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DIFFERENTIAL IDENTIFICATION OF SUCCESSFUL TECHNICAL STUDENTS IN JUNIOR COLLEGE.
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TECHNICAL AND NONTECHNICAL CURRICULUMS OF A SINGLE JUNIOR COLLEGE WERE EXAMINED TO BETTER HELP STUDENTS AND COUNSELORS TOWARD MORE REALISTIC DECISIONS IN CAREER CHOICE. THE PROJECT WAS SUCCESSFUL IN (1) DIFFERENTIATING STUDENTS IN VARIOUS CURRICULUMS WITHIN THE COLLEGE, (2) DIFFERENTIATING CHARACTERISTICS OF GRADUATES FROM THOSE OF UNDERGRADUATES, AND (3) MAXIMIZING THE PREDICTION OF GRADE POINT AVERAGE. RESULTS INDICATED THAT NEW PREDICTABILITY DATA OBTAINED FROM THIS DIFFERENTIAL STUDY COULD BE USED TO EFFECTIVELY COUNSEL CERTAIN STUDENTS ABOUT THEIR CHOICE OF PROGRAM. (GD)

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DIFFERENTIAL IDENTIFICATION OF SUCCESSFUL TECHNICAL STUDENTS IN JUNIOR COLLEGE

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This project would have been impossible without the gracious cooperation of many people, most of whom it is impossible to name here.

Of the officials of the junior college examined in this study, Central Florida Junior College in Ocala, Florida, four particularly helpful men who most certainly should be acknowledged are: Dr. Joseph W. Fordyce, former President of Central Florida, now President of Santa Fe Junior College in Gainesville, Florida, authorized the contract. Dr. Henry E. Goodlett, President, cooperated in the continuing operation of the project. Mr. Elwood Castles, Director of Business Services, was responsible for all the financial aspects of the contract. Mr. Charles Lee, in charge of Data Processing, was responsible for much of the data on the punched cards that were used in the analyses.

In addition, two other men were of great help. Dr. Joseph T. Sutton, Director of Instutional Research, University of Alabama, helped with advice on procedures. Dr. Warren F. Jones, Chairman of the Department of Psychology, Stetson University, Deland, Florida, read the entire manuscript and made excellent suggestions for its improvement.

RESPONSIBILITIES

The duties involved in this project were divided three ways, as indicated by the writers of the different sections of this report:

Cooper	Data Gathering
Guertin	Data Processing and Results
Turner	Balance of report

Although the prime responsibilities for the report are as listed above, each writer was requested to suggest changes for the material written by the others.

The time schedule of the contract was June 1, 1965 - September 30, 1966. All three of the writers moved to new colleges during the summer of 1966. Since the data gathering could not be completed until May 1966, the time consumed in moving shortened the time available for the research analysis. All of the analyses called for in the contract were performed, but there was no time for the extra analyses that had been planned beyond the contract obligations.

CONTENTS

INTRODUCTION

The major aim of this project is the same as the apparent aim of many other research studies that take college Grade Point Average (GPA) as a criterion. This aim is reduction of the waste that arises from the attempt of "round" students to graduate from "square" curricula, that is to say, from the attempt of students with certain characteristics to graduate from curricula whose graduates tend to have different characteristics.

In the United States today, two of the most urgent needs are, in the employment field, to increase the number of workers in the technical occupations, and, in the academic field, to decrease the waste implicit in the high percentage of college failure. It is the hypothesis of this project that many students who would fail in their pursuit of a non-technical degree could succeed if they attempted a technical curriculum in junior college. This would help both to minimize failures and to maximize the number of needed technical workers.

As Sanborn and Wasson (1966) have so recently pointed out, counselors who deal with students bound for senior colleges have more information than they can handle, while very few studies have provided meaningful information for those students thinking of vocational programs. These writers have reviewed unpublished research by Hoyt that adds evidence to the conviction that students in terminal vocational programs do indeed have different measurable characteristics than liberal arts candidates.

This project will attempt to add meaningful information for technical students. It seeks to analyse students in the technical and selected non-technical curricula in one school and to suggest that other junior colleges may find this type of analysis well worthwhile. The school is one of the junior colleges in a state school system--that of the State of Florida. No claim is made that the selection of this college was a random selection, and no generalizations will therefore be drawn about all junior colleges or all technical students. Indeed, one of the axioms of this research is that colleges are so different that each would do well to investigate itself, and not force its students and counselors to rely on data published by other schools.

The use of the word "differential" in the title of this project is to contrast the present approach with the global or general prediction used by 95 percent of the studies reviewed by Fishman and Pasanella (1960) in their survey of the literature. Global studies concentrate on qualities that affect grades in a college as a whole; differential, specific courses or curricula. These writers conclude that colleges that are more concerned with guided admission than with selection per se tend to be more attracted to differential studies.

In the analysis of this Florida junior college, these questions about students in both technical and non-technical curricula will be investigated.

1. Can students in the various curricula be differentiated.

2. Can graduates be differentiated from non-graduates.

3. How can Grade Point Average (GPA) prediction be maximized.

A note on Philosophy versus Practice

Many colleges have reported a multiple correlation (R) from .70-.94 between their GPA and various items of information that are available even before the students have attended their first college class. An R of this magnitude, it seems to the writers, flashes a warning to some of the potential students of these schools and to their high school and college counselors. It says that this is a quite "predictable" college—that students who have favorable scores on those items that entered into the R will probably pass and be able to graduate, while students who have less favorable scores probably will not pass. This second group of students, if they choose to attend this college, will be attempting to fit a more-or-less roundish peg into a more-or-less square hole. Some will succeed, most will fail.

On the other hand, some junior colleges have, as a part of their philosophy, the belief that they should be of help to more people than those who score favorably on those factors usually associated with college prediction. A junior college president devoted to this philosophy would, it is felt, be dismayed if the usual college predictors worked as well at his school as in a college that severely restricted admissions by a statistical formula.

Here, then, is a statistical way to indicate if philosophy and practice are at cross-purposes. No brief is held here for any philosophy. No claim is made here that a low R indicates practice is in line with an open-door policy. The claim is made, however, that a college with such a philosophy and a high R might feel it advisable to investigate the extent to which its faculty wishes in practice to deviate from its stated philosophy.

