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Analysis of Grade Point Average and Grades in Selected Courses for Students in Selected Occupational Programs.

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Comparing the performance of students majoring in Data Processing Programming, Dental Assisting, Electronics Technology and Mid-Management with control groups matched on the basis of sex and ACT scores, no apparant discrimination against the technical majors was found in terms of earned grade point averages or grades in selected courses, with the exception of Dental assistant students' grades in Social Science 131. For overall grade point averages, controls were introduced for high school graduation status and age. Mid-Management and Data Processing Programming students appear to earn higher grade point averages than students not in these programs with the previously mentioned controls operating. In addition, Data Processing Programming students earn higher grades in Business 105 when controls are introduced for Social Science, Natural Science, and Composite ACT scores. (Author/MC)

DALLAS COUNTY JUNIOR COLLEGE DISTRICT

RESEARCH STUDY 68 - 2

Analysis of grade point average and grades in selected courses for students in selected occupational programs

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RESEARCH STUDY 68 - 2

TITLE: Analysis of grade point average and grades in selected courses for students in selected occupational programs.

OBJECTIVES: The following two basic questions were asked: (1) Are there differences between the earned grade point averages of students in a selected occupational program and a sample of students not in the program? These comparisons were made for students in the following programs: Data Processing Programming, Mid-Management, Dental Assisting, and Electronic Technology. (2) Are there differences in the grades earned in selected courses for students in a selected occupational program and a sample of students not enrolled in the program? Comparisons were made for the following courses within each program:

- Data Processing Programming: Communications 131, Business 101 and Business 105
- Dental Assistant: Communications 131, Social Science 131, and Biology 131
- Electronics Technology: Communications 131, Physical Science 131 and Mathematics 131
- Mid-Management: Business 105, Communications 131 and Social Science 131

The analyses provided statistical controls for whether or not the students had graduated from high school, age, and ACT scores. In addition, the method by which each sample of non-occupational students was selected provided a matching control for sex.

PROCEDURE: The "population" from which the samples were selected consisted of the 2,916 students enrolled during the fall semester of the 1967-68 academic year, and for which ACT scores were available. The GPA and grades in courses includes all enrollments through the fall semester. Students are not identified by specific program major. Therefore, in order to select the students majoring in a particular program, a course which would normally be taken only by students in that program and which was required for the program was identified. Students who had enrolled in Data Processing 134 were assumed to be Data Processing Programming majors. Similarly, Electronic Technology 130 was used to select Electronic Technology students; Dental Assisting 130 was used to identify Dental Assistant majors; and enrollment in any of the mid-management courses 130, 131, 132, or 133 was used to identify mid-management majors. All students meeting these criteria were selected, rather than a sample.

For each of the four occupational program samples, a pseudo-random sample of students not taking the identifying course(s) was generated by instructing the computer to select two students of the same sex for each student identified as an occupational program major. The four "matching" non-occupational student samples were then twice as large as the number of corresponding occupational majors. In selecting these matching groups, the computer was also instructed to skip systematically through the master file so that any bias due to sequencing of the master file would be eliminated. For example, the computer might have started with the first student and then looked at the 11th, 21st, etc. students. If the master file were passed without the required number of students having been selected, the computer would have made another pass using the 2nd, 12th, 22nd, etc. students. The resulting sample sizes are indicated in Table 1.

An attempt was made to also include Chemical Technology students, Data Processing Operator students, and Pattern Drafting and Draping students, but samples of sufficient size for reliable statistics were not obtained.

In order to ask the basic questions of the data, the subjects were conceptually arranged into a 4 cell table.

CELL 1 Occupational Majors and High School Graduates	CELL 2 Occupational Majors and Non-High School Graduates
CELL 3 Non-Occupational Majors and High School Graduates	CELL 4 Non-Occupational Majors and Non-High School Graduates

The basic question is: Are there differences between the criterion scores (GPA or course grade) in Cells 1 and 3, and Cells 2 and 4? Since it was desirable to control for age and ACT scores, each question was restated as: For students with the same control variable score (e.g., age), are there differences between the criterion scores in Cells 1 and 3 and between the criterion scores in Cells 2 and 4?

