical engineers and packaging majors, albeit, closer to electrical engineers.

8. Zoology. On the CQT and MSU tests, this group generally scored above the mean for men's groups. Their strongest showing was on the CQT Numerical, where they ranked fifth out of fourteen and, in rating their abilities, they viewed numerical reasoning as their strongest area. In high school, science and mathematics were their favorite courses; nonacademic subjects were not popular with this group. Two-thirds of them were Michigan residents. Of all the male groups, zoology majors most valued a college education for its own sake. They were primarily interested in

the biological science occupations (many of them had started in the pre-medical major and subsequently transferred to zoology) and secondarily in the physical science occupations, but were somewhat uncertain of a specific vocational choice. Over half the group had college-educated fathers who held executive-managerial positions or were in the professions.

Zoology majors did not closely resemble any other major. In the 27-group analysis, they were closest to psychology men in discriminant space, but even this was a distant relationship.

9. Mathematics. Mathematics men scored higher than the other male groups on the CQT Numerical and the MSU English tests; on the remaining three orientation tests, they were well above average. Self-ratings of general capacity, numerical reasoning, and anticipated grade-point average were also the highest of the male groups. They were fairly certain of a major choice before entering college, and over half of the group persisted in that choice. Physical science occupations were strongly preferred, followed by mechanical-technical and business detail occupations. Business contact work was most strongly rejected. In high school, they enjoyed mathematics and science and read technical books, but did not like the nonacademic subjects. They came to college primarily for educational-vocational reasons. Parents' educational levels were about average; father's occupational level was below average.

Over all, mathematics men and engineers were very much alike, falling into a close-knit cluster in discriminant space. Forty-four percent of the classification sample was assigned to this cluster.

10. History. The history men scored high on the CQT Verbal and Information tests, low on the CQT Numerical, and slightly above average on MSU Reading and English. Self-ratings of ability tended to match these positions. As expected, they favored social studies in high school and were most likely to read biography and history books for pleasure. Unlike most male groups in the study, they enjoyed arts and letters in high school. No one occupational preference group was strongly favored by history men. Their choices were distributed over a number of groups. Least popular with these men were artistic, mechanical-technical, business detail, and physical science occupations. Most popular were social service, verbal-linguistic, and business contact occupations. Parents' educational level was about average and father's occupational level also tended toward the mean. Almost half of the mothers were working ouside the home. Twenty percent of these men expected to be fully self-supporting in college.

History men were the only male major from the College of Arts and Letters included in the study. They closely resembled political science majors. They were characterized in the discriminant analyses as highly verbal with abstract, general interests. From the classification results, it appeared that these men could fit comfortably into any of the four social science majors, but particularly into political science.

11. Social science. Social science men had the lowest mean score on the CQT Numerical of all male majors and were below average on the remaining four orientation tests. Their scores were consistently lower than the other three male groups from the College of Social Science. Self-ratings of ability were quite realistic. They appeared to have no strong educational-vocational preferences. In high school, they liked all subject areas. They were uncertain about selecting a major in college; all but two of them changed majors at least once. There was no consensus of opinion on occupational group preferences and the choices they made were viewed as tentative. Educational level of parents was above average, although father's occupational level was close to the mean for male majors.

In the 27-group analysis, these characteristics placed social science men in the center of a large swarm of majors in such a way that as a group, they were not close to any one major.

Aside from their position on function one of the 14-group analysis, where they were clearly characterized as verbal-social science, this group never came to the surface. The assignment of the cross-validation sample of social science men suggested that the group had a general identity, but not a specific one.

12. Pre-law. Social science pre-law majors consistently overrated their abilities. Group scores on the CQT Verbal and MSU Reading tests were higher than two-thirds of the men's majors, but the pre-law group rated itself higher on these two areas than did any other male group. They recognized that numerical reasoning was their weakest area, but again, they tended to be optimistic. They enjoyed all high school subjects taken, especially social studies. Almost 40 percent of the group were out-of-state students. One-third of these men selected verbal-linguistic occupations as most suitable and another one-third selected physical science occupations. Among male groups, they had the most highly educated parents; 62 percent of the fathers and 52 percent of the mothers had at least a bachelor's degree. Almost two-thirds of the fathers were either in executive-managerial positions or in the professions. Few pre-law majors planned to work for college expenses during the school year. They were more likely than other male groups to view a college education as a social necessity and as expected by the family.

Pre-law men were characterized in the discriminant analyses as verbal-social science in their orientation and generalist and abstract in their interests. They were most similar to political science majors. In the 27-group classification, half of the pre-law check sample was assigned to women's majors. In the 14-group classification, one of these was correctly assigned to pre-law and two were placed in the correct cluster, giving them 62 percent hits and near hits.

13. Political science. Political science majors had average or above average mean scores on all orientation tests except the CQT Numerical, on which they had the second lowest mean score among the male groups. In general, self-ratings of ability appeared consistent with scores. High school social studies courses were most popular with these men and science and mathematics courses were least popular. Forty-one percent of the group was from out-of-state, the highest proportion of out-of-state students in any of the male majors. Political science also had the highest proportion of students who expected to be either entirely self-supporting or primarily self-supporting through college. Father's educational level was somewhat below average, although occupational level was average. Fifty-five percent of the mothers were employed outside the home, the highest proportion for any major in the study. Political science majors showed preferences for verbal-linguistic, business contact, executive-managerial, and social service occupations. They came to college for educational-vocational reasons with little family influence in the decision.

This group was characterized as highly generalist and abstract in interests and strongly verbal-social science in orientation. Their position in discriminant space was very close to history, suggesting a high degree of overlap between these two groups. Classification results also pointed to overlapping groups.

14. Psychology. Psychology men had high mean scores on the orientation tests and realistic self-ratings of ability. As a group, they out-scored the other three social science majors. Although they liked all their high school courses more than they disliked them, they had no one favorite subject matter area. They came from large high schools. Thirty-six percent were out-of-state students. Physical and biological science occupations were selected most often by these men, while at the same time, they rejected mechanical-technical occupations. Social service was the next most popular choice. They said they were uncertain of their first major choice and all but five of them changed majors at least once. Father's educational and occupational levels were above average. Mother's educational level was slightly below average. Forty-two percent of the mothers were employed. Although psychology men valued the college experience for the educational benefits, the social aspects of campus life were also important to them.

Psychology men had both numerical-physical science abilities and interests and verbal-social science abilities and interests. The discriminant analyses located them midway between the extreme majors at each pole. In both the 27- and 14-group analyses, they were placed at the extreme abstract end of the applied-abstract function. They were more specialist than generalist. This unique combination of characteristics separated them from close association with any other major. Even zoology, with which they were clustered, was a distant partner. In the 27-group classification, half the men in the cross-validation sample were assigned to women's majors.

15. Home economics teaching. Their mean scores on four of the orientation tests were about average for female majors, but on the MSU English test they were lower than the other women's groups. They rated themselves as average or above in all categories and expected to maintain at least a 3.00 grade point average. Nonacademic subjects (which included home economics) were most popular with these women in high school, followed by social studies. They came primarily from very small Michigan high schools. Twenty-seven percent of them, the highest percentage in the study, lived on farms. Occupational preferences centered strongly on the social service professions; only two women failed to select this group. The biological science occupations ran a poor second. Parents of these women were least likely to have a college education; fathers' occupational level was also lowest of all female groups. Forty-eight percent of the students

expected to provide most or all of their own financial support for college. The family was seen, however, as an important influence in their decision to come to college and their choice of vocation. The status value of a college education was also viewed as important.

In general, this major contained students who were neither highly verbal nor highly numerical in interests and abilities. They were strongly service oriented and conventional, resembling special and elementary education more than other majors. Sixty percent of the cross-validation sample of home economics teaching majors were assigned to the cluster composed of these three majors.

16. Retailing of textiles and clothing. Except for an average mean score on the CQT Verbal, they had low orientation test scores. Self-ratings of ability were all above average, but they did not expect to maintain much more than a 2.50 grade point average. Retailing majors were predominantly concerned with business and artistic interests in college, but in high school they preferred social studies courses and disliked science and mathematics. They were less interested in social service occupations than most women, but more interested in artistic and business contact occupations. Father's educational level was about average, while mother's was below average. One-fourth of the fathers were skilled laborers. These women came to college for educational and vocational advantages.

Although more verbally oriented than numerical, retailing majors were not strongly verbal. Business contact activities coupled with a relatively weak interest in social service suggested occupations that would deal with people at some distance. They were not really close to any major in discriminant space, although they formed a loose cluster with speech and art practice majors in the 13-group analysis. The cross-validation sample of retailing women was assigned more accurately in the 27-group case than any other female group and only mathematics women had a better hit rate in the 13-group classification.

17. Mathematics. Mathematics women were unique among the women's majors. On the orientation tests, they outscored all female groups on the CQT Information test, all male and female groups on the MSU Reading and English tests, and all but electrical engineers and mathematics men on the CQT Numerical test. On the CQT Verbal, they were well above the over-all mean. Self-ratings of general capacity and numerical reasoning reflected their actual abilities, but they down-graded their real position on reading skill. They anticipated at least a 3.00 grade point average through college. Twenty-nine percent came from out-of-state high schools. As a group, they enjoyed high school courses; mathematics and science courses were strongly favored, of course. They came to college to pursue an education, less influenced by family expectations and more by their high

school experiences than other women. They were certain of a major choice prior to college entrance. Sixty-nine percent of those who graduated in mathematics had originally entered in mathematics. The overwhelming choice of occupational group was physical science. Unlike the male majors whose first choice was physical science, the mathematics women rejected mechanical-technical occupations. Social service and biological science professions ranked second and third.

Father's educational and occupational levels were above average; mother's educational level was below average.

Mathematics women occupied a singular position in discriminant space. They resembled no other major of either sex. Being highly numerical-scientific in orientation drew them away from the women's groups and the verbal-social science men's groups. Rejection of mechanical-technical interests kept them out of the numerical-scientific-technical men's groups. In the 27-group classification, they were more likely to be misassigned to male majors than to female majors. In the 13-group case, 90 percent of the sample was correctly classified.

18. Nursing. Nursing majors scored above the mean on the numerical and reading tests, approximately at the mean on the information test, and below the mean on the verbal and English tests. In high school, they liked arts and letters most and social studies least. Biological

sciences were enjoyable, but physical sciences and mathematics were not. Ninety-one percent of these women were in-state students. Father's educational level was about average; mother's educational level was above the mean for women. Thirty-nine percent of the mothers worked outside the home. Nursing majors expressed few doubts about major field or vocational choice. Seventy-four percent of these graduates started in the nursing major. As expected, their occupational preference group was biological science.