Another question, then, that this project may help to answer is as follows:

4. How "predictable" is this college.

Of course, whether or not the college wants to be this predictable would be a matter for further investigation by the college.

PROCEDURES

Overview

As the writers were conscious of their contract obligation to provide all the information that might be needed to replicate the study, the procedures used are described in more detail, perhaps, than is the case in many reports. Therefore, in the interests of clarity, it seems wise to summarize here the population, data and analysis used in the study. This will be done by taking appropriate sections from the contract.

I. Population

The original sample consists of all students who enrolled full-time (12 semester hours or more) in the Fall semesters of 1962 or 1963 who also enrolled in one of five programs—technical education, business administration, education, engineering, and liberal arts. (The technical students are a combination of students in civil engineering technology, design drafting technology, electronics technology, and laboratory technology for the citrus industry.) College officials selected these five programs as being the ones they estimated would have no fewer than 35 graduates for the original sample.

How successfully these data may be generalized are studied by a cross-validation sample, composed of students of the same description registering in the Fall of 1964.

II. Data

Data are given in the same order as in the tables in this report.

A. Independent variables

1. Socioeconomic level of the "breadwinning" parent or guardian, represented by the "socio-economic index" (Albert J. Reiss, Jr., Occupations and Social Status, Free Press of Glencoe, Inc., New York: 1961, pp. 263-275)

2. Test Scores

a. Florida Twelfth Grade Placement Tests:

(1) Psychological
(2) English
(3) Social Studies
(4) Mathematics
(5) Natural Sciences

b. A. C. E. Psychological Examination for College Freshmen, 1954 Edition:

(1) Language
(2) Quantitative

c. School and College Achievement Test (starting in the Fall of 1964, this test replaced the ACE as the ability test administered during college orientation):

(1) Verbal
(2) Quantitative

d. Cooperative English Test, Higher Level:

(1) Mechanics of Expression
(2) Effectiveness of Expression
(3) Reading Comprehension

3. High School Rank

B. Dependent Variables

1. Grade point average, both for first term and overall for all terms attended —until graduation or leaving the college

2. Graduate of this college, or a non-graduate

III. Analysis: The criterion is grade point average

A. The first task determines whether or not the predictor variables significantly distinguish among students who enter these programs. This analysis is made by discriminant function. Another two-group discriminant function analysis determines whether or not the technical group is distinguishable from a group composed of the students in the other programs.

B. The second task is to see if graduates can be identified by their characteristics. This analysis is by discriminant function.

C. The third task is to predict GPA from the predictor variables for students in each program. This relationship with the criterion will be explored with multiple regression and the eta coefficient of nonlinear regression.

Data Gathering

The data used in this study were obtained from the college records already available. Most of it was found in the students' folders.

A data collection sheet was constructed which included all the items which it was thought might possibly be used. A number of the items were already in quantitative form; others were quantified for statistical treatment as explained in the following discussion. This discussion will include all items recorded except the test scores, all of which were recorded as national percentiles, except the Florida tests where state-wide percentiles were used.

Socioeconomic index

Two items of data on the application provide information which can be used with some degree of assurance in the assigning of a socioeconomic rating. These are "parents' occupations" and "parents' educational level". While there is considerable doubt that socioeconomic status can ever be measured accurately or even that "socioeconomic" is a measurable value, numerous attempts have been made to develop scales that would give numerical values to categories of occupations and educational levels.

It is recognized that neither of these indicators will give, either singly or in combination, the best possible index of socioeconomic condition. However, these two in combination, with the possible inclusion of income, have been widely used where measures were needed for statistical study of populations for which this information is available.

The socioeconomic index used in this study evolved over a period of years from a study started by Cecil C. North and Paul K. Hatt of the "prestige of occupations."[1] Following up on a study by Morpheus Smith in 1943, North and Hatt in 1945-46 designed a study of occupational prestige that led to the NORC (National Opinion Research Center) Study. In March, 1947, a survey was conducted under the joint sponsorship of NORC, the President's Scientific Advisory Board, the College Study in Intergroup Relations at Wayne State University, and the Graduate School of Ohio State University.

The NORC-North-Hatt occupational prestige scores served as a basis for numerous studies dealing with occupational status. But in a number of instances the NORC-North-Hatt scores did not prove adequate for the reason that scores were not available for occupations employing more than half the labor force. The development of a socioeconomic index for all occupations was carried out through Project RG-5667, "Occupational Classification for Vital Statistics Use", with the aid of a research grant to the University of Chicago from the United States Public Health Service. The new index then was to represent each of the occupations in the detailed classifications of the 1950 Census of Population. As defined by Duncan, this index was to have "both face validity in terms of its constituent variables, and sufficient predictive efficiency with respect to the NORC occupational prestige ratings so that it can serve as an acceptable substitute for them in any research where it is necessary to grade or rank occupations in the way that the NORC score does but where some of the occupations are not on the NORC list."[2]

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[1] A complete description of this socioeconomic index is found in Albert J. Reiss, Jr., Occupations and Social Status, (New York: Free Press of Glencoe, Inc, 1961 pp. 109-161.

[2] Ibid., p. 115

The method selected to develop a socioeconomic index for all occupations makes use of measures of educational level and income level. There was considerable evidence to show that these variables could be used in combination to estimate an occupation's "prestige". The major purpose for the development of the scale was not to predict unknown variables but to construct from information found in the 1950 Census a graduated rating scale for occupations to be used in future research which required a system of stratification. The Socioeconomic Index for Occupations in the 1950 Detailed Classification of the Bureau of the Census is given in three forms, any one of which could be used in statistical analysis. The one selected for this study uses a scale with a range approximately between 1 and 100. This scale makes for ease of computation but its use offers the possibility of confusion with percentile rank. It is actually a ranking of occupations in relation to each other on the basis of prestige and is not related to the number of individuals in each group.

Students of social stratification are in general agreement that the occupation of the husband is more likely to reflect the socioeconomic status of the family than is that of the wife. Although there is an increasingly large number of working wives, it is still true that the occupations given for most mothers is "housewife." Hence the occupation of the father only was used in deriving the socioeconomic index for the family.

Program in which enrolled and program finally selected.