In order to ask this restatement of the main question (controlling for another variable), it is necessary to show that the relationship between the control variable and the criterion variable is the same in each of the four cells, i.e., the change in the criterion variable per unit change in the control variable is the "same" (not significantly different) within each of the four groups. If the relationships can be considered the same, the main questions may be asked with the effect of the control variables removed. If the relationships are different, more limited and more specific questions would need to be asked, e.g., at what level of the control variable is the criterion variable the same in two groups?

To examine the relationships with particular course grades, high school graduation status was not considered, since the number of students taking a particular course were much smaller. Therefore, these analyses basically treat the differences in course grades between two groups, those majoring in a program and those not majoring in a program. Also, age was omitted as a control variable since the analyses concerned with grade point average indicated that this variable had limited functional relationships with the achievement criterion.

Since the samples relating to particular courses were drawn from the samples used in the analysis of grade point averages, the numbers of students involved were reduced drastically, more so than anticipated. Due to the direction of the observed differences (most of them favored the program majors), the small number of program majors who had particular courses, and the method in which the non-program samples were originally selected, these analyses were not recomputed.

Details of the analyses are found in the appendix.

RESULTS

Table 1 presents the sample sizes selected for analysis.

Table 2 presents some basic descriptive data for the program and non-program groups for the four majors studied.

Table 3 reports the results of analysis for Dental Assistant students and non-Dental Assistant students. The only statistically significant relationship occurred when grades in Social Science 131 were examined with the ACT Social Science scale as a control variable. The Dental Assistant students received almost one letter grade lower in Social Science 131 than non-Dental Assistant students with the same ACT Social Science score. A number of the differences observed tend to indicate that Dental Assistant students receive lower grades in Biology 131, Communications 131, Social Science 131 and also have slightly lower grade point averages. None of the differences are statistically significant, except for the one already noted.

The analyses for Electronic Technology students versus students not majoring in Electronic Technology are presented in Table 4. No statistically significant differences were found between majors and non-majors on grade point average or specific course grades. Only one instance of unequal relationships between course grade and control variable was found, which was not obviously an artifact of the sample (due to the relatively small number of non-majors having taken specific courses). This was for Math 131 and the ACT Math score. Figure 2 presents this information graphically. It appears that for students with ACT scores of approximately 15 on the Math sub-scale, majors and non-majors in Electronic Technology perform equally well in Math 131. For scores greater than 15, Electronic Technology majors tend to perform at a higher level than non-majors. Below scores of 15, the non-majors appear to earn higher grades than majors. There is no immediately apparent explanation for this.

Table 5 presents the analysis for Mid-Management students versus non-Mid-Management students on course grades for Communications 131, Social Science 131, and Business 105. No statistically significant results were found, with the smallest obtained probability being equal to .21, even though the sample sizes are somewhat more respectable for these two groups of students than for other analyses of this variety. The relationship between the various control variables and each of the course grades appear to be the same for each of the two groups. The observed differences, even though statistically insignificant, appear to hover around zero for Communications 131 and Social Science 131. For Business 105, the observed differences indicate that majors earned somewhat lower grades than non-majors (about 1/4 of a letter).

Table 6 presents the analyses based on the sample of Data Processing Programming students and a matching sample of non-Data Processing Programming students. Since there were no non-high school graduates in the control group, the comparisons were only for those who were high school graduates. Statistically significant results at the .01 level or greater were obtained between the program and non-program groups for each of the six control variables. In each case the programming-majors scored at least 1/2 grade point higher than the non-programming students. The effects of the control variables within the groups were essentially the same. All of the observed differences for Communications 131, Business 101 and Business 105 grades favor the program majors, except for the -.13 difference on Communications 131 with ACT English score serving as a control variable. Only the differences associated with Business 105 grades using Social Science, Natural Science, and ACT Composite Scores as control variables were significant at the .05 level or less. Even considering the small sample sizes, it appears to be a safe generalization that Data

Processing Programming students score at least as well as or better than non-Data Processing Programming students on overall grade point average and grades earned in three specific courses.