Nurses were characterized as moderately scientific-numerical and nonverbal in nature with specialized and applied interests. In both discriminant analyses, nursing was too far from the other women's groups to be included in a cluster. Of the majors in the 13-group analysis, special education and social work were the shortest distance away. The cross-validation sample had 33 percent direct hits in the 27-group case and 22 percent direct hits in the 13-group case.

19. Elementary education. The elementary education group had 253 members, 51 percent of whom had originally chosen elementary education. The performance of the group was consistently low in comparison with other female majors. Their verbal and reading scores ranked thirteenth out of thirteen. Nevertheless, they rated themselves as average in each area. They came from large high schools. Their favorite subjects were in the arts and letters area. Ninety

percent were in-state students. Both parents had higher educational levels than average; father's occupational level was at the mean. Although they came to college for educational-vocational reasons, campus life and the attendant social experiences were more important than for many majors. Social service occupations were preferred by most of these women. Seventy-five percent of the group was certain that teaching was the proper vocation for them. They were more strongly influenced by family in this choice than any other group.

Elementary education majors were characterized as conventional-feminine. They were nonscience, nonnumerical, and more verbal than nonverbal in their interests and abilities. In discriminant space, they fell near social work majors and special education majors. They appeared to be a loosely-knit hetergeneous group which overlapped a number of women's groups. Results of the classification supported this view. Members of the cross-validation sample were assigned to every female major except speech. Elementary education was a major which accommodated a variety of women with ease.

20. Special education. Their performance on orientation tests was about average in all areas. Ratings of ability showed that special education majors viewed themselves as average in general ability, verbal reasoning, and reading skill and below average in numerical reasoning.

They expected to maintain at least a B- average in college. Two-thirds of them changed majors at least once during their four years. Although they enjoyed their high school courses, as a group they were not strongly committed to an academic area. Their common commitment was to service, apparently. In making occupational preference selections, they consistently chose the social service occupational group, but spread their remaining choices over the other areas, rejecting only mechanical-technical occupations. Father's mean educational and occupational levels were slightly below average, while mother's educational level was above average. Forty-one percent of the mothers were employed outside the home. Special education majors were more likely to feel that they had been influenced in their choice of profession by personal experiences outside of home and school than were other women, and yet they saw family influence as important in the decision to come to college.

It was difficult to characterize special education women on the basis of their position on the discriminant functions, for they remained buried among other groups near the middle of the scale. They were closest to social work and elementary education majors in the discriminant space. When the cross-validation sample was classified, no direct hits were scored in either the 27-group or the 13-group case. It appeared, in fact, that the "typical" special education major was a displaced home economics teaching major.

21. Speech. Speech majors had low orientation test scores in all areas except English, where they were average. They thought of themselves as above average in verbal and reading ability, however, and at least average in general capacity. They disliked mathematics and science in high school and particularly enjoyed arts and letters. They had a strong reading preference for novels and literary classics. Ninety-five percent of the group attended Michigan high schools. They were more likely to emphasize the educational value of a college degree than most major groups. Father's educational level was about at the mean, while mother's educational level was below the mean. Twenty percent of the fathers were engaged in office, clerical, and sales work. Seventy-five percent of the mothers did not work. Speech majors were less interested in social service occupations than most women, although over half of them selected this group. The next most popular areas were the artistic occupations and the verbal-linguistic occupations.

In the 27-group analysis, speech was characterized as highly verbal-humanistic and artistic-technical in orientation. Theirs was also an applied rather than abstract group. In the 13-group analysis, it appeared that the "highly-verbal" label had resulted from their strongly non-scientific/nonnumerical character. The group was near the middle of the verbal function. The artistic quality held up in the 13-group case. The members of the cross-validation sample were more likely to be assigned to the English group than any other.

22. Art practice. Art practice majors did not do well on the orientation tests and they knew it. As a group they expected to maintain about a 2.50 grade point average in college. Throughout high school, they enjoyed the fine arts, disliked mathematics and science, and tolerated the other subjects. They attended larger high schools than most of the groups in the study. Sixty-five percent of them entered college in the art practice major. Their vocational choices were based on personal needs and interests and only one woman in the group failed to select artistic occupations. Their only other consistent choice was, of course, social service occupations. Parents' educational levels were well below average. Twenty-four percent of the fathers and 18 percent of the mothers had not completed high school. One-fourth of the men were skilled laborers; 10 percent were unskilled laborers. Mean occupational level of fathers was well below the average for women's groups.

Compared to other female groups, art practice majors were least scientific-numerical in character and about at the mid-point on the verbal distribution. They had specialized interests, preferred application to abstraction, and were highly artistic. They were closest to speech majors in discriminant space and when classified, the cross-validation sample appeared more like retailing of textiles and clothing majors. The individuals in the analysis sample, however, looked very much like art practice majors.

23. English. English majors outscored all other major groups on the CQT Verbal test and were well above the women's means on the remaining four tests. Their self-ratings were high except for numerical reasoning on which they considered themselves average. They anticipated a GPA of at least 3.00. English women, more than any other major group, favored arts and letters in high school, although they also liked social studies. Science and mathematics courses were rated low and nonacademic subjects they neither liked nor disliked. They came primarily from Michigan high schools. Their parents were above average on educational level and fathers were also above average on occupational level. Fifty-seven percent of these men were either in executive-managerial positions or in the professions. English majors chose social service occupations first and verbal-linguistic occupations second.

The discriminant analyses showed them to be highly verbal-abstract with low scientific-numerical interests. They were closest to history and social science women in discriminant space. The cross-validation sample had about 30 percent direct hits.

24. History. History women were above the female mean on all five orientation tests. Their best performance was on CQT Information; only mathematics women did better. As expected, their favorite high school subjects were in the social studies and more of them read history and biography books for pleasure than any other group. Two occupational preference groups received most of their attention, social service and verbal-linguistic. None of these women selected mechanical-technical occupations. Parents' educational level was interesting. Fifty percent of the fathers had at least a bachelor's degree, which was higher than the majority of women's groups, but 27 percent had not completed high school, which was more than any other women's major. Only 10 percent of the mothers had not completed high school. Although father's mean educational level was below average, mean occupational level was above average. Forty-two percent of the mothers worked (the highest percentage among the female majors) which may be partially explained by the fact that 17 percent of the history majors came from families with only one parent in the home. Fewer history women expected strong financial support from parents than did other groups. They came to college first for an education but the social contacts and campus life were given more weight by these women than by any other major.

The plot of group centroids for history women showed them to be more verbal than numerical-scientific in general orientation, abstract rather than applied and more generalists than specialists. They were closest to English majors in discriminant space. The cross-validation sample was classified 25 percent direct hits and 25 percent near hits.

25. Social science. Social science women ranked third among the women's majors on the orientation tests and rated themselves accordingly. They expected to maintain at least a B average in college. Thirty percent of the group came from out-of-state high schools. Social science women preferred arts and letters courses in high school and were much more likely to read literary classics than biography and history for pleasure. Parents' mean educational level was high; 62 percent of their fathers and 48 percent of their mothers had at least a bachelor's degree and only 6 percent had not completed high school. Father's occupational level was also above average. Nevertheless, 45 percent of these women did not expect to receive strong financial support from their families. They came to college uncertain about a major and a vocational choice. Ninety-one percent changed majors at least once before graduating in social science. Three occupational groups drew their interest: social service, verbal-linguistic, and business contact. None selected mechanical-technical occupations. They came to college for educational and social reasons.

The group was characterized by strong verbal-abstract interests. They were more service oriented than creative-artistic in occupational outlook. They were most closely associated with English majors in discriminant space.

26. Psychology. Psychology women ranked second among female majors on the CQT Verbal and Numerical tests and the MSU Reading test and fourth on the two remaining tests. Self-ratings were consistent with performance. This was the only group of the 27 to contain a majority of out-of-state students. They favored arts and letters in high school but liked science and mathematics courses better than most women's groups and particularly the other two social science majors. Their reading preferences were atypical; they were the only group that did much reading of technical books or mystery books. Social service occupations and biological science occupations interested them most. Like mathematics women, they were not interested in verbal-linguistic professions. Parents' mean educational levels were above average and father's occupational mean was high. Sixty-four percent of the men were in the professions or in executive-managerial positions. Their reasons for coming to college were strongly centered on educational-vocational needs. Family influence played more of a role than in most groups and the status advantages of a college education were less important than for any of the other 26 groups.

Psychology women were not really close to any group in discriminant space, but English majors seemed to share more common characteristics than the others. Psychology majors were high on scientific interests, numerical ability, and verbal ability, but low on verbal interests. They were also characterized as highly abstract and fairly specialized in their interests. In the 13-group classification, two-thirds of the check sample were assigned to the correct cluster, but only 22 percent were direct hits.

27. Social work. Social work majors scored lower on the orientation tests than two-thirds of the women's majors. They rated themselves as about average in relation to other college students, except in numerical ability where they said they were somewhat below average. Most of the group was neutral about science and mathematics courses in high school and enjoyed social studies. Vocational choices fell primarily into two groups, social services and biological sciences. Fifty-five percent of their fathers had college degrees; 30 percent were in the professions and 30 percent were in executive-managerial occupations. Mother's educational level was above average, primarily because two-thirds of them had additional education beyond high school. Half of the students expected to receive all necessary college support from their parents, while none expected to be entirely self-supporting. Family influence and expectations figured in their choice of vocation and decision to come to college.

Social work women appeared to be other-directed rather than inner-directed and, in this respect, resembled home economics teaching, elementary education, and special education majors. Their abilities and interests were neither strongly verbal nor numerical.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

Purpose

The purpose of this study was to investigate relationships which exist between students' characteristics, as measured by orientation data, and their final undergraduate majors. Measures of ability/achievement, family and background experiences, self-ratings and interests, and educational/vocational preferences were selected as relevant student variables. One major hypothesis was proposed.

> Undergraduate major fields can be differentiated on the basis of selected characteristics of freshman students who attain senior standing or graduate in each major.

Methodology

The student sample was drawn from the first-time freshmen who entered Michigan State University during either Fall 1963 or Fall 1964 and had graduated or attained senior standing by Spring 1967, having earned no more than 30 quarter credits from another institution. The major sample consisted of the undergraduate major fields represented in the student sample which contained at least 40 students of one sex. A total of 909 men and 856 women in 27 groups representing 23 different major fields made up the final study sample from which a 20 percent random sample was drawn for cross-validation purposes.

Data for the 47 student variables selected were available from three sources: (1) the Student Master Record, (2) the Office of Evaluation Services test records, and (3) the Personal Information Inventory. Multivariate discriminant analysis and a maximum likelihood classification technique based on discriminant scores were chosen as the appropriate statistical treatments.