The choice of program was indicated at two separate times for each student. The first choice was indicated on the application blank that was submitted before matriculation. Many listed "undecided" when asked for their choice of program. A second choice was made after the student had enrolled and had contact with the counseling staff. In many cases the choice was the same the student had indicated originally. In others, his choice was different from that stated on his application form. All students, including the "undecided" ones, had some program listed as the final choice. This final choice was the one used in this project. All of the numerous programs (see Appendix A for complete list) were coded in one of four major areas as follows:

1. General college - transfer - non-terminal education
2. Business - terminal education
3. Technical - terminal education
4. Nursing - terminal education

Marital status of student and marital status of student's parents

This information was taken from the application blank. Thus, even if a change occurred after enrollment, no change was indicated for this variable. The coding used for student's parents as well as for the student was:

1. Single
2. Married (neither divorced nor widowed)
3. Divorced
4. Widowed

College transferred from

Some students attended another college before the one used in this study. Coding for this variable was established by writing down the names of each different college as they appeared in the students' folders and assigning a code number to each. Other students that attended the same college were assigned the numbers thus designated.

Educational level of parents

This information was available from the application in a form that allowed its stratification into four levels. The lowest group in education includes those who did not complete high school; the next higher level, those who graduated from high school; the third higher level, those who had attended college but were not graduated; and the highest category was made up of those who were graduated from college.

It would have been desirable to have had information permitting further stratification of the group with less than high school level, as well as those whose formal education was extended to postgraduate work and advanced professional degrees. As this information was not available, it was necessary to use the following four-point scale:

1	2	3	4
Less than high school	High school graduates	Some college	College graduates

Financial arrangement for college

On his application each student was asked to indicate the source or sources from which he expected to receive his financial support for college and to indicate the approximate portion from each. The categories to be used were: (1) entirely dependent on parent and/or other person, (2) three-fourths dependent, (3) one-half dependent, (4) one-fourth dependent, (5) entirely independent (all personal earnings). In order to quantify the information thus collected, a scale of financial dependency was constructed which allowed for the arrangement of responses according to the degree to which the student was dependent upon sources other than his own work or savings. If the item was left blank, scale value five was recorded.

1	2	3	4	5
Entirely dependent on parent or other person	3/4 dependent	1/2 dependent	1/4 dependent	Entirely independent

High school subject liked most and high school subject liked least

Each student was arked to write on his application the name of the high school subject he liked most and the subject he liked least. A list was compiled of the nine subjects which appeared with the greatest frequency. These were numbered one through nine and the numbers thus assigned used to identify the subjects for subjects liked most as well as for subjects liked least, as follows:

1. English
2. foreign language
3. math
4. science
5. social studies
6. physical education
7. music
8. commercial
9. shop

Subjects which appeared one or more times and were coded "0" were business law, geometry, psychology, chemistry, physics, home economics, agriculture, Bible history, reading, trigonometry, economics, and journalism.

High school rank

Rank in high school graduating class was recorded as given on the high school transcripts, one number over another. The top number indicated the rank in class; the bottom, the total number of students graduating in the class. The percentile was then computed.

Junior college grade point average

Grade points earned at the junior college were calculated according to the system in use at the college. Four grade points were awarded for an "A"; three for a "B"; two for a "C"; one for a "D"; and none for an "F". Hours attempted and grade points earned were calculated for each term of enrollment. Credits earned at another college were not included in these calculations. The term and year for each enrollment was indicated.

Other items

Various items of personal information were taken from the individual's statistical card, already in use at the college, and the coding used was the same as already in use (see Appendix B). Included in this data are sex, date of birth, county and state of residence, religion, high school attended last, foreign student or not, and race.

Other items recorded are: (1) last attendance at this junior college (term and year), (2) number of dependents, (3) number of older children in family, (4) number of younger children in family, and (5) number of high school activities listed on application (if more than eight were listed, the number nine was recorded).

Data Processing

To help the reader recognize when specific groups and sub-groups are being referred to, the names of these groups will be capitalized, e.g., Original, Cross-validation, Technical. Thus, "Technical" refers to the students in the technical sample in this study; "technical" (not capitalized) could refer to such students anywhere.

A total of 1050 students enrolled for the first time in the fall of 1962 and the fall of 1963 at the junior college. Punched cards were prepared for them as described. This two-year sample is referred to as the Original group.

A total of 594 students enrolled for the first time in the fall of 1964. Punched cards were prepared on them, the Cross-validation group.

Although information was obtained on all the above students and transferred to punched cards, not all the subjects fitted the sample requirements for this study.

College officials were asked to name the curricula that would have had at least 35 graduates from those enrolling in 1962 and 1963. The five thus named were the programs to be analyzed here--liberal arts, education, business, pre-engineering, and technical (civil engineering technology, design drafting technology, electronics technology, and laboratory technology for the citrus industry). Only full-time students (those attempting 12 or more semester hours per term) were included.

Only males enrolled in the programs could be employed (because only males were in the technical curriculum and sex could not be handled as a variable). After sorting the Original sample by programs it was realized that not enough males (13) had elected the education program to permit reliable analysis, and so that program sample had to be eliminated. Thus, 463 subjects were left in the Original group. Similarly, 222 were left in the Cross-validation sample.

Table 1

NUMBER OF CASES IN THE SAMPLES

Sample	Lib. Arts	Bus.	Engin.	Tech.	Total
Original	320	62	30	51	463
Cross-valid.	181	19	10	12	222
					685

The Original sample, as shown in Table 1, contains enough subjects in each program group to provide reasonably reliable statistical analysis. However, with Business containing only 19 Cross-validation subjects, Engineering only 10 and Technical only 12, it is apparent that the only results really worthy of attention in this sample would be on Liberal Arts and Total.

As expected, some of the data on subjects could not be located in their files. This further reduces the reliability of cross-validation analyses. Table 2 shows the actual number of variables present among the subjects in each subsample. As revealed in the table, the number of observations for the socioeconomic variable for the Cross-validation Engineering subsample is only six. Reference to the last line of the table showing total cases gives the maximum number of observations in each subsample. Since the Original Liberal Arts sample had 320 cases and there were only 311 socioeconomic observations, there would be nine missing observations.

Because two of the sub-tests (Mechanics of English and Effectiveness of Expression) of the English test were not given to the students entering in 1964-65, full cross-validation would not be possible for data including these two sub-tests. Therefore, data from these sub-tests were not used in the present study.