The relationship of Communications 131 grades with ACT Natural Science scores and the ACT Composite Score was not the same for the two groups of students. Since the other three ACT sub-scales seem to be related to course grade in the same way for the two groups of students, the unequal relationship for the ACT Composite appears to be due to the Natural Science component in this score. Figure 1 graphically illustrates the nature of these dissimilar relationships. It appears that for students with ACT scores (Natural Science or Composite) of approximately 15, there is no difference in the Communications 131 course grade for Data Processing Programming majors and non-Data Processing Programming majors. For scores greater than approximately 15, majors appear to score higher than non-majors. For scores less than 15, non-majors appear to score higher than majors. The reason for this is not readily apparent, and it could very easily be a chance situation.

SUMMARY

In general, it can be stated that technical majors, at least in the four programs analyzed, are not apparently discriminated against as compared with control students matched for sex and ACT scores. In addition, for overall grade point average, controls were introduced for high school graduation status and age. The only statistically significant difference which does not favor the technical major is that for Dental Assistant students in Social Science 131. Mid-Management students and Data Processing Programming students appear to earn higher grade point averages than students not in these programs, with the previously mentioned controls operating. In addition, Data Processing Programming students earn higher grades in Business 105, when controls are introduced for Social scores, Natural Science scores, and ACT Composite Score.

There appears to be no evidence to support any negative discrimination against technical students. If it is suspected that programs other than those examined in this study exhibit discrimination, additional evidence will need to be collected.

TABLE 1

SAMPLE SIZES FOR GPA ANALYSES

Programs	Majors Total	Majors High School Graduates	Majors Non-Graduates	Non-Majors Total	Non-Majors High School Graduates	Non-Majors Non-Graduates
Electronic Technology	74	67	7	148	141	7
Dental Assisting	23	23	0	46	43	3
Data Processing Programming	25	21	4	50	50	0
Mid-Management	61	58	3	122	115	7

SAMPLE SIZES FOR COURSE GRADE ANALYSES

Programs and Courses		Majors	Non-Majors
Electronic Technology	Comm. 131	35	16
	Math 131	41	5
	Physics 131	25	3
Dental Assisting	Bio. 131	10	3
	Comm. 131	14	10
	S.S. 131	12	5
Data Processing Programming	Comm. 131	11	6
	Bus. 101	9	3
	Bus. 105	10	6
Mid-Management	Comm. 131	36	12
	S.S. 131	21	11
	Bus. 105	49	23

TABLE 2

DESCRIPTIVE DATA

VARIABLES

GROUP	ACT ENGLISH	MEAN MATH	SCORE SCO SCI	NAT SCI	COMPOSITE	MEAN AGE	TOTAL MEAN GPA
Dental Assistant							2.30
Program	15.09	11.30	15.43	14.30	14.03	22.52	
Non-Program	16.85	15.48	16.21	16.77	16.33	20.87	
Electronic Technology							2.22
Program	13.26	16.03	15.82	17.16	15.57	22.05	
Non-Program	13.57	13.62	14.47	14.86	14.13	22.16	
Mid-Management							2.17
Program	15.07	16.18	16.95	17.03	16.31	20.56	
Non-Program	15.00	14.85	15.74	16.13	15.43	21.61	
Data Processing							2.30
Program	15.80	16.04	17.72	17.04	16.65	22.28	
Non-Program	14.94	14.68	15.86	15.68	15.29	22.42	

TABLE 3

Comparison for Dental Assistant Students
Minus Non-Dental Assistant Students

Control Variable

Criterion	Age	ACT English	Math	SCALE Soc Sci	Nat Sci	Composite
GPA						
Grad	-.17	-.09	.02	-.20	-.10	.06
Control Variable Coefficient	-.03	.07	.06	.02	.05	.06
Constant	2.71	1.08	1.45	1.68	1.39	1.18
N=69						
BIO 131 $\bar{X}$=1.69 σ = .91						
Difference		-.12	-.15	-.20	+.13	+.02
Control Variable Coefficient		.08	-.11	.11	.07	.10
Constant		.36	3.20	-.03	.66	.07
N=13						
COM 131 $\bar{X}$=2.25 σ=1.13						
Difference		-.44	-.27	-.53	-.07	-.39
Control Variable Coefficient		.13	.13	.08	.18	.16
Constant		.62	.86	.97	-.18	.30
N=24						
SS 131 $\bar{X}$=1.65 σ=1.08						
Difference		-.71	-.22	-.89*	-.55	-.60
Control Variable Coefficient		.14	.11	.12	.16	.17
Constant		.29	.42	.68	-.11	-.14
N=17						