Results

The 27-group discriminant analysis yielded 26 functions, of which 10 were significant at the .001 level, a rejection of the null hypothesis. Each of the first five significant functions was interpreted using the standardized discriminant weights of greatest magnitude. These five functions explained 79 percent of the dispersion among the majors.

The first function, a verbal/humanistic-numerical/technical split, accounted for 51 percent of the trace. There was a marked separation of majors into two distinct groupings; the verbal/humanistic majors clustered together at the low negative end of the scale with an appreciable gap between them and the numerical/technical majors at the high negative end of the scale.

The verbal/humanistic grouping contained only female majors, while the numerical/technical grouping contained all the male majors plus the mathematics women. Although the first function spread the verbal/humanistic majors out so that no two group centroids occupied the same point in discriminant space, the numerical/technical majors were dispersed over a greater range of discriminant space. Thus, the first function provided finer discriminations among the majors characterized by numerical, scientific, and technical interests and abilities than it did among the verbal/humanistic majors.

Function two, interpreted as generalist to specialist in nature, accounted for 11 percent of the trace. Group centroids were distributed in gradual steps on this function, from political science (-.34) at the extreme generalist end to mathematics women (-1.88) at the extreme specialist end of the scale.

The plot of group centroids on the third function produced a series of small clusters along an abstract to applied continuum. Psychology men and women, social science women, English, and mathematics women majors formed the extreme abstract cluster and art practice, packaging, general business administration, accounting, and marketing formed the extreme applied cluster. There was a distinct, although not large, break at the midpoint of the centroid distribution.

The high negative weights in function four were labeled artistic/technical; only four major groups had negative centroids. They were art practice, speech, retailing of textiles and clothing, and English. The remaining twenty-three majors were densely concentrated within the positive half of the scale, covering four-tenths of a point, from packaging with a group centroid of .06 to nursing with a group centroid of .48.

Function five detached accounting from one end of the centroid distribution and zoology and nursing from the other, leaving 24 majors packed into the middle of the distribution. The nature of the discrimination was unclear and accordingly, function five was not labeled.

The remaining five significant functions together accounted for less than 12 percent of the dispersion and were not interpreted.

The separate discriminant analyses of 14 male and 13 female majors each produced five significant functions which accounted for 80 and 76 percent of the dispersion, respectively. In the male analysis, the first function spread the majors from high numerical-physical science interests and abilities to high verbal-social science interests and abilities. Function two was similar to the third function in the 27-group analysis (labeled applied to abstract) and separated the men's groups in much the same way. The third function suggested a distinction between major groups with strong educational goals and groups with strong vocational goals. Function four identified a socio-economic status factor associated with college attendance. Zoology and pre-law students were separated out at the high status end of the scale and packaging and history were at the low status end.

In the female analysis, function one distributed the groups along a continuum of numerical ability coupled with an interest in natural sciences. The second function was a verbal continuum. Function three suggested a fine arts-creative versus social service division of majors. Functions four and five were not labeled because the heterogeneous combination of high weight variables in each function did not lend themselves to a common interpretation.

Three cluster analyses were performed using inter-centroid distances and a computational scheme suggested by Rao (1952). The 27-group case produced six multi-group clusters and two "clusters" which contained only one major each. The results of the cluster formation supported the secondary hypothesis that men and women in the same major have different patterns of characteristics. The 14-group case produced four multi-group clusters of male majors identical in composition to the first four clusters in the 27-group case. The 13-group case produced three multi-group clusters and the same one-major "clusters" as the 27-group analysis.

For each analysis, clusters were compared on the first three significant functions by means of a three-dimensional plot of group centroids.

A maximum likelihood procedure based on function weights and discriminant scores was used to classify three 20 percent cross-validation samples into majors and clusters. Assignments were scored as hits (classification into correct major), near hits (classification into correct cluster), and misses. Results were significantly better than chance.

Thus, it would seem that as Holland (1966a) suggests, there is a tendency for students to seek environments which permit them to exercise their skills and abilities, to take on agreeable problems and roles, and to avoid disagreeable ones. Results of this investigation demonstrate that it is possible to differentiate among environments on the basis of the dominant characteristics of members of each environment. Further, it appears that these characteristics are fairly stable over time.

Conclusions

The following general conclusions were drawn from the results of the study.

1. Of the student characteristics included in the study the greatest differences among the major fields were related to two dimensions of student character: (1) the strength of their verbal and numerical interests

<u>and abilities and (2) preference for either the natural sciences or the social sciences</u>. In the 27-group analysis, the first function separated the majors on a numerical-scientific-technical to verbal-humanistic continuum and these dimensions accounted for 51 percent of the dispersion. In both the 14- and 13-group analyses, these same dimensions accounted for 33 and 44 percent of the trace respectively.

2. <u>Ability/achievement measures and educational-vocational preference measures were the most potent discriminators of major field differences</u>. Across all significant functions of the three discriminant analyses test scores, occupational group preferences, reasons for coming to college, and influence on vocational choice were assigned high function weights more often than the other classes of variables.

3. <u>Major fields varied in their tolerance of incongruent student members</u>. Borrowing a concept from hematology, there appeared to be "universal donor" majors and "universal recipient" majors. The former can be described as having narrowly defined and specific environments which reject or are rejected by incongruent student types, although congruent student types are accepted in a variety of environments. The latter can be described as having diffuse

and broadly defined environments which accept and are accepted by a variety of student types, but whose congruent types are spread over a narrow range of similar environments. In this study, general business administration, among the men's groups, and elementary education, among the women's groups, would be classified as "universal recipients." Both these majors contained students who most closely resembled a variety of other fields, but had very few students misassigned to them. Zoology and mathematics women would be classified as "universal donors." These majors contained relatively few incongruent students but had some members from each of the other majors misassigned to them.

4. The interest and ability differences between men and women in the same major were differences of degree rather than kind. The discriminant analysis and classification procedure demonstrated that men and women in the same major were more like members of their sex group than like members of their major group. When men and women in the same major were each described in relation to other majors of their sex group, however, the descriptions shared many common characteristics and the major appeared to hold the same relative position among its peers.

5. <u>More precise measures of student characteristics are needed to clarify major field differences suggested by this study</u>. Verbal and numerical interests and abilities and preferences for the natural sciences, social sciences, and creative arts were measured more directly and specifically than were abstract, applied, general, or specialized interests and orientations. Nevertheless, these latter dimensions were implied from the data. Understanding of the impact of these characteristics on major field differences requires more specific instrumentation than is currently used with incoming freshmen.

6. <u>The general characteristics and composition of the clusters which were formed in this study were in general agreement with results of previous research</u>. The similarities between the male-group clusters of the present study and Holland's (1966a) classification scheme for men's vocations were particularly striking. The fourteen male groups in the present study were clustered as follows: mechanical engineering, electrical engineering, and mathematics; packaging, accounting, general business, and marketing; economics, history, social science, pre-law, and political science; and, zoology and psychology. Holland's taxonomy would have grouped mechanical engineering, electrical engineering, mathematics,

and zoology; accounting, economics, general business, and marketing; and, history and political science. Holland's study did not include the packaging major and the remaining three (psychology, pre-law, and social science) were not grouped with any of the above majors.

Implications

The results of the study and conclusions derived from them have implications for three related areas: (1) counseling and academic advisement, (2) administrative decision-making, and (3) needed research.

Counseling and Academic Advisement

The methods employed in this study re-organized the available data into patterns of inter-related characteristics descriptive of major fields. The data, in this form, provide comparative models which could be used by students and their advisers in the planning of academic programs. The more general information provided by the cluster analysis should be of particular value to no-preference students in the development of exploratory programs; it would also be applicable for students contemplating a change of major in that it could be used to identify major fields with similar potentials for interest satisfaction but differing intellectual demands or to identify fields with similar intellectual demands but differing potentials for interest satisfaction.

Administrative Decision-Making

The decision to reorganize existing units within a university structure (e.g., separating or combining departments within a college) or to create new units (e.g., starting a small liberal arts college within the university) encompasses a variety of concerns. One of these ought to be a consideration of the effect of the "mix" of congruent and incongruent human characteristics that will result from the re-structuring. The results of this study suggest that selection and retention of students within a unit are partially related to the dominant human characteristics found there. There is some evidence in previous research to suggest that selection and retention of faculty are also related to this factor. It is important to mention that information of this sort can be used either to perpetuate the status quo or to introduce new qualities into an environment. A discussion of the relative merits of these alternatives is beyond the scope of this investigation.

Needed Research

As indicated earlier, there is a need to improve the precision of the most potent variables in the orientation data. In the interests of economy, those measures currently collected but seldom used could be eliminated. Research time could be profitably spent on the identification of those human characteristics which play an important role in defining major field similarities and differences. Results of this investigation suggest a need for more directly interpretable interest and personality measures.

An important aspect of major field environment, which was not touched on in the current study, is the impact of faculty characteristics. While it is unlikely that parallel measures of faculty members' characteristics would be available for analysis, it seems logical to assume that some of the information routinely collected on faculty would prove discriminating. Indirect measures of faculty characteristics, such as Thistlethwaite's (Mimeo., ca., 1960) faculty press index based on student perceptions of faculty behavior, have been successful in distinguishing among major fields.

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APPENDICES

APPENDIX A

VARIABLES FROM THE PERSONAL INFORMATION INVENTORY

APPENDIX A

VARIABLES FROM THE PERSONAL INFORMATION INVENTORY

VARIABLE / PERSONAL INFORMATION INVENTORY ITEM / SCALING CODE

Variable: 1. Reading preferences

Personal Information Inventory Item:

1. The type of book I prefer to read now for pleasure
____0. Novels
____1. Technical books
____2. Mystery books
____3. Biography and history
____4. Literary classics

Scaling Code:

1. For each type of book:

0 = did not prefer
1 = did prefer

Variable: 2. High school subjects

Personal Information Inventory Item:

2. For the same school subjects circle the letter to indicate how well you liked it.
   a. Liked very much
   b. Liked more than disliked
   c. Disliked more than liked
   d. Disliked very much
   e. Never studied the subject

1. Art	a	b	c	d	e
2. Biology	a	b	c	d	e
3. Business	a	b	c	d	e
4. Chemistry	a	b	c	d	e
5. English	a	b	c	d	e
6. Foreign Langs.	a	b	c	d	e
7. Government	a	b	c	d	e
8. History	a	b	c	d	e
9. Home Economics	a	b	c	d	e
10. Mathematics	a	b	c	d	e
11. Music	a	b	c	d	e
12. Physical Educ.	a	b	c	d	e
13. Physics	a	b	c	d	e
14. Speech	a	b	c	d	e
15. Shopwork	a	b	c	d	e

Scaling Code:

2a. Categorized by subjects:
1. Fine and applied arts and letters (1,5,6, 11,14)
2. Science and mathematics (2,4,10,13)
3. Social studies (7,8)
4. Non-academics (3,9, 12,15)

b. Scaled:

4 = a
3 = b
2 = c
1 = d,e

c. Scored: Total points in a category divided by the number of subjects rated.