Table 2

ACTUAL NUMBER OF OBSERVATIONS OF THE VARIABLES FOR EACH SUB-SAMPLE

	Original Group					Cross-validation Group				
Variable	All	Lib.A.	Bus.	Engin.	Tech.	All	Lib.A.	Bus.	Engin.	Tech.
Socieec.	454	311	62	29	48	181	152	15	6	8
Psych.	389	266	56	24	43	192	159	14	8	11
Engl.	389	266	56	24	43	192	159	14	8	11
Soc. St.	389	266	56	24	43	192	159	14	8	11
Math.	389	266	56	24	43	192	159	14	8	11
Nat. Sci.	389	266	56	24	43	192	159	14	8	11
ACE V	412	282	51	29	50	192	161	17	10	12
ACE Q	412	282	51	29	50	198	159	17	10	12
Rdg. Comp.	231	143	36	21	31	158	125	14	8	11
H.S. Rk.	297	196	37	22	42	151	124	10	6	11
1st GPA	463	320	62	30	51	222	181	19	10	12
O/A GPA	463	320	62	30	51	222	181	19	10	12
Total cases	463	320	62	30	51	222	181	19	10	12

Since all the data on the punched cards were not to be used in original form it was necessary to produce a final data card that would contain the data to be analyzed. A computer program was written that would transfer the data from the original cards to cards that would be used in the statistical analysis. At the same time the program divided out data on the original card to produce quotients for First-term GPA, Overall GPA and percentile standing for rank in high school. In addition, the total number of grade points and hours attempted in college were computed and punched. This derived data card was then ready for analysis except that the Original sample had scores based upon the ACE while the Cross-validation sample had scores from the SCAT. The scales of these two tests are not directly comparable. Therefore, the SCAT scores were rank ordered and converted to percentiles. Likewise, the ACE scores were rank ordered to produce percentile to ACE conversion tables for both verbal and quantitative scores. The SCAT percentiles from the Cross-validation sample were looked up in the conversion table with a computer program and converted to ACE equivalent scores which were punched in place of the SCAT scores in the Cross-validation cards. After further manipulation on the reproducing machine all 13 variables to be used in the study were punched on a single data card for each subject.

Techniques for handling missing data

During the data collecting period, a technique was being developed for computing a multiple regression equation from data when some observations were missing. After many months of work the program was ready and after the data were collected, the analyses were begun. However, this program produced some multiple regression coefficients larger than unity, and therfore had to be replaced. The error was not entirely unexpected since the computational formula depends upon means and standard deviations. But these parameters for a particular variable will vary depending upon which other variable it is being paired with in the correlation computation. There is no problem in computing a zero-order correlation because only two variables are studied at a time and exact means and standard deviations are computed by omitting the pair of data for a subject where one or both scores are missing. However, in the multiple comparisons of multiple regression it is not possible to arrive at exact values for these parameters. If the missing data pairs had the same means and standard deviations as the remaining data the output of the program would be correct and would be based upon the correct zero-order correlations. However, dull, bright, or careless students may manage to escape some routine data gathering and introduce a bias in the nature of the data missing.

Since there was a rather large amount of missing data, especially for the Reading Comprehension scores, it was necessary to provide some technique for handling it rather than throwing out all subjects that had any missing values. A computer program was written that would compute the mean for each variable and then insert it in the punched card output in the place of missing values.

After this technique was tried, it was decided to try still another approach to the missing data problem.

A computer program was developed that would estimate missing values on the basis of the other scores present. To use the program it was necessary to derive multiple regression equations to be read into it. For this phase, the mean value was punched in place of each missing value on each card. The combined Original and Cross-validation samples were run through the BIMD stepwise regression analysis. The equations from these analyses were fed into the program for calculating missing values along with the initial data cards containing missing values. Means for the ten independent variables were also read into the program.

This program for estimating missing values operates on one subject's card at a time, It identifies the location of missing values and places means in each. It then estimates the first missing value from the regression equation corresponding to it, employing, for the other nine variables either 1) the actual scores or 2) the means when the actual values were missing. This procedure is used for each missing value. The whole procedure for that subject is iterated as many times as there are missing values. Thus, if four values were missing there would be four estimates of the missing value for each based upon successive estimates of the predictors for that variable where there originally were missing values, as well as the actual predictor scores.

The increased error introduced by using means to make estimates tends to reduce the zero-order correlation and this would be reflected in the multiple regression coefficients, the coefficient weights in these equations, and the discriminant function effectiveness.

Table 3 shows Pearson correlation coefficients between overall GPA and each variable. Those derived by employing mean values in place of the missing observations can be compared with 1) the values derived where missing values were skipped in the computations to provide exact correlations and 2) the values obtained by using multiple regression estimates. If the correlations derived from missing values are considered as a base, the largest difference was .12 between it and either of the others. Generally, there is closer agreement between the estimate and the missing data than between the means and the missing data results.

Also employed as a check was a computer program which leaves out cases that have missing data. The multiple correlations thus obtained for the samples with the largest numbers of cases were never more than .03 more than those obtained from the estimated data. Since the number of cases was much larger for the estimated data, it was decided to use exclusively the cards with the estimates.

Non-linearity

Another question considered about the relationship between Overall GPA and each variable was possible non-linearity. This was investigated statistically by a computer program from the College of Education library at the University of Florida that was developed by one of the writers (W.G.) The program presents intervalized data parameters and coefficients of non-linear relationship along with tests of significance for rejecting the linear regression hypotheses.

Table 4 presents statistics for evaluating the linearity of regression of Overall GPA on each variable. Table 5 presents the same statistics for regression of each variable on the Overall GPA. The symbols n.s.