*Significant with alpha = .05

TABLE 4

Comparison for Electronic Technology Students Minus Non-Electronic Technology Students

Control Variable

Criterion	Age	ACT English	SCALE Math	Soc Sci	Nat Sci	Composite
GPA						
Grad	.08	.10	.00	.05	.05	.02
Non-Grad	-.13	-.33	-.37	-.37	-.39	-.43
Control Variable Coefficient	.03	.03	.04	.03	.02	.05
Constant	1.52	1.83	1.63	1.68	1.88	1.43
N=222						
COM 131 $\bar{X}$=2.18 σ=1.12						
Difference		-.23	-.10	-.02	+.17	-.11
Control Variable Coefficient		.08	.02	.00	-.04	.03
Constant		.99	1.84	2.16	2.67	1.75
N=51						
MTH 131 $\bar{X}$=1.78 σ=1.14						
Difference		.07	.07	.33	.19	.19
Control Variable Coefficient		.11	.12	.05	.03	.13
Constant		.36	-.10	1.03	1.00	-.21
N=46						
PS 131 $\bar{X}$=2.21 σ=1.15						
Difference		.23	.08	.24	.08	.00
Control Variable Coefficient		.00	.06	.08	.04	.08
Constant		1.99	1.17	.80	1.46	.92
N=28						

TABLE 5

Comparison for Mid-Management Students
Minus Non-Mid-Management Students

Control Variables

Criterion	Age	ACT English	Math	SCALE Soc Sci	Nat Sci	Composite
GPA						
Grad	.44	.41	.42	.39	.40	.40
Non-Grad	.46	.53	.51	.53	.51	.50
Control Variable Coefficient	.03	.01	-.01	.01	.00	.01
Constant	1.81	2.48	2.51	2.16	2.32	2.26
N=183						
COM 131						
$\bar{X}$ =2.31						
σ = .90						
Difference		.07	.08	-.02	.09	.03
Control Variable Coefficient		.05	.01	.06	-.01	.06
Constant		1.55	2.20	1.38	2.35	1.37
N=48						
SS 131						
$\bar{X}$ =2.50						
σ = .87						
Difference		-.03	-.01	+.01	-.01	-.08
Control Variable Coefficient		.07	.04	.08	.04	.09
Constant		1.50	1.93	1.32	1.96	1.11
N=32						
BUS 105						
$\bar{X}$ =2.04						
σ = .98						
Difference		-.21	-.28	-.26	-.26	-.26
Control Variable Coefficient		.03	.01	.03	-.01	.04
Constant		1.48	1.73	1.47	2.10	1.31
N=72						

~~**Significant with alpha = .01~~

TABLE 6

Comparison for Data Processing Programming Students Minus Non-Data Processing Programming Students

Control Variables

Criterion	Age	ACT English	SCALES Math	Soc Sci	Nat Sci	Composite
GPA	**	**	**	**	**	**
Grad	.67	.58	.59	.51	.57	.53
Control Variable Coefficient	.05	.02	.01	.04	.02	.05
Constant	1.58	2.77	2.45	1.91	2.25	1.82
N=75						
COM 131 $\bar{X}=2.53$ $\sigma=.92$						
Difference		-.13	+.30	+.10	+.31	+.21
Control Variable Coefficient		.12	.01	.07	.06	.10
Constant		.20	2.18	1.39	1.43	.8656
N=17						
BUS 101 $\bar{X}=1.67$ $\sigma=1.75$						
Difference		+1.17	+.80	+.61	+1.18	+.74
Control Variable Coefficient		.17	.15	.21	.16	.25
Constant		-.93	-.63	-2.47	-2.28	-3.39
N=12						
BUS 105 $\bar{X}=2.38$ $\sigma=1.05$						
Difference		+.96	+1.03	+1.12*	1.07*	1.02*
Control Variable Coefficient		.10	.05	.09	.06	.10
Constant		.34	1.11	.14	.72	.21
N=16						