Variable: 3. Self-rating of abilities[a]

Personal Information Inventory Item:

3a. Compared to other entering students here, I think my general capacity for college work is
0. Superior____ (Upper 10%) 1. Above Average____ (Upper quarter)
2. Average____ (Middle 50%) 3. Below Average____ (Lower quarter)
4. Low____ (Lower 10%)

b. Compared to other entering students here, I think my aptitude for solving numerical reasoning problems is
0. Superior____ 1. Above Average_____
2. Average____ 3. Below Average_____
4. Low____

c. Compared to other entering students here, I think my aptitude for understanding and reasoning words is
0. Superior____ 1. Above Average____
2. Average____ 3. Below Average____
4. Low_____

d. Compared to other students entering here, I think my reading skill is
0. Superior____ 1. Above Average_____
2. Average____ 3. Below Average_____
4. Low_____

e. The grade average I think I will be able to obtain at MSU is
0. A____ 1. B to B+____
2. C+ to B-____ 3. C____
4. C- or under_____

Scaling Code:

3. Scaled:

5 = Superior
4 = Above Average
3 = Average
2 = Below Average
1 = Low

3e. Scaled:
5 = A
4 = B to B+
3 = C+ to B-
2 = C
1 = C- or under

APPENDIX A--Continued

VARIABLE	PERSONAL INFORMATION INVENTORY ITEM	SCALING CODE
4. Selection of three occupational groups[a]	4. In the following list select the one group of occupations in which, on the basis of interests and abilities, you believe you fit best. Check it under first choice. Select the one group of your second choice and mark it under second choice. Mark a third choice, too. Then mark under X any group of the six remaining in which you feel sure you would fit. ____Occupations requiring special artistic abilities, such as musician, actor, artist, interior decorator, designer, etc. ____Occupations involving work in the physical sciences, such as engineer, chemist, mathematician, physicist, etc. ____Occupations involving work in the biological sciences, such as zoologist, botanist, nurse, physician, veterinarian, physical therapist, etc. ____Occupations involving mechanical and/or technical skills, such as farmer, aviator, printer, forester, industrial arts, science instruction, etc. ____Occupations involving social service activities, such as social worker, youth organization leader, personnel man, teacher, etc. ____Occupations involving business detail, such as accountant, business statistician, cashier, banker, stenographer, office clerical worker, etc. ____Occupations involving business contacts with people, such as the various fields of selling, promotional work, politics, etc. ____Occupations involving verbal or linguistic work, such as lawyer, author, newspaper man, advertising man, librarian, etc. ____Occupations involving executive responsibilities such as office manager, foreman, production manager, director, etc.	4. For each group: 0 = not selected 1 = selected as first, second, or third choice NOTE: The final sentence in the instructions for this item should have read, "Then mark under X any group of the six remaining in which you feel sure you would NOT fit." Due to a printing error, the NOT was omitted. This error was not corrected during the administration of the Inventory, which made it necessary to ignore all occupational ratings except the first three.
5. Educational level of father[a]	5. Education (check one for each person) 0. Grade school 1. Attended high school 2. Completed high school 3. Technical or business school 4. College 5. Post-college work	5. 1 = Grade school 2 = Attended high school 3 = Completed high school 4 = Technical or business school; College 5 = Post-college work
6. Educational level of mother[a]	6. Same as #5 above.	6. Same as #5 above.

APPENDIX A--Continued

VARIABLE	PERSONAL INFORMATION INVENTORY ITEM	SCALING CODE
7. Occupational level of father[b]	7. Chief employment (check one for each adult) 0. Manual worker--no special training required 1. Skilled labor 2. Business owner 3. Farm owner or operator 4. Executive or managerial 5. Office, clerical, and sales 6. Teacher (elementary or secondary) 7. Professional 8. Service (store clerk, barber) 9. Homemaker	7. 1 = Manual worker; Service 2 = Office, clerical, and sales 3 = Skilled labor 4 = Farm owner or operator; Business owner 5 = Executive or managerial 6 = Professional; Teacher
8. Employment of mother	8. Same as #7 above.	8. 0 = Homemaker only 1 = Working outside the home
9. Marital status of parents	9. Parents' marital status (check one) 0. Married 1. Separated 2. Divorced 3. Divorced, one or both remarried 4. Father widowed and unmarried 5. Mother widowed and unmarried 6. Father widowed and remarried 7. Mother widowed and remarried	9. 3 = Married 2 = Divorced or widowed and remarried 1 = Separated, divorced, or widowed and unmarried
10. Number of older siblings	10. Family information Brothers Sisters Age .. ____________	10. 0 = None 2 = One or two 4 = Three or more
11. Number of younger siblings	11. Same as #10 above.	11. Same as #10 above.
12. Sources of financial support for college	12. Plans for financial support (rank if more than one) 0.____Entirely supported by family 1.____Part-time work will be necessary (___hrs. a week) 2.____Vacation and summer work 3.____Total self-support will be necessary 4.____Scholarship	12. 4 = Entirely supported by family 3 = Scholarship; Vacation & summer work 2 = Part-time work will be necessary 1 = Total self-support will be necessary
13. Strength of first major	13. My feelings with regard to this major as my best choice is 5. Absolutely fixed choice_____ 4. Reasonably certain_____ 3. Fairly certain_____ 2. Somewhat doubtful_____ 1. Very uncertain_____	13. Same as PII item with the addition of: 1 = No preference
14. Certainty of vocational choice	14. My present vocational choice is ___________________. That this choice is the one for which I really want to prepare I am 0. Very certain_____ 1. Fairly certain_____ 2. Uncertain_____ 3. Doubtful_____ 4. Very doubtful_____	14. 3 = Very certain; Fairly certain 2 = Uncertain 1 = Doubtful; Very doubtful; No choice

APPENDIX A--Continued

VARIABLE	PLRSONAL INFORMATION INVENTORY ITEM	SCALING CODE
15. Factors influencing vocational choice	15. Rank in order the five most important factors influencing your vocational choice 0.____Family suggestion or tradition 1.____Friend's or teacher's advice 2.____The vocation of someone I admire or respect 3.____Suggested by study in school 4.____Counselor's suggestion 5.____Interest and aptitude testing 6.____A long personal interest in the work 7.____It is most profitable financially 8.____It is best suited to my abilities 9.____It is most interesting intellectually X.____Ability in related school subjects Y.____Other________________________	15a. Categorized by items: 1. Family and significant others (0,1,2,4) 2. High school experiences (3,5,X) 3. Personal needs and interests (6,7,8,9) b. Scaled: 5 = Rank 1 4 = Rank 2 3 = Rank 3 2 = Rank 4 1 = Rank 5 c. Scored: Total points in each category.
16. Reasons for coming to college	16. Students usually have many good reasons for coming to college. Rank in order the five reasons that seem most important to you. You may add others or explain. 0.____To get a liberal education 1.____To prepare for a vocation 2.____For the prestige of a college deg. 3.____To be with old school friends 4.____To make friends and helpful connections 5.____For social enjoyment; "College Life" 6.____To please parents or friends 7.____Family tradition 8.____To learn more of certain subjects 9.____It was the thing to do, foregone conclusion; I never questioned why X.____Without college training, there is less chance of getting a job Y.____Will enable me to make more money	16. Categorized by items: 1. Educational and vocational needs (0,1,8) 2. Social needs (3,4,5) 3. Family influence (6,7,9) 4. Status needs (2,X,Y) Scaled and scored as #15 above.

[a] Item revised in 1964 edition.

[b] Students classified father's occupation as falling into one of nine PII occupational groups. The North-Hatt classification system (Reiss, 1961; pp. 54-57), and the Warner occupational scales (Warner, Meeker, & Eells, 1960; pp. 140-141), were employed in coding the nine PII occupational groups into six occupational categories. Seventy-nine of the ninety occupations used in the North-Hatt were distributed among the nine PII groups. The nine PII groups were then combined into six categories on the basis of mean North-Hatt scores and the six groups were ranked on the North-Hatt mean score. These groups were also paired with comparable groups on the Warner occupational scale and the resulting rank order compared with the North-Hatt ranks. Disagreements between the two scales were decided in favor of the North-Hatt rank order. Results are summarized below.

PII Occupational Groups	North-Hatt Mean Score	North-Hatt Range	North-Hatt Rank	Warner Rating	Warner Rank	Dissertation Scale
1. Manual worker; Service	48.4	33-60	6	5-7	6	6
2. Office, clerical, & sales	66.5	62-68	5	2-5	4	5
3. Skilled labor	69.4	62-77	4	4-5	5	4
4. Farm owner or operator; Business owner	73.5	62-82	3	2-4	3	3
5. Executive or managerial	81.2	67-93	2	1-3	1.5	2
6. Professional; Teacher	84.3	71-96	1	1-3	1.5	1

APPENDIX B

ORIGINAL AND FINAL FREQUENCY DISTRIBUTIONS OF RESCALED VARIABLES

APPENDIX B

VARIABLES INCLUDED IN TABLES 1-2: APPENDIX B

Ability/Achievement Measures

1. CQT Verbal
2. CQT Information
3. CQT Numerical
4. MSU English
5. MSU Reading

Reading Preferences

6. Novels
7. Technical books
8. Mystery books
9. Biography and History
10. Literary classics

High School Courses

11. Fine and applied Arts and Letters
12. Science and Mathematics
13. Social studies
14. Non-academics

Self-Ratings

15. General capacity
16. Numerical reasoning
17. Verbal reasoning
18. Reading skill
19. Anticipated college GPA

Occupational Interest Groups

20. Artistic
21. Physical science
22. Biological science
23. Mechanical and technical
24. Social service
25. Business detail
26. Business contact
27. Verbal and linguistic
28. Executive and managerial

Family and Background Experiences

29. Educational level of father
30. Educational level of mother
31. Occupational level of father
32. Employment of mother
33. Marital status of parents
34. Number of older siblings
35. Number of younger siblings
36. Size of high school graduating class
37. High school in- or out-of-state
38. Sources of financial support

Educational and Vocational Preferences

39. Strength of first major choice
40. Certainty of vocational choice

Factors influencing vocational choice:

41. Family and significant others
42. High school experience
43. Personal interests and needs

Reasons for coming to college:

44. Educational/vocational needs
45. Social needs
46. Family influence
47. Status needs

APPENDIX B--Continued

ORIGINAL AND FINAL FREQUENCY DISTRIBUTIONS OF RESCALED VARIABLES

Scale	Variable 11 Orig.	Variable 11 Final	Variable 12 Orig.	Variable 12 Final	Variable 13 Orig.	Variable 13 Final	Variable 14 Orig.	Variable 14 Final	Variable 15 Orig.	Variable 15 Final
0	0	...	1	...	5	...	98	...	...	...
1	9	9	11	12	12	17	32	...	1	...
2	197	197	203	203	155	155	183	313	6	7
3	940	940	926	926	725	725	747	747	929	929
4	619	619	624	624	868	868	705	705	718	718
5	...	...	...	...	...	...	...	...	111	111

Scale	Variable 16 Orig.	Variable 16 Final	Variable 17 Orig.	Variable 17 Final	Variable 18 Orig.	Variable 18 Final	Variable 19 Orig.	Variable 19 Final	Variable 20 Orig.	Variable 20 Final
0	...	...	...	...	...	...	...	...	1312	1312
1	16	...	3	...	4	...	1	...	164	453
2	152	168	89	92	99	103	114	115	157	...
3	838	838	952	952	931	931	712	712	132	...
4	617	617	614	614	631	631	869	869	...	...
5	142	142	107	107	100	100	69	69	...	...