Table 3

COMPARISON OF ZERO-ORDER CORRELATIONS BETWEEN VARIABLES AND OVERALL GPA COMPUTED BY OMITTING MISSING VALUES, BY EMPLOYING MEANS IN PLACE OF MISSING OBSERVATIONS, AND BY ESTIMATING VALUES FROM MULTIPLE REGRESSION

Computation Procedure	Variable Number										
	1	2	3	4	5	6	7	8	9	10	Sample
Punched Means	02	30	26	33	35	28	31	29	27	34	All
Missing Data	02	32	29	36	38	31	33	30	37	43	
Estimates	02	32	28	35	37	30	31	29	33	37	
Punched Means	00	31	28	32	34	30	35	31	31	34	Lib.Arts
Missing Data	00	34	32	36	37	33	38	33	45	46	
Estimates	00	33	31	34	36	32	36	31	38	39	
Punched Means	15	16	32	36	50	25	14	11	27	18	Bus.
Missing Data	15	16	32	37	50	25	14	11	33	24	
Estimates	15	18	33	38	51	27	15	11	33	21	
Punched Means	16	24	-01	38	18	20	26	15	29	43	Engin.
Missing Data	16	28	00	42	30	25	26	14	33	46	
Estimates	16	25	01	38	18	21	24	14	30	43	
Punched Means	00	27	18	29	25	12	20	30	00	32	Tech.
Missing Data	00	31	20	32	30	15	20	31	-01	34	
Estimates	-01	30	21	31	29	15	20	30	08	34	

Table 4

STATISTICS FOR EVALUATING THE LINEARITY OF REGRESSION OF OVERALL GPA ON EACH VARIABLE

	Statistics						
Variable	Pearson r	Raw Eta	Corrected Eta	F-test Raw Eta	F-test Corrected Eta	Blakeman Raw Eta	Blakeman Corrected Eta
Socioec.	02	11	00	n.s.	n.s.	n.s.	n.s.
Psych.	32	35	33	n.s.	n.s.	n.s.	n.s.
Engl.	28	31	30	n.s.	n.s.	n.s.	n.s.
Soc. St.	35	36	34	n.s.	n.s.	n.s.	n.s.
Math.	37	38	36	n.s.	n.s.	n.s.	n.s.
Nat. Sci.	30	32	29	n.s.	n.s.	n.s.	n.s.
ACE V	31	31	29	n.s.	n.s.	n.s.	n.s.
ACE Q	29	30	28	n.s.	n.s.	n.s.	n.s.
Rdg. Comp.	33	36	34	n.s.	n.s.	n.s.	n.s.
H. S. Rk.	37	41	40	s.	n.s.	s.	n.s.

Table 5

STATISTICS FOR EVALUATING THE LINEARITY OF REGRESSION OF EACH VARIABLE ON OVERALL GPA

Variable	Statistics						
	Pearson r	Raw Eta	Corrected Eta	F-test Raw Eta	F-test Corrected Eta	Blakeman Raw Eta	Blakeman Corrected Eta
Socioec.	02	12	00	n.s.	n.s.	n.s.	n.s.
Psych.	32	33	31	n.s.	n.s.	n.s.	n.s.
Engl.	28	31	28	n.s.	n.s.	n.s.	n.s.
Soc. St.	35	36	34	n.s.	n.s.	n.s.	n.s.
Math.	37	39	37	n.s.	n.s.	n.s.	n.s.
Nat. Sci.	30	32	30	n.s.	n.s.	n.s.	n.s.
ACE V	31	35	34	n.s.	n.s.	s.	n.s.
ACE Q	29	30	27	n.s.	n.s.	n.s.	n.s.
Rdg. Comp.	33	35	33	n.s.	n.s.	n.s.	n.s.
H. S. Rk.	37	40	38	n.s.	n.s.	n.s.	n.s.

mean not significant and s. means significant at the .05 or better level of confidence. The only recognizable non-linearity is found for the regression of Overall GPA on High School Rank. This non-linearity occurs at the extreme scale ends where both high and low rankers obtain a higher than predicted GPA. The highest 15 individuals on High School Rank obtained a mean Overall GPA of 2.88 compared with a mean predicted by the linear regression of 2.73; the lowest 25, 1.80 compared with 1.61. The regression of ACE verbal on Overall GPA does not deviate significantly from linearity according to an F-test, a t-test of Zeta, and Blakeman's criterion test based upon the corrected Eta. (However, Blakeman's test based upon the raw Eta did suggest non-linearity.) There then appears to be little value in transforming scores with such a slight indication of non-linearity.

Programs for multiple regression and discriminant functions.

Standard "BIMD" programs from the University of California at Los Angeles were employed in computing multiple regression equations and discriminant functions. Other computer programs were from the University of Florida College of Education library or were developed especially for this project. The IBM 709 computer was used for all calculations. The step-wise regression program was selected because it introduces variables one at a time based upon the largest partial correlation with the criterion. Interpretation of even step-wise equations is difficult because small differences in partial correlations can cause one pair of correlated variables to enter for one sample to the exclusion of the other, while the reverse may occur for a slightly different sample.

The differential importance of variables in identifying members of different programs is made clear in the discriminant functions. Both multiple and two group analyses were employed as appropriate in making the group discriminations. Because some of the computer programs used had restrictions on the numbers of cases per group, it was necessary to eliminate randomly members of some groups on two of the three discriminant function runs. The same restrictions did not obtain for the cross-validation computer programs. Therefore, for the four-group analysis of the Original sample it was necessary to reduce randomly the Liberal Arts group from 320 to 150 individuals; and for the two group analysis of Technical vs. Non-technical groups it was necessary to reduce randomly the Non-technical group from 412 to 300 cases. The analysis of Graduate vs. Non-graduate did not overload theprograms so no cases had to be eliminated.

Multiple regression equations are computed for each program subsample with Overall GPA and another set for First-term GPA. The Cross-validation group provides data to fit the multiple regression equations and discriminant functions produced from the Original sample to see how well they predict.

RESULTS

The means and standard deviations for the ten independent variables and the three other variables entering computations are presented in Table 6. While an analysis of the differences in means between program samples is outside the scope of the contract, four important reference values were examined for significance of differences betweeu groups.