*Significant with alpha = .05

**Significant with alpha = .01

Figure 1

Relationship of Comm 191 Grades with ACT Natural Science and Composite Scores for Majors and Non-Majors in Data Processing Programming

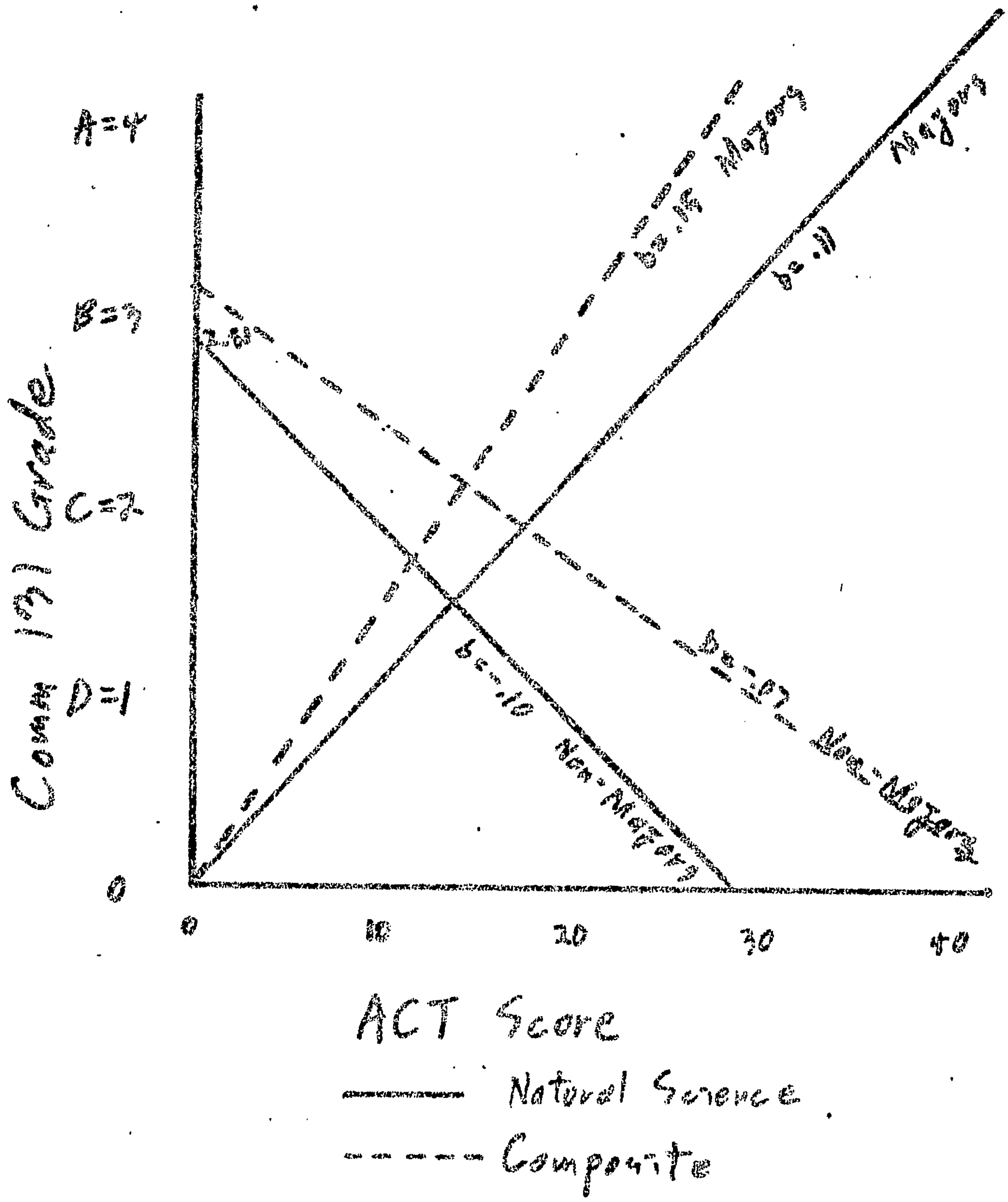
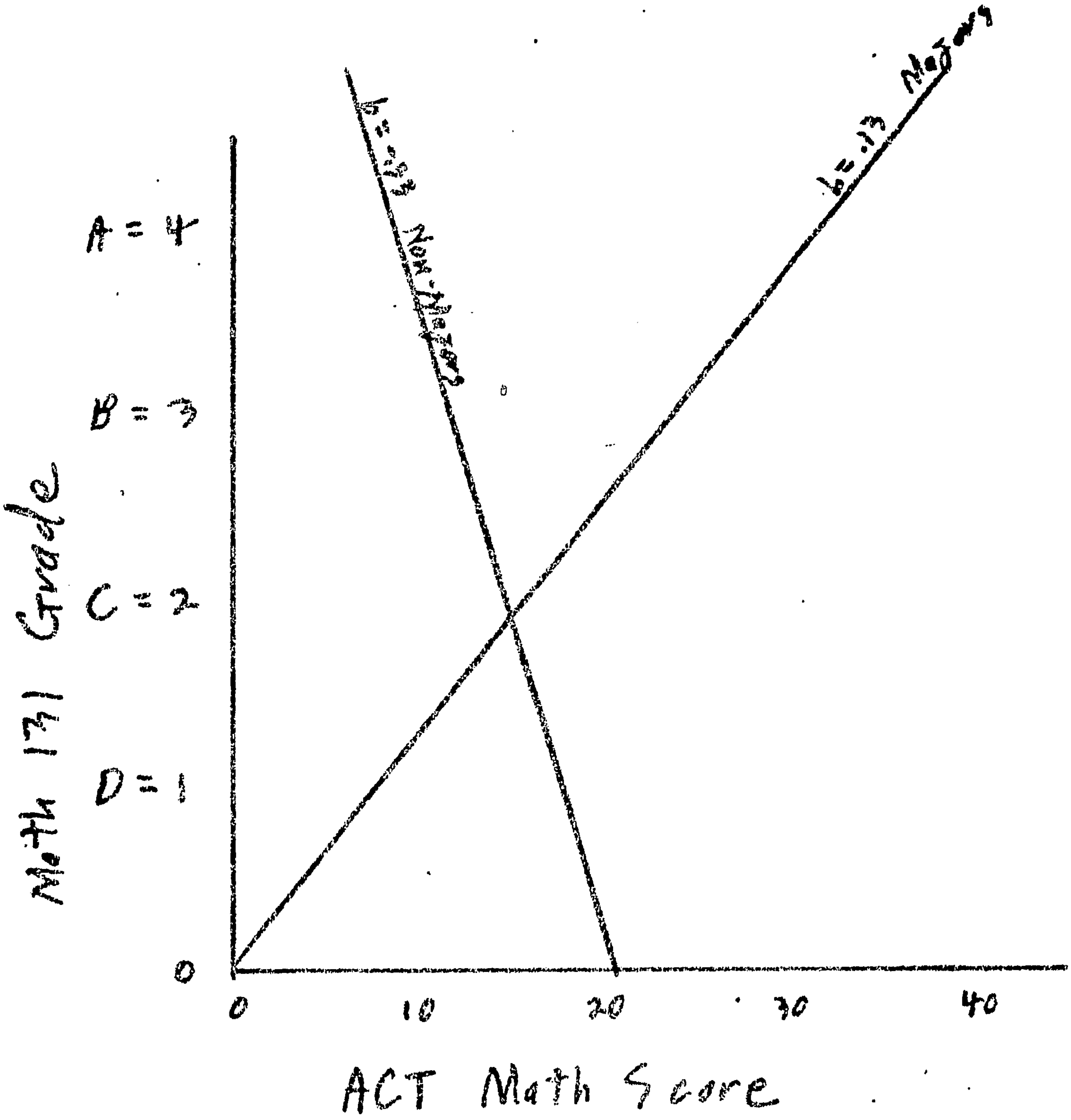