APPENDIX B--*Continued*

ORIGINAL AND FINAL FREQUENCY DISTRIBUTIONS OF RESCALED VARIABLES

Scale	Variable 21 Orig.	Final	Variable 22 Orig.	Final	Variable 23 Orig.	Final	Variable 24 Orig.	Final	Variable 25 Orig.	Final
0	1061	1061	1127	1127	1468	1468	768	768	1275	1275
1	95	704	155	638	138	297	168	997	189	490
2	140	...	255	...	123	...	297	...	217	...
3	469	...	228	...	36	...	532	...	84	...

Scale	Variable 26 Orig.	Final	Variable 27 Orig.	Final	Variable 28 Orig.	Final	Variable 29 Orig.	Final	Variable 30 Orig.	Final
0	1247	1247	1188	1188	1308	1308	...	...	...	...
1	243	518	238	577	228	457	100	100	64	64
2	182	...	214	...	164	...	208	208	156	156
3	93	...	125	...	65	...	468	468	681	681
4	...	...	...	...	...	...	166	746	244	780
5	...	...	...	...	...	...	580	243	536	84
6	...	...	...	...	...	...	243	...	84	...

APPENDIX B--Continued

ORIGINAL AND FINAL FREQUENCY DISTRIBUTIONS OF RESCALED VARIABLES

Scale	Variable 31 Orig.	Variable 31 Final	Variable 34 Orig.	Variable 34 Final	Variable 35 Orig.	Variable 35 Final	Variable 39 Orig.	Variable 39 Final	Variable 40 Orig.	Variable 40 Final
0	...	...	836	836	666	666	...	...	...	...
1	109	150	618	...	556	...	216	216	482	668
2	41	179	220	838	305	861	411	411	186	920
3	179	292	55	...	135	...	404	553	239	177
4	292	339	23	91	56	238	149	585	681	...
5	106	471	8	...	20	...	585	...	177	...
6	233	334	5	...	15	...	...	...	...	...
7	50	...	...	...	9	...	...	...	...	...
8	471	...	...	...	1	...	...	...	...	...
9	284	...	...	...	2	...	...	...	...	...

APPENDIX C

COMPUTATION OF INTRA- AND INTER-CLUSTER DISTANCES FOR TWENTY-SEVEN GROUP CASE

APPENDIX C

COMPUTATION OF INTRA-CLUSTER DISTANCES FOR TWENTY-SEVEN GROUP CASE USING INTERCENTROID DISTANCES

Major Added to a Cluster	Inter-Centroid Distance (D)	Number of Terms (n)	Increase in D ÷ Increase in n	Average Distance ($\Sigma D/n$)	Cluster	Designation
3,5	0.499	1	....	.499	3,5	
2	2.180	3	0.841	.727	2,3,5	
1	5.180	6	1.000	.863	1,2,3,5	B
19,27	0.593	1	....	.593	19,27	
20	1.862	3	0.635	.621	19,20,27	
21	4.602	6	0.913	.767	19,20,21,27	
16	8.345	10	0.936	.834	16,19,20,21,27	
22	13.453	15	1.021	.897	16,19,20,21,22,27	
15	20.307	21	1.142	.967	15,16,19,20,21,22,27	F
10,13	0.676	1	....	.676	10,13	
12	2.334	3	0.829	.778	10,12,13	
11	5.084	6	0.917	.847	10,11,12,13	
4	9.081	10	0.999	.908	4,10,11,12,13	C
6,7	0.755	1	....	.755	6,7	
9	2.559	3	0.902	.853	6,7,9	A
23,24	0.751	1	....	.751	23,24	
25	2.517	3	0.883	.839	23,24,25	
26	5.546	6	1.009	.924	23,24,25,26	E
8,14	0.978	1	....	.978	8,14	D

APPENDIX C

COMPUTATION OF INTER-CLUSTER DISTANCES FOR THE TWENTY-SEVEN GROUP CASE USING INTERCENTROID DISTANCES

		A			B				C					D		E				F							G	H
		6	7	9	1	2	3	5	4	10	11	12	13	8	14	23	24	25	26	15	16	19	20	21	22	27	17	18
A	6			0.85																								
	7	0.76					1.42				1.54				1.23			2.26					2.37				1.53	2.11
	9	0.78	1.03																									
B	1	1.21	0.92	1.29																								
	2	1.51	1.31	1.45	0.98			0.86			1.34				1.42			2.17					2.02				1.86	1.92
	3	1.67	1.41	1.61	1.06	0.84																						
	5	1.65	1.41	1.57	0.96	0.84	0.50																					
C	4	1.27	1.27	1.29	1.45	1.36	1.16	1.21																				
	10	1.69	1.75	1.58	1.62	1.46	1.28	1.32	1.07																			
	11	1.57	1.49	1.45	1.25	1.26	0.84	0.88	1.07	0.89			0.91		1.18			1.63					1.86				1.68	1.86
	12	1.58	1.55	1.45	1.60	1.54	1.19	1.27	0.84	0.89	0.88																	
	13	1.77	1.82	1.63	1.75	1.63	1.35	1.45	1.02	0.68	0.98	0.76																
D	8	1.23	1.28	1.08	1.21	1.36	1.32	1.26	1.34	1.35	1.11	1.26	1.46		0.98			1.65					1.88					
	14	1.27	1.50	1.04	1.50	1.64	1.51	1.53	1.17	1.01	1.06	1.04	1.02	0.98													1.28	1.64
E	23	2.47	2.57	2.24	2.47	2.39	2.18	2.23	2.15	1.50	1.67	1.81	1.72	1.99	1.62													
	24	2.22	2.31	2.05	2.21	2.10	1.92	1.97	1.88	1.21	1.44	1.56	1.46	1.76	1.44	0.75			0.92									
	25	2.43	2.53	2.14	2.45	2.30	2.04	2.09	1.95	1.41	1.51	1.65	1.57	1.89	1.53	0.77	1.00						1.26				1.51	1.38
	26	2.11	2.24	1.86	2.22	2.16	1.97	2.00	1.94	1.48	1.48	1.62	1.68	1.63	1.36	0.97	1.03	1.02										
F	15	2.21	2.26	2.10	2.08	1.86	1.77	1.83	1.94	1.38	1.42	1.72	1.63	1.79	1.62	1.31	1.09	1.38	1.27									
	16	2.41	2.46	2.25	2.15	1.95	1.76	1.78	2.11	1.62	1.50	1.92	1.86	1.96	1.81	1.27	1.26	1.41	1.37	1.08								
	19	2.42	2.40	2.19	2.13	2.01	1.80	1.82	2.15	1.61	1.50	1.89	1.88	1.90	1.80	1.10	1.00	1.26	1.30	1.03	0.94				0.97			
	20	2.30	2.35	2.14	2.18	2.10	1.93	1.94	2.10	1.57	1.53	1.86	1.81	1.85	1.67	0.96	0.87	1.20	1.04	0.89	0.99	0.65						
	21	2.60	2.65	2.42	2.34	2.29	2.08	2.07	2.42	1.89	1.73	2.15	2.09	2.12	1.97	1.16	1.33	1.45	1.45	1.30	0.82	0.87	0.90				1.82	1.14
	22	2.61	2.62	2.50	2.32	2.31	2.14	2.13	2.51	2.03	1.85	2.31	2.34	2.20	2.15	1.38	1.46	1.68	1.66	1.48	0.97	1.00	1.12	0.81				
	27	2.36	2.38	2.17	2.15	2.10	1.81	1.85	2.08	1.60	1.44	1.81	1.79	1.82	1.68	1.13	0.99	1.26	1.19	1.07	0.99	0.59	0.62	0.97	1.21			
G	17	1.61	1.73	1.26	1.82	1.87	1.89	1.84	1.75	1.68	1.53	1.63	1.81	1.29	1.27	1.62	1.58	1.61	1.23	1.76	1.84	1.76	1.64	1.93	2.03	1.75		1.53
H	18	2.15	2.17	2.02	1.95	1.99	1.91	1.82	2.17	1.73	1.52	1.90	2.00	1.57	1.72	1.42	1.29	1.59	1.24	1.17	1.31	1.03	0.90	1.22	1.29	1.03	1.53	

APPENDIX D

COMPUTATION OF INTRA- AND INTER-CLUSTER DISTANCES FOR FOURTEEN GROUP CASE

APPENDIX D

COMPUTATION OF INTRA-CLUSTER DISTANCES FOR THE FOURTEEN GROUP CASE USING INTERCENTROID DISTANCES

Major Added to a Cluster	Inter-Centroid Distance (D)	Number of Terms (n)	Increase in D ÷ Increase in n	Average Distance ($\Sigma D/n$)	Cluster	Designation
3,5	0.498	1	....	.498		
2	1.972	3	1.474	.657		
1	4.569	6	2.597	.762	1,2,3,5	B'
6,9	0.544	1	....	.544		
7	2.062	3	1.518	.687	6,7,9	A'
10,13	0.623	1	....	.623		
12	2.165	3	1.542	.722		
11	4.506	6	2.341	.751		
4	7.937	10	3.431	.794	4,10,11,12,13	C'
8,14	0.873	1	....	.873	8,14	D'