Simple analysis of variance showed the between groups variance for variables analyzed to be not significant at the five percent level of confidence. High School Rank was significant at the one percent level of confidence. The t-tests of the three variables with significant F-ratios were significant at the five percent level for:

ACE Q higher for Engineering than Liberal Arts

High School Rank higher for Engineering than Liberal Arts

At the one percent level:

ACE Q higher for Engineering than Business

High School Rank higher for Engineering than Business

High School Rank higher for Technical than than Business

High School Rank higher for Technical than Liberal Arts

Overall GPA higher for Technical than Liberal Arts

First Question

The first question investigated deals with how well members of the four program groups can be identified on the basis of 10 variables available at the time of admission to college. The functions were successful in identifying group membership as shown in Table 7. The chi-square obtained from the computer program was 58.75

Table 6

MEANS AND STANDARD DEVIATIONS FOR THE 13 VARIABLES BY PROGRAM SAMPLES FOR THE COMBINED ORIGINAL AND CROSS-VALIDATION SAMPLES

	Means			
Variable	Lib.A.	Bus.	Engin.	Tech.
Socioec.	45.74	47.28	44.53	40.75
Psych.	50.86	48.75	61.38	53.65
Engl.	47.25	45.64	55.98	46.25
Soc. St.	53.95	53.30	63.18	52.40
Math.	58.98	54.85	76.65	64.84
Nat. Sci.	59.53	57.05	71.92	65.98
ACE V	55.10	54.31	58.45	55.71
ACE Q	35.39	34.73	40.63	39.98
Rdg. Comp	29.06	25.36	37.45	26.02
H.S. Rk.	45.01	42.05	55.65	53.08
1st GPA	2.07	2.17	2.26	2.24
O/A GPA	2.02	2.11	2.20	2.30
Total College Hrs. Attempted	44.71	49.69	47.88	59.29
No. Cases	501	81	40	63

	Standard Deviations			
Variable	Lib.A	Bus.	Engin.	Tech.
Socioec.	21.01	21.71	19.54	20.33
Psych.	25.34	20.19	23.37	21.26
Engl.	23.52	21.53	23.33	22.41
Soc. St.	24.07	20.73	25.57	23.81
Math.	22.93	22.34	18.34	18.69
Nat. Sci.	23.52	21.43	21.33	20.24
ACE V	12.94	11.39	18.25	11.85
ACE Q	9.65	9.98	9.57	7.72
Rdg. Comp.	20.13	18.29	26.05	19.51
H.S. Rk.	20.16	17.74	25.63	23.48
1st GPA	7.60	6.97	8.04	7.05
O/A GPA	6.94	5.57	7.19	7.16
Total College Hrs. Attempted	18.91	18.36	18.04	22.56
No. Cases	501	81	40	63

with 30 degrees of freedom and the corresponding level of significance is less than .01. The classifications resulting from the discriminant analysis appear in Table 7.

Table 7

CLASSIFICATION MATRIX BASED UPON DISCRIMINANT FUNCTIONS EMPLOYING TEN VARIABLES - ORIGINAL SAMPLE

		Largest Computed Function (Same order as rows)				
		1	2	3	4	Total
Actual	Lib. A.	35	49	29	37	150
Group	Bus.	12	30	7	13	62
Member-	Engin.	5	4	15	6	30
ship	Tech.	9	8	13	21	51
						293

The principal diagonal of the matrix in Table 7 shows correct identifications. There were 101 correct out of 293 people or 34 percent correct identifications while the chance rate would be 25 percent.

Table 8 gives the coefficients for the four discriminant functions for each variable. The relative size in the row, not the column, discloses the importance of the variable in contributing to the discrimination between the groups. Thus, the most differentiating are a high Mathematics score characterizing Engineering students, high Social Science characterizing Business, high Natural Science and ACE Quantitative characterizing Technical, and high Reading Comprehension characterizing Liberal Arts.

These discriminant function equations held up on cross-validation. Seventy-eight percent of the students were correctly identified by program group as compared to a chance rate of 25 percent. The obtained classification matrix is shown in Table 9.

Table 8

DISCRIMINANT FUNCTIONS IDENTIFYING THE PROGRAM SUBSAMPLES

	Program			
	Lib. A.	Bus.	Engin.	Tech.
Socioec.	.600	.635	.509	.508
Psych.	-1.411	-1.390	-1.481	-1.342
Engl.	.161	.123	.138	.071
Soc. Sci.	.596	.778	.592	.481
Math.	.038	- .128	.423	.039
Nat. Sci.	.295	.246	.457	.541
ACE V	4.473	4.462	4.350	4.443
ACE Q	2.664	2.959	2.677	3.200
Rdg. Comp.	-2.111	-2.227	-2.124	-2.331
H.S. Rk.	.590	.591	.752	.758
Constant	-159.2	-164.4	-187.0	-183.3
No. of S's	150	62	30	51

Table 9

CLASSIFICATION MATRIX BASED UPON DISCRIMINANT FUNCTIONS EMPLOYING TEN VARIABLES - CROSS-VALIDATION

		Largest Computed Function (Same order as rows)				
		1	2	3	4	Total
Actual	Lib. A.	167	6	1	7	181
Group	Bus.	18	0	0	1	19
Member-	Engin.	9	0	1	0	10
ship	Tech.	6	0	0	6	12
						222

A subsidiary question investigated deals with how well the Technical sample could be differentiated from the combined Non-technical sample. A two-group discriminant function failed to make such a discrimination at a significant level. Although correct identifications were 78 percent as compared with a chance rate of 50 percent, the significance level was only .10. The coefficients from this two-group discrimination weight the variables as they were in the four-group discrimination. As seen in Table 10, the Technical student is characterized by being lowest in Social Studies, while highest in Natural Science and ACE Quantitative.

Table 10

DISCRIMINANT FUNCTION COEFFICIENTS IDENTIFYING TECHNICAL VS. NON-TECHNICAL STUDENTS

Variable	Coefficient
Socioec.	-.237
Psych.	.010
Engl.	-.377
Soc. St.	-.411
Math.	.035
Nat. Sci.	.578
ACE V	.384
ACE Q	1.124
Rdg. Comp.	-.299
H.S. Rk.	.355

Cross-validation sample values were calculated and the mean difference for the computed function values in the Technical vs. Non-technical group was evaluated. A t-value of 6.02 was significant at the .01 percent level of confidence.

Second Question

The discriminant functions have shown the characteristics of the students in the various programs. However, what makes for success within each program is not apparent from the above analyses. Before looking at multiple regression of GPA on the 10 variables to get a more precise idea of what forecasts excellence in performance within programs, it is appropriate to see the results of one more discriminant function analysis.

This time the groups were Graduates vs. Non-Graduates and analysis was of all programs combined. The discriminant function correctly identified only 58 percent with a chance rate of 50 percent; however these results were significantly better than chance at the .05 level of confidence.

Table 11 gives the coefficients for the discriminant function which gives high values for Non-graduates and low for Graduates. The chief differentiator is the higher ACE Quantitative score for Graduates.