Figure 7

Relationship of Math 171 Grades with ACT Math Score for Majors and Non-Majors in Electronic Technology



APPENDIX

For each subject the following vectors were generated. Multiple linear regression procedures were used to compute least-squares solutions for the vector coefficients and to test the appropriate hypotheses.

Y = criterion score (GPA or course grade)
$X^{(1)}$ = 1 if occupational major and high school graduate, 0 otherwise
$X^{(2)}$ = 1 if occupational major and non-high school graduate, 0 otherwise
$X^{(3)}$ = 1 if non-occupational major and high school graduate, 0 otherwise
$X^{(4)}$ = 1 if non-occupational major and non-high school graduate, 0 otherwise
$X^{(5)}$ = control variable (Age, or ACT, English, Math, Social Science or Natural Science score)
$X^{(6)} = X^{(1)} \cdot X^{(5)}$ control scores for major graduates
$X^{(7)} = X^{(2)} \cdot X^{(5)}$ control scores for major non-graduates
$X^{(8)} = X^{(3)} \cdot X^{(5)}$ control scores for non-major graduates
$X^{(9)} = X^{(4)} \cdot X^{(5)}$ control scores for non-major non graduates

$Z^{(1)} = X^{(1)} + X^{(2)}$ = 1 if occupational major, 0 otherwise
$Z^{(2)} = X^{(3)} + X^{(4)}$ = 1 if non-occupational major, 0 otherwise
$Z^{(3)} = X^{(1)} + X^{(3)}$ = 1 if high school graduate, 0 otherwise
$Z^{(4)} = X^{(2)} + X^{(4)}$ = 1 if not high school graduate, 0 otherwise

The appropriate full model was:
$Y = a_1X^{(1)} + a_2X^{(2)} + a_3X^{(3)} + a_4X^{(4)} + a_6X^{(6)} + a_7X^{(7)} + a_8X^{(8)} + a_9X^{(9)}$ with 8 independent predictors. The hypothesis that the relationship between the control variable and the criterion is the same in the four groups (i.e., the slopes of the four separate regression lines are the same) is stated as:

$$a_6 = a_7 = a_8 = a_9 = c_1$$

This restriction on the full model yields the following restricted model:

$$Y = a_1X^{(1)} + a_2X^{(2)} + a_3X^{(3)} + a_4X^{(4)} + a_5X^{(5)} \text{ where } a_5 = c_1$$
with 5 independent predictors

If the above hypothesis is not rejected at the 5% level, the main question may be asked: Are there criterion differences between students in the program and those not in the program?

$$a_1 = a_3 = c_2 \text{ and } a_2 = a_4 = c_3$$

The appropriate restricted model is then:

$$Y = c_2 Z^{(3)} + c_3 Z^{(4)} + a_5 X^{(5)}$$

with 3 independent predictors. This model is compared with the 5 predictor model serving as the full model.

Similar models were constructed to examine course grades, but since the numbers of students were smaller, high school graduation status was ignored and only two categories were used. The full model was then

$$Y_{(\text{course grade})} = a_1 Z^{(1)} + a_2 Z^{(2)} + a_5 Z^{(5)} + a_6 Z^{(6)}$$

where $Z^{(5)} = X^{(6)} + X^{(7)}$ and $Z^{(6)} = X^{(8)} + X^{(9)}$. The appropriate restricted model for the **"equal slopes" hypothesis** $(a_5 = a_6 = c_1)$ is

$Y = a_1 Z^{(1)} + a_2 Z^{(2)} + c_1 X^{(5)}$ and the completely restricted model for the main hypothesis $(a_1 = a_2 = c_2)$ is

$Y = c_2 V + c_1 X^{(5)}$ where V = the unit vector.