APPENDIX D--Continued

COMPUTATION OF INTER-CLUSTER DISTANCES FOR THE FOURTEEN GROUP CASE USING INTERCENTROID DISTANCES

		A'			B'				C'					D'	
		6	7	9	1	2	3	5	4	10	11	12	13	8	14
	6			0.69											
A'	7	0.69				1.36					1.51			1.09	
	9	0.54	0.83												
	1	1.12	0.79	1.13			0.76								
	2	1.50	1.20	1.37	0.79										
B'	3	1.68	1.35	1.58	0.93	0.74					1.28			1.39	
	5	1.64	1.35	1.55	0.88	0.74	0.50								
	4	1.19	1.16	1.14	1.15	1.23	1.03	1.05					0.79		
	10	1.69	1.72	1.56	1.53	1.50	1.23	1.28	0.92						
C'	11	1.57	1.43	1.46	1.15	1.15	0.80	0.83	0.80	0.72				1.06	
	12	1.57	1.52	1.44	1.47	1.52	1.18	1.25	0.78	0.79	0.76				
	13	1.78	1.79	1.64	1.69	1.69	1.34	1.46	0.94	0.62	0.87	0.75			
D'	8	0.97	1.05	0.81	1.06	1.28	1.26	1.23	0.97	1.24	1.04	1.10	1.30		0.87
	14	1.21	1.43	1.07	1.48	1.65	1.54	1.60	0.98	0.94	1.11	0.99	0.92	0.87	

APPENDIX E

COMPUTATION OF INTRA- AND INTER-CLUSTER DISTANCES FOR THIRTEEN GROUP CASE

APPENDIX E

COMPUTATION OF INTRA-CLUSTER DISTANCES FOR THE THIRTEEN GROUP CASE USING INTERCENTROID DISTANCES

Major Added to a Cluster	Inter-Centroid Distance (D)	Number of Terms (n)	Increase in D ÷ Increase in n	Average Distance ($\Sigma D/n$)	Cluster	Designation
19,27	0.463	1	....	.463		
20	1.428	3	.483	.476		
15	3.851	6	.808	.642	15,19,20,27	E'
21,22	0.624	1	....	.624		
16	2.139	3	.758	.713	16,21,22	F'
23,25	0.625	1	....	.625		
24	2.128	3	.752	.709		
26	4.789	6	.887	.798	23,24,25,26	G'
18	....	..	....	....	18	H'
17	....	..	....	....	17	I'

APPENDIX E--Continued

COMPUTATION OF INTER-CLUSTER DISTANCES FOR THE THIRTEEN GROUP CASE USING INTERCENTROID DISTANCES

		E' 15	E' 19	E' 20	E' 27	F' 16	F' 21	F' 22	G' 23	G' 24	G' 25	G' 26	H' 18	I' 17
E'	15													
	19	0.77			0.64		0.96				0.96		0.96	1.61
	20	0.77	0.49											
	27	0.88	0.46	0.47										
F'	16	0.95	0.86	0.94	0.94			0.71						
	21	1.16	0.82	0.86	0.90	0.72					1.16		1.22	1.75
	22	1.24	0.89	0.96	1.02	0.79	0.62							
G'	23	1.14	0.88	0.82	0.92	1.03	0.93	1.07			0.80			
	24	0.91	0.78	0.71	0.81	1.06	1.16	1.18	0.68				1.31	1.50
	25	1.16	1.01	1.02	1.07	1.11	1.21	1.31	0.62	0.82				
	26	1.17	1.07	0.90	0.98	1.23	1.25	1.37	0.85	0.89	0.92			
H'	18	1.15	0.95	0.84	0.91	1.33	1.18	1.16	1.34	1.18	1.52	1.19		1.41
I'	17	1.64	1.65	1.51	1.64	1.71	1.76	1.79	1.60	1.49	1.66	1.26	1.41	

APPENDIX F

GROUP MEANS AND STANDARD DEVIATIONS FOR TWENTY-SEVEN GROUPS AND FOR ALL GROUPS ON FORTY-SEVEN VARIABLES

APPENDIX F

GROUP MEANS AND STANDARD DEVIATIONS FOR TWENTY-SEVEN GROUPS AND FOR ALL GROUPS ON FORTY-SEVEN VARIABLES

Major Group	Variables 1		2		3		4		5		6		7		8	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1.	47.37	10.61	53.98	7.77	42.17	6.02	23.48	5.29	29.72	6.52	0.69	0.46	0.15	0.36	0.11	0.31
2.	49.34	11.23	54.05	7.99	41.83	5.77	23.57	6.40	30.93	7.80	0.62	0.49	0.07	0.25	0.10	0.30
3.	47.77	10.52	52.60	7.12	39.44	6.97	22.43	5.21	27.91	6.08	0.69	0.46	0.07	0.25	0.12	0.32
4.	59.94	9.85	59.35	6.34	43.24	6.77	27.32	5.27	35.47	7.71	0.56	0.50	0.06	0.24	0.00	0.00
5.	47.04	8.14	51.14	6.73	39.33	7.55	22.29	5.31	28.82	6.30	0.69	0.46	0.06	0.24	0.08	0.27
6.	60.68	10.76	61.96	5.51	46.39	3.37	28.32	5.33	37.50	6.00	0.62	0.48	0.18	0.38	0.11	0.31
7.	50.94	13.49	58.09	7.51	45.89	2.38	25.80	6.39	32.83	8.25	0.54	0.50	0.20	0.40	0.14	0.35
8.	54.60	11.47	58.54	8.12	42.49	6.15	25.24	5.35	33.68	6.66	0.70	0.46	0.08	0.27	0.08	0.73
9.	57.42	14.93	60.20	8.65	46.68	4.39	29.11	5.94	37.00	8.15	0.58	0.49	0.24	0.43	0.08	0.26
10.	60.20	11.80	58.72	8.37	38.00	8.30	25.90	5.85	35.24	6.75	0.54	0.50	0.06	0.24	0.04	0.20
11.	53.38	10.21	54.58	7.13	37.67	8.33	24.22	6.49	32.04	7.15	0.76	0.42	0.09	0.29	0.02	0.13
12.	58.15	11.01	57.94	7.21	39.79	8.42	25.76	5.24	35.29	5.98	0.59	0.50	0.12	0.32	0.03	0.17
13.	57.03	11.69	57.88	7.59	37.91	8.78	26.48	6.48	33.66	8.30	0.50	0.50	0.09	0.28	0.07	0.25
14.	60.33	10.13	58.72	8.74	40.96	8.01	26.85	7.28	36.52	7.14	0.65	0.48	0.18	0.39	0.06	0.23
15.	53.82	11.11	49.84	7.71	32.53	8.30	24.00	5.63	31.63	7.75	0.84	0.36	0.03	0.16	0.03	0.16
16.	54.09	8.57	45.59	6.86	29.09	7.22	25.41	4.04	29.65	4.62	0.82	0.38	0.00	0.00	0.05	0.24
17.	58.61	12.79	56.22	7.87	46.05	2.91	30.63	4.75	37.85	6.34	0.68	0.46	0.00	0.00	0.05	0.22
18.	51.11	9.96	47.81	7.59	32.95	8.80	25.65	5.25	32.84	4.65	0.78	0.41	0.03	0.16	0.03	0.16
19.	50.07	10.69	47.19	7.56	30.25	8.92	25.49	5.53	30.09	5.91	0.82	0.39	0.005	0.07	0.01	0.10
20.	53.19	10.09	47.30	7.18	31.70	8.63	26.51	4.10	32.32	5.57	0.78	0.41	0.00	0.00	0.05	0.23
21.	51.78	9.96	44.53	6.73	26.12	9.97	26.34	4.68	29.97	6.70	0.88	0.33	0.03	0.17	0.03	0.17
22.	51.05	11.80	45.72	7.83	27.28	8.08	25.67	5.11	29.69	6.40	0.87	0.33	0.00	0.00	0.03	0.16
23.	63.17	9.01	52.08	8.69	32.58	10.10	29.62	5.08	35.21	7.17	0.64	0.48	0.04	0.20	0.03	0.16
24.	58.74	9.41	54.08	7.75	32.92	9.90	27.28	5.02	34.10	6.48	0.79	0.40	0.00	0.00	0.05	0.22
25.	61.09	8.40	53.69	7.43	36.91	9.39	29.03	5.24	34.77	7.36	0.71	0.45	0.03	0.17	0.00	0.00
26.	61.46	9.85	52.57	8.08	39.86	6.93	28.94	5.30	36.66	6.33	0.69	0.46	0.08	0.28	0.20	0.40
27.	52.30	12.04	47.49	6.97	29.77	8.39	26.14	5.91	31.23	6.27	0.84	0.37	0.00	0.00	0.02	0.15
Total	54.34	11.96	53.06	9.09	37.04	9.73	26.05	5.96	32.69	7.33	0.70	0.46	0.07	0.25	0.06	0.23