While the discriminant function was able to discriminate between Non-graduates and Graduates at a statistically significant level, it produced results only eight percent better than chance and is therefore of little practical value. It is to be noted that, as would be hypothesized, higher means on all ten variables occurred for the Graduates. Since this was true, and since the discriminant functioms produced results only eight percent greater than chance, it was hypothesized that a simple summing of scores to obtain a total score would provide as satisfactory a discrimination. When these total scores were rank ordered by size, the 251 lowest should have been Non-graduate and the 212 highest, Graduates. This procedure produced 55 percent correct identifications as compared to the discriminant function which gave 58 percent correct. A t-test of the difference between means of the summed scores for Graduates and Non-graduates gave a value of 2.69 which is significant at the .01 level of confidence.

Table 11

DISCRIMINANT FUNCTION COEFFICIENTS IDENTIFYING NON-GRADUATES VS. GRADUATES

Variable	Coefficient
Socioec.	.026
Psych.	.277
Engl.	.096
Soc. St.	-.221
Math.	-.054
Nat. Sci.	.065
ACE V	.129
ACE Q	-.833
Rdg. Comp.	-.246
H.S. Rk.	-.159

Cross-validation of the discriminant function that differentiated Non-graduates from Graduates gave 63 percent correct identifications. A chi-square for the classification matrix was 42.5 —— a result significantly better than chance at the .01 level of confidence.

Third Question

The data were now analyzed further with multiple regression equations to predict Overall GPA and First Term GPA from the ten variables. Variables were brought into the equations in a step-by-step fashion, the one with the highest partial r coming first, then the next highest, etc. The equation was regarded as completed when introduction of the variable with the next highest partial r raised the multiple correlation less than .01.

Table 12 gives the size of the multiple correlations for predicting Overall GPA and First Term GPA for the Total sample and for program subsamples. For predicting Overall GPA they range from .476 for all subjects to .632 for the Engineering subsample. Those for predicting First Term GPA range from .314 for Technical to .701 for the Engineering subsample. It must be remembered that the Engineering sample was smallest so it is statistically predictable that its multiple correlation would be largest.

Table 12 also gives the regression coefficients obtained in the step-wise fashion described above. In general, the patterns of coefficients appear rather similar for both Overall and First Term GPA's. Every variable except Psychological entered at least one of the equations. The generally strongest predictors were Social Studies, Mathematics, Reading Comprehension, and High School Rank.

Liberal Arts students' GPA's were simply predicted by variables heavily loaded on general intelligence (Mathematics, Reading Comprehension, and High School Rank). In contrast to this, predicting GPA's for Engineering students was more complex with five variables entering for both Overall and First Term GPA. Even more complex is the nature of the predictors for Technical students. The best predictors for Technical students were high ACE Quantitative and Social Studies and low Reading Comprehension.

Table 12

MULTIPLE REGRESSION COEFFICIENTS AND CORRELATIONS FOR OVERALL GPA'S AND FIRST TERM GPA'S ALONG WITH CROSS-VALIDATION CORRELATIONS

	Dependent Variable									
	Overall GPA					First Term GPA				
Correlation	All	Lib.A.	Bus.	Engin.	Tech.	All	Lib.A.	Bus.	Engin.	Tech
R	.476	.508	.607	.632	.492	.437	.472	.600	.701	.314
CV r*	.409	.392	.445	.245	.513					
Variable										
Socioec.				.43						
Psych.										
Engl.				-2.38					-1.95	
Soc.St.			.82	2.05	1.25	.63			2.10	1.11
Math.	.61	.52	1.61			.62	.55	1.80		
Soc.Sci.								.91		-.80
ACE V			-.71						1.28	
ACE Q			-1.40		1.97			-2.76		.79
Rdg. Comp.	.61	.92		1.17	-1.42		1.09		.63	-.85
H.S. Rk.	.87	.99		-.13	.56	.74	.91			.41
Constant**										
C	118.4	105.6	171.7	182.4	102.2	110.8	106.3	172.0	120.4	191.1

* Cross-validation coefficient of correlation between actual and predicted GPA.

** GPA was figured on a basis of 4 for A, 3 for B, etc., then multiplied by 100. Thus, an exact C average would be 200.0.

Other inverse relationships between variables and GPA appear in other program subsamples and are even more surprising. For example, Engineering students have higher GPA's if they have a low English score. Equally surprising, Business students have higher GPA's if they have a low ACE Quantitative score judging by the coefficients in Table 12. Such findings must be considered in relation to the particular grading practices in the college for the programs concerned. Reference to Table 3 which shows the correlations of the actual variables with the GPA criterion fails to reveal negative relationships between these variables and GPA; they are merely lower than for the other variables in the Table. For example, consider variable 3 (English), correlated with GPA for Engineering majors at -.01, .00, and .01; likewise, variable 9 (Reading Comprehension), correlated with GPA for the Technical students at -.01, .00, and .08.

As was necessary for cross-validating the discriminant functions, a program had to be written to compute predicted GPA's of the Cross-validation sample based upon the equations obtained from the Original data. The program then correlated the predicted and actual GPA's for the Cross-validation subjects. Since the task of predicting Overall GPA's appeared to be similar to that for predicting First Term GPA's the more stable Overall GPA criterion was preferred for cross-validation.

Table 12 also presents correlation data from the Cross-validation subsamples expressing the relationships between the Overall GPA criterion and the value predicted from the 10 variable scores when inserted in the multiple regression equations obtained from the analysis of the Original sample. As would be expected, the multiple regression equation based upon the smallest number of Original scores, 30 for Engineering, showed the greatest shrinkage. The least shrinkage was for the Technical group, which produced a slightly larger correlation in cross-validation than originally. This occurs by chance every once in a while, and is certainly not considered of significance here.

SUMMARY AND CONCLUSIONS

In this section the questions raised in the Introduction will be examined and some conclusions will be drawn.

It is worth repeating that because means were used to estimate any missing data, all calculated statistics are smaller than if original data had been available, because error is increased.

1. Can students in the various curricula be differentiated?

The answer is affirmative at the .01 level of confidence. This adds more evidence to that of Hoyt quoted above, supporting the conviction that technical students are different, and ought to have more differential studies made of them. This would give students interested in technical curricula more of the meaningful data needed to make wise decisions.