APPENDIX F--Continued

Major Group	9		10		11		12		13		14		15		16	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1.	0.03	0.17	0.09	0.29	2.83	0.62	3.40	0.60	3.15	0.71	3.43	0.66	3.31	0.46	3.57	0.53
2.	0.17	0.38	0.09	0.28	2.76	0.60	3.29	0.59	3.50	0.53	3.45	0.70	3.41	0.53	3.83	0.62
3.	0.16	0.37	0.03	0.16	2.92	0.63	3.11	0.56	3.41	0.61	3.35	0.76	3.39	0.49	3.41	0.59
4.	0.35	0.48	0.06	0.24	2.88	0.80	3.38	0.59	3.59	0.60	3.32	0.67	3.79	0.76	3.74	0.70
5.	0.22	0.41	0.04	0.19	2.92	0.59	3.24	0.61	3.41	0.63	3.49	0.61	3.33	0.47	3.55	0.57
6.	0.07	0.26	0.09	0.28	2.82	0.60	3.75	0.43	3.13	0.76	3.09	0.71	3.73	0.72	4.09	0.69
7.	0.08	0.28	0.11	0.32	2.97	0.61	3.80	0.40	3.23	0.76	3.31	0.78	3.68	0.67	3.88	0.67
8.	0.05	0.23	0.27	0.44	2.92	0.71	3.54	0.50	3.14	0.66	2.97	0.64	3.70	0.61	3.73	0.60
9.	0.08	0.26	0.12	0.33	2.94	0.57	3.68	0.46	3.18	0.67	2.95	0.77	4.00	0.74	4.45	0.58
10.	0.36	0.48	0.20	0.40	3.20	0.63	3.16	0.64	3.78	0.46	3.22	0.73	3.60	0.63	3.36	0.74
11.	0.11	0.31	0.07	0.26	3.24	0.63	3.20	0.67	3.45	0.66	3.33	0.71	3.54	0.57	3.25	0.61
12.	0.32	0.47	0.18	0.38	3.03	0.71	3.35	0.54	3.62	0.54	3.21	0.80	3.91	0.70	3.71	0.82
13.	0.33	0.47	0.14	0.34	3.10	0.69	3.07	0.67	3.74	0.44	3.19	0.75	3.69	0.56	3.43	0.85
14.	0.07	0.26	0.24	0.43	3.13	0.72	3.15	0.78	3.39	0.70	3.11	0.76	3.83	0.63	3.69	0.83
15.	0.18	0.39	0.13	0.34	3.34	0.47	3.32	0.61	3.58	0.54	3.63	0.53	3.42	0.67	3.13	0.69
16.	0.03	0.17	0.24	0.43	3.26	0.61	2.94	0.54	3.59	0.49	3.35	0.59	3.32	0.47	3.12	0.53
17.	0.10	0.30	0.39	0.49	3.41	0.54	3.68	0.56	3.27	0.77	3.10	0.76	3.93	0.78	4.12	0.59
18.	0.11	0.31	0.22	0.41	3.54	0.50	3.35	0.53	3.14	0.78	3.38	0.71	3.35	0.48	3.19	0.56
19.	0.09	0.28	0.18	0.39	3.51	0.55	3.06	0.70	3.36	0.65	3.26	0.71	3.32	0.49	3.09	0.61
20.	0.14	0.34	0.24	0.43	3.43	0.50	3.05	0.61	3.35	0.81	3.24	0.67	3.27	0.44	2.89	0.45
21.	0.03	0.17	0.38	0.48	3.56	0.56	2.81	0.68	3.16	0.79	3.19	0.73	3.34	0.47	2.91	0.58
22.	0.03	0.16	0.28	0.45	3.64	0.48	2.95	0.75	3.08	0.73	3.08	0.73	3.26	0.44	2.74	0.59
23.	0.10	0.30	0.49	0.50	3.71	0.48	2.93	0.67	3.46	0.62	3.01	0.74	3.62	0.61	3.06	0.72
24.	0.21	0.40	0.23	0.42	3.51	0.64	3.00	0.60	3.82	0.45	3.05	0.64	3.49	0.59	3.15	0.74
25.	0.09	0.28	0.37	0.48	3.60	0.49	2.94	0.71	3.37	0.68	3.09	0.73	3.66	0.58	3.17	0.81
26.	0.05	0.23	0.31	0.46	3.54	0.50	3.29	0.74	3.29	0.74	3.09	0.73	3.69	0.62	3.46	0.69
27.	0.07	0.25	0.14	0.35	3.30	0.55	2.88	0.69	3.47	0.66	3.16	0.61	3.35	0.48	2.86	0.73
Total	0.13	0.34	0.19	0.39	3.23	0.66	3.22	0.67	3.39	0.67	3.23	0.73	3.53	0.62	3.42	0.78

Variables (column groups 9–16)

APPENDIX F--Continued

Major Group	Variables															
	17		18		19		20		21		22		23		24	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1.	3.05	0.54	3.14	0.55	3.25	0.63	0.11	0.31	0.82	0.39	0.37	0.48	0.51	0.50	0.13	0.34
2.	3.14	0.57	3.07	0.58	3.48	0.56	0.05	0.22	0.53	0.50	0.14	0.34	0.26	0.44	0.29	0.46
3.	3.23	0.53	3.16	0.61	3.29	0.65	0.15	0.35	0.39	0.49	0.17	0.38	0.24	0.43	0.29	0.46
4.	3.68	0.72	3.50	0.65	3.79	0.63	0.06	0.24	0.65	0.48	0.15	0.35	0.18	0.38	0.24	0.42
5.	3.16	0.50	3.22	0.54	3.12	0.47	0.08	0.27	0.41	0.49	0.27	0.45	0.24	0.42	0.25	0.44
6.	3.48	0.71	3.48	0.76	3.48	0.44	0.16	0.37	1.00	0.00	0.41	0.49	0.57	0.49	0.12	0.33
7.	3.31	0.57	3.20	0.52	3.80	0.46	0.06	0.23	1.00	0.00	0.34	0.47	0.57	0.49	0.20	0.40
8.	3.35	0.74	3.46	0.72	3.65	0.71	0.11	0.31	0.68	0.47	0.86	0.34	0.22	0.41	0.24	0.43
9.	3.58	0.91	3.52	0.78	3.98	0.64	0.12	0.33	0.97	0.17	0.42	0.49	0.32	0.46	0.29	0.45
10.	3.68	0.78	3.62	0.80	3.52	0.75	0.16	0.37	0.26	0.44	0.30	0.46	0.16	0.37	0.52	0.50
11.	3.42	0.62	3.40	0.62	3.38	0.62	0.16	0.37	0.38	0.48	0.42	0.49	0.22	0.41	0.27	0.44
12.	3.74	0.78	3.85	0.84	3.68	0.72	0.08	0.28	0.44	0.50	0.38	0.48	0.08	0.28	0.24	0.42
13.	3.52	0.68	3.66	0.66	3.69	0.56	0.02	0.13	0.31	0.46	0.21	0.40	0.09	0.28	0.40	0.49
14.	3.70	0.74	3.67	0.72	3.91	0.62	0.20	0.40	0.63	0.48	0.52	0.50	0.19	0.39	0.39	0.49
15.	3.21	0.69	3.32	0.76	3.61	0.67	0.29	0.45	0.13	0.34	0.37	0.48	0.08	0.27	0.95	0.22
16.	3.41	0.55	3.38	0.54	3.24	0.54	0.65	0.48	0.06	0.24	0.21	0.40	0.06	0.24	0.65	0.48
17.	3.41	0.85	3.49	0.67	3.85	0.52	0.29	0.45	0.90	0.30	0.46	0.50	0.07	0.26	0.54	0.50
18.	3.14	0.58	3.38	0.63	3.32	0.70	0.32	0.47	0.27	0.44	0.94	0.23	0.16	0.37	0.62	0.48
19.	3.35	0.55	3.34	0.58	3.27	0.66	0.40	0.49	0.10	0.30	0.35	0.48	0.04	0.21	0.92	0.27
20.	3.32	0.52	3.35	0.62	3.41	0.54	0.38	0.48	0.22	0.41	0.41	0.49	0.08	0.27	0.94	0.23
21.	3.44	0.61	3.56	0.56	3.31	0.63	0.56	0.50	0.06	0.24	0.22	0.41	0.09	0.29	0.69	0.46
22.	3.33	0.47	3.26	0.49	3.10	0.59	0.97	0.16	0.08	0.27	0.26	0.44	0.18	0.38	0.64	0.48
23.	3.81	0.64	3.72	0.75	3.68	0.64	0.43	0.50	0.15	0.36	0.29	0.45	0.03	0.16	0.86	0.34
24.	3.62	0.62	3.56	0.81	3.41	0.81	0.36	0.48	0.21	0.40	0.36	0.48	0.00	0.00	0.90	0.30
25.	3.71	0.61	3.63	0.64	3.68	0.62	0.31	0.46	0.11	0.32	0.28	0.45	0.00	0.00	0.83	0.38
26.	3.77	0.63	3.57	0.60	3.63	0.64	0.37	0.48	0.29	0.45	0.57	0.49	0.08	0.28	0.83	0.38
27.	3.37	0.65	3.33	0.64	3.23	0.68	0.26	0.44	0.13	0.35	0.56	0.50	0.09	0.29	0.86	0.35
Total	3.43	0.67	3.42	0.68	3.50	0.68	0.26	0.44	0.40	0.49	0.37	0.48	0.18	0.38	0.54	0.50

APPENDIX F--Continued

Major Group	25 Mean	25 S.D.	26 Mean	26 S.D.	27 Mean	27 S.D.	28 Mean	28 S.D.	29 Mean	29 S.D.	30 Mean	30 S.D.	31 Mean	31 S.D.	32 Mean	32 S.D.
1.	0.25	0.43	0.14	0.34	0.11	0.31	0.46	0.50	3.14	1.09	3.05	0.88	3.42	1.59	0.49	0.50
2.	0.78	0.42	0.24	0.43	0.19	0.39	0.50	0.50	3.00	1.02	3.00	0.76	3.41	1.61	0.36	0.48
3.	0.47	0.50	0.36	0.48	0.31	0.46	0.60	0.49	3.69	0.82	3.45	0.79	4.43	1.24	0.36	0.48
4.	0.24	0.42	0.47	0.50	0.35	0.48	0.68	0.47	3.59	1.03	3.53	0.61	4.09	1.52	0.24	0.42
5.	0.41	0.49	0.41	0.49	0.22	0.41	0.59	0.49	3.37	1.14	3.22	0.94	4.12	1.38	0.24	0.42
6.	0.21	0.41	0.09	0.28	0.07	0.26	0.32	0.47	3.36	1.01	3.25	0.87	3.89	1.63	0.25	0.43
7.	0.20	0.40	0.06	0.23	0.11	0.32	0.48	0.50	3.20	1.28	3.26	0.91	4.08	1.50	0.26	0.44
8.	0.16	0.37	0.11	0.31	0.08	0.27	0.35	0.48	3.38	1.28	3.14	0.84	4.38	1.53	0.32	0.47
9.	0.35	0.48	0.11	0.31	0.17	0.37	0.26	0.44	3.45	1.02	3.26	0.82	3.74	1.75	0.36	0.48
10.	0.18	0.38	0.44	0.50	0.56	0.50	0.42	0.49	3.44	0.96	3.40	0.82	3.70	1.65	0.50	0.50
11.	0.22	0.41	0.42	0.49	0.49	0.50	0.36	0.48	3.49	1.06	3.47	0.76	4.02	1.44	0.33	0.47
12.	0.12	0.32	0.41	0.49	0.65	0.48	0.47	0.50	3.68	1.05	3.62	0.94	4.88	1.11	0.41	0.49
13.	0.14	0.34	0.57	0.50	0.66	0.48	0.53	0.50	3.36	1.11	3.47	0.77	4.16	1.39	0.53	0.50
14.	0.09	0.29	0.33	0.47	0.37	0.48	0.26	0.44	3.59	0.87	3.24	0.98	4.15	1.43	0.46	0.50
15.	0.21	0.41	0.34	0.47	0.29	0.45	0.08	0.27	3.34	0.87	3.29	0.76	3.55	1.50	0.39	0.49
16.	0.35	0.48	0.53	0.50	0.26	0.44	0.18	0.38	3.47	1.17	3.21	0.93	3.94	1.51	0.32	0.47
17.	0.29	0.45	0.10	0.30	0.27	0.44	0.05	0.22	3.63	0.82	3.29	0.86	4.32	1.37	0.29	0.45
18.	0.16	0.37	0.08	0.27	0.14	0.34	0.08	0.27	3.49	1.26	3.54	0.89	4.00	1.43	0.41	0.49
19.	0.37	0.48	0.27	0.44	0.30	0.46	0.05	0.23	3.58	0.98	3.53	0.83	4.09	1.47	0.35	0.48
20.	0.27	0.44	0.24	0.43	0.27	0.44	0.05	0.23	3.43	0.86	3.68	0.84	3.86	1.45	0.43	0.50
21.	0.25	0.43	0.34	0.47	0.41	0.49	0.09	0.29	3.50	1.06	3.19	0.84	3.84	1.42	0.25	0.43
22.	0.21	0.40	0.26	0.44	0.23	0.42	0.10	0.30	3.13	0.96	3.08	0.73	3.62	1.51	0.31	0.46
23.	0.15	0.36	0.26	0.44	0.65	0.48	0.11	0.31	3.54	1.13	3.43	0.80	4.25	1.66	0.36	0.48
24.	0.10	0.30	0.31	0.46	0.49	0.50	0.08	0.27	3.38	1.15	3.49	0.81	4.31	1.47	0.31	0.46
25.	0.20	0.40	0.48	0.50	0.54	0.50	0.08	0.28	3.94	1.04	3.60	0.76	4.26	1.46	0.26	0.44
26.	0.14	0.35	0.11	0.32	0.48	0.50	0.03	0.17	3.74	1.00	3.51	0.73	4.43	1.34	0.37	0.48
27.	0.32	0.47	0.32	0.47	0.19	0.39	0.05	0.21	3.70	0.88	3.63	0.75	4.42	1.37	0.37	0.48
Total	0.28	0.45	0.29	0.45	0.32	0.47	0.27	0.44	3.47	1.05	3.37	0.85	4.04	1.52	0.36	0.48

APPENDIX F--Continued

Major Group	Variables 33		34		35		36		37		38		39		40	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1.	2.82	0.55	1.02	1.12	1.29	1.28	26.29	16.81	0.85	0.36	2.74	0.95	1.69	0.65	2.63	0.60
2.	2.81	0.54	0.96	1.13	1.69	1.33	23.86	18.46	0.79	0.41	2.62	0.96	1.81	0.51	2.78	0.49
3.	2.80	0.55	1.28	1.16	1.28	1.25	23.27	14.93	0.84	0.37	3.03	0.98	1.60	0.54	2.51	0.75
4.	2.79	0.53	1.29	1.18	1.82	0.89	28.35	16.00	0.59	0.49	2.79	0.99	1.74	0.61	2.53	0.70
5.	2.88	0.43	1.41	0.99	1.29	1.24	28.45	20.38	0.86	0.34	3.08	0.90	1.71	0.69	2.43	0.80
6.	2.80	0.55	1.04	1.25	1.61	1.48	27.14	16.18	0.62	0.48	2.68	0.93	1.93	0.59	2.82	0.54
7.	2.88	0.40	1.31	1.16	1.88	1.43	25.00	15.90	0.68	0.46	2.66	0.98	1.88	0.52	2.97	0.17
8.	2.81	0.51	1.08	1.10	1.84	1.17	25.00	16.16	0.73	0.44	3.00	0.93	1.70	0.73	2.51	0.72
9.	2.86	0.46	1.24	1.29	1.54	1.29	28.94	20.50	0.68	0.46	2.70	0.89	1.74	0.64	2.45	0.80
10.	2.82	0.55	0.84	1.06	1.44	1.50	27.90	16.98	0.74	0.44	2.50	1.08	1.66	0.62	2.54	0.78
11.	2.80	0.52	1.45	1.17	1.05	1.20	23.84	15.32	0.80	0.40	2.89	1.04	1.53	0.68	2.33	0.81
12.	2.91	0.37	1.29	1.18	1.76	1.35	24.79	15.28	0.65	0.48	3.03	0.92	1.65	0.59	2.56	0.69
13.	2.69	0.68	1.10	1.06	1.24	1.28	25.98	15.67	0.60	0.49	2.57	1.10	1.55	0.62	2.34	0.78
14.	2.80	0.56	1.07	1.14	1.04	1.14	30.57	21.56	0.61	0.49	2.83	1.00	1.54	0.69	2.41	0.78
15.	2.89	0.45	1.00	1.10	1.68	1.49	16.00	13.84	0.84	0.36	2.61	1.09	1.68	0.57	2.71	0.64
16.	2.85	0.49	1.18	0.98	1.24	1.54	24.41	16.76	0.82	0.38	2.88	1.08	1.94	0.68	2.53	0.78
17.	2.85	0.47	1.07	1.09	1.56	1.29	25.44	19.03	0.71	0.45	3.00	0.91	1.95	0.62	2.58	0.73
18.	2.76	0.59	1.24	1.26	1.84	1.50	24.89	14.79	0.92	0.27	2.97	1.03	2.00	0.52	2.92	0.36
19.	2.92	0.34	1.14	1.14	1.46	1.35	32.15	18.78	0.90	0.31	2.98	1.08	1.75	0.62	2.64	0.64
20.	2.76	0.63	1.08	1.19	1.68	1.27	26.95	18.66	0.84	0.37	2.94	1.09	1.76	0.75	2.59	0.75
21.	2.88	0.48	1.31	1.18	1.12	1.22	27.56	16.38	0.94	0.24	2.97	1.07	1.94	0.66	2.56	0.70
22.	2.97	0.16	1.23	1.07	1.44	1.50	29.51	16.47	0.92	0.27	3.10	0.98	1.87	0.65	2.69	0.65
23.	2.85	0.49	0.97	1.15	1.61	1.32	27.88	19.86	0.81	0.40	2.99	0.86	1.65	0.60	2.50	0.78
24.	2.67	0.73	0.82	1.17	1.90	1.28	29.44	18.70	0.72	0.45	2.87	0.88	1.69	0.61	2.77	0.58
25.	2.83	0.38	1.31	1.26	2.17	1.46	28.94	20.64	0.69	0.46	2.71	1.08	1.40	0.60	1.97	0.84
26.	2.80	0.52	1.31	1.35	1.37	1.33	23.66	15.54	0.54	0.50	2.94	1.04	1.74	0.60	2.43	0.84
27.	2.86	0.35	1.30	1.13	1.12	1.32	28.79	19.86	0.84	0.37	3.19	0.87	1.65	0.56	2.49	0.76
Total	2.84	0.50	1.15	1.16	1.49	1.35	27.16	18.06	0.78	0.42	2.87	1.01	1.72	0.64	2.57	0.72

APPENDIX F--Continued

Major Group	Variables													
	41		42		43		44		45		46		47	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1.	2.69	3.36	5.62	3.10	6.31	3.56	8.14	2.46	0.92	1.22	0.55	1.10	5.23	2.26
2.	3.14	2.47	5.19	2.67	6.46	3.22	8.46	2.09	0.79	1.23	0.66	1.21	4.78	2.25
3.	3.33	3.02	4.23	2.80	6.72	3.48	8.57	2.08	0.91	1.35	0.83	1.37	4.49	2.23
4.	2.56	2.65	3.94	3.14	7.82	3.28	8.62	2.33	0.97	1.34	0.65	1.23	4.56	2.96
5.	2.80	2.56	4.71	2.90	7.24	2.67	8.57	3.05	0.80	1.17	0.53	1.00	4.98	2.80
6.	1.23	1.77	5.18	2.82	8.27	2.84	8.57	2.60	1.12	1.59	0.82	1.34	4.16	2.48
7.	2.11	1.72	5.54	3.15	7.17	2.70	8.46	2.74	0.94	1.22	0.66	1.79	4.86	2.31
8.	2.76	2.61	4.19	2.51	7.73	2.92	10.08	2.20	0.68	1.01	0.51	1.11	3.73	1.87
9.	1.65	2.02	5.36	2.88	7.80	3.24	9.18	2.72	1.00	1.48	0.77	1.48	3.74	2.36
10.	2.62	2.35	4.30	2.68	7.80	3.05	9.32	2.48	1.00	1.43	0.70	1.25	3.80	2.28
11.	3.11	2.90	4.65	2.89	6.94	3.08	8.94	2.49	0.96	1.28	0.84	1.40	4.04	2.26
12.	2.56	2.81	4.15	2.89	7.50	3.31	8.18	3.51	1.47	1.82	1.00	2.30	4.06	2.52
13.	2.09	2.25	3.72	3.06	8.26	3.45	9.69	2.47	0.91	1.29	0.47	0.86	3.45	2.39
14.	1.98	2.17	3.87	2.59	8.61	2.77	9.54	2.50	1.17	1.44	0.63	1.18	3.52	2.19
15.	3.26	2.94	3.58	2.74	7.58	3.08	9.45	2.47	1.37	1.61	0.97	1.61	2.63	1.88
16.	2.65	3.19	4.06	2.18	7.91	2.69	10.09	2.34	1.50	1.48	0.74	1.29	2.44	2.24
17.	2.46	2.74	5.05	2.63	7.46	2.62	10.51	1.86	1.61	1.46	0.37	0.72	2.37	2.02
18.	2.54	2.63	4.27	2.32	7.54	3.03	9.86	2.34	1.22	1.42	0.62	1.07	3.08	2.72
19.	3.98	2.96	3.36	2.63	7.15	3.06	9.19	2.66	1.69	1.75	0.81	1.38	3.03	2.29
20.	2.46	2.55	3.57	2.52	8.46	2.61	9.73	2.43	1.38	1.42	1.14	1.54	2.57	2.01
21.	2.25	2.02	4.19	2.10	8.28	2.58	10.28	1.92	1.22	1.52	0.97	1.65	2.53	1.73
22.	2.77	3.29	4.95	3.01	7.13	3.26	9.38	2.16	1.69	1.65	0.74	1.55	2.92	2.12
23.	2.85	2.64	4.53	2.50	7.35	3.16	10.18	2.22	1.69	1.52	0.61	1.06	2.33	1.92
24.	2.51	2.78	4.13	3.09	7.74	3.68	9.72	2.22	1.95	1.74	0.59	1.06	2.59	2.16
25.	2.97	2.98	4.63	2.85	7.03	3.41	10.11	2.04	1.77	1.82	0.40	0.90	2.26	1.48
26.	2.77	2.32	3.77	2.56	8.14	2.85	10.09	2.28	1.57	1.68	1.11	1.62	1.89	2.15
27.	3.56	3.39	3.28	2.55	7.14	3.10	9.49	2.15	1.72	2.04	1.19	1.87	2.60	2.16
Total	2.80	2.79	4.31	2.84	7.45	3.16	9.28	2.54	1.28	1.56	0.73	1.36	3.48	2.44