2. Can graduates be differentiated from non-graduates?

The answer is affirmative from a statistical point of view (at the .05 level of confidence), but questionable from a practical point of view (since correct predictions were made only 58 percent of the time, compared with a purely chance prediction rate of 50 percent).

3. How can Grade Point Average prediction be maximized?

The factors are given by the multiple regression coefficients in Table 12. The factors and the weights necessary to maximize prediction are different for each program.

This is evidence that each program is different in so far as what makes for success in each program; in other words, not only are the students who select the programs differentiable, but the programs themselves are differentiable. This adds more weight to the conclusion that differential studies should be attempted.

4. How predictable is this junior college?

The statistical answer is given by the R's in Table 12. When the R's by program are compared with the .40-.60 range Bloom and Peters (1960) give for differential studies, it is seen that three of the twelve are below the usual range. When the R's for all programs combined are compared with the .55-.65 range for general prediction, all three are below the usual range for senior colleges.

As suggested in the introduction, this college espouses the open door policy. The writers feel that the results of this study are certainly not inconsistent with this philosophy. It is hoped that the college itself will examine the evidence and inferences here presented and see if it agrees with this conclusion.

From the above it is obvious that the college, if it wished to, could use the results of this study in an attempt to salvage some potential failures in this way: Using the multiple regression equations appropriate to each major curricula, the college might routinely predict GPA for these curricula for each entering student. The student's counselor might use these predictions if, in his judgment, they might be useful data in counseling certain students about their choice of program. For example, if a certain student had no real preference as between the liberal arts and the technical programs, and his predicted liberal arts GPA was 1.4 while the predicted technical GPA was 2.3, the counselor <u>might</u> use these data and the standard errors of estimate, to say something such as: "Research into the past experience of students at this college indicates that only 31% of entering students with measurable characteristics like yours succeed in the liberal arts program. However, 64% of the students with test scores like yours who took the technical program did succeed. Obviously there were lots of exceptions in both curricula, but I thought you might like to know the apparent 'odds' both for and against you, as far as research can help us to figure these odds."

It is recommended that further research in the area of the present project try to concentrate on schools that stress completeness of records. When half of the students admitted to a school somehow manage not to take tests that all students are supposed to take, it is hard to know what to do about the missing data and hard to be supremely confident of the results obtained.

It is hoped that many more junior colleges will examine in this same manner their various curricula, especially technical, both to help their own students and counselors toward more realistic decisions and to help themselves examine their philosophy and practice.

APPENDIX A

MAJOR FIELDS OF STUDY

Agriculture	1003
Architecture	1006
Art	1009
Biology	1012
Business Administration	1015
Business Education	1018
Criminology	1021
Dental Hygiene	1024
Pre-Dental	1027
Education	1029
Elementary Education	1030
Secondary Education	1033
Engineering	1036
English	1039
Foreign Language	1040
Foreign Service	1042
Forestry	1045
History	1048
Home Economics	1051
Hotel Restaurant Management	1054
Journalish Advertising	1057
Law	1060
Liberal Arts-General Education	1063
Mathematics	1066
Medical Technology	1069
Medicine	1072
Ministry	1075
Music Education	1078
Nursing	1081
Occupational Therapy	1084
Optometry	1087
Pharmacy	1090
Physical Education	1093
Physical Therapy	1096
Political Science	1097
Psychology	1099
Religious Education	1100
Science	1102
Social Welfare	1105
Veterinary	1108
Undecided	1111
Other	1114
Just Taking Courses	1117
Certification	1118
Business Terminal Programs	2120
Medical Secretary	2123
Secretarial Science	2126
Stenographic	2129
Technical Education Programs	3131
Civil Engineering	3132
Design Drafting	3135
Electronics	3138
Citrus Technology	3141
Nursing Education	4144

APPENDIX B

INFORMATION ON STATISTICAL CARD
(Codes)

County

1	Dade	24	St. Lucie	47	Citrus
2	Duval	25	Jackson	48	Clay
3	Hillsborough	26	Osceola	49	Hendry
4	Pinellas	27	Highlands	50	Washington
5	Polk	28	Pasco	51	Holmes
6	Palm Beach	29	Columbia	52	Baker
7	Orange	30	Hardee	53	Charlotte
8	Volusia	31	Suwannee	54	Dixie
9	Escambia	32	Indian River	55	Gilchrist
10	Broward	33	Santa Rosa	56	Hamilton
11	Alachua	34	Desoto	57	Okeechobee
12	Lake	35	Madison	58	Calhoun
13	Leon	36	Walton	59	Franklin
14	Marion	37	Taylor	60	Glades
15	Manatee	38	Monroe	61	Flagler
16	Sarasota	39	Levy	62	Lafayette
17	Seminole	40	Hernando	63	Union
18	Lee	41	Nassau	64	Collier
19	Brevard	42	Martin	65	Wakulla
20	St. Johns	43	Okaloosa	66	Gulf
21	Gadsden	44	Sumter	67	Liberty
22	Putnam	45	Bradford		
23	Bay	46	Jefferson		

APPENDIX B

INFORMATION ON STATISTICAL CARD
(Codes)
(Continued)

State

01 Ala.	19 La.	37 Okla.
02 Alas.	20 Me.	38 Oreg.
03 Ariz.	21 Md.	39 Pa.
04 Ark.	22 Mass.	40 R.I.
05 Calif.	23 Mich.	41 S. Car.
06 Col.	24 Minn.	42 S.Dak.
07 Conn.	25 Miss.	43 Tenn.
08 Del.	26 Mo.	44 Tex.
09 D.C.	27 Mont.	45 Utah
10 Fla.	28 Neb.	46 Vt.
11 Ga.	29 Nev.	47 Va.
12 Hawaii	30 N.H.	48 Wash.
13 Idaho	31 N.J.	49 W.Va.
14 Ill.	32 N.Mex.	50 Wis.
15 Ind.	33 N.Y.	51 Wyo.
16 Iowa	34 N. Car.	52 U.S. Prot.
17 Kan.	35 N. Dak.	53 Territory
18 Ky.	36 Ohio	54 Foreign

Religion

01 Baptist	09 Methodist
02 Catholic	10 Presbyterian
03 Christian	11 Protestant
04 Congregational	12 Christian Sci.
05 Episcopal	13 No preference
06 Greek Orthodox	14 None
07 Jewish	15 Other
08 Lutheran	

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