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ABSTRACT

The usefulness of equations to predict graduation from college was studied using data from the 1974 freshman class of a major research university. The following predictor variables were assessed using multiple regression and discriminant analyses: sex, race, residency, major, high school rank, high school size, Scholastic Aptitide Test scores, and predicted grade point average. The percentage of variance that was explained was 14.4 percent for blacks, 4.9 precent for whites, and 7.4 percent for blacks and whites. Discriminant analyses yielded correct predictions for 64.5 percent of the blacks, 57.65 percent of the whites, and 64.78 percent of both races. It is concluded that while the results are not impressive, they do support the need for continued research in the area. (Author/SW)

Predicting College Graduation for Black and White Freshman Applicants

by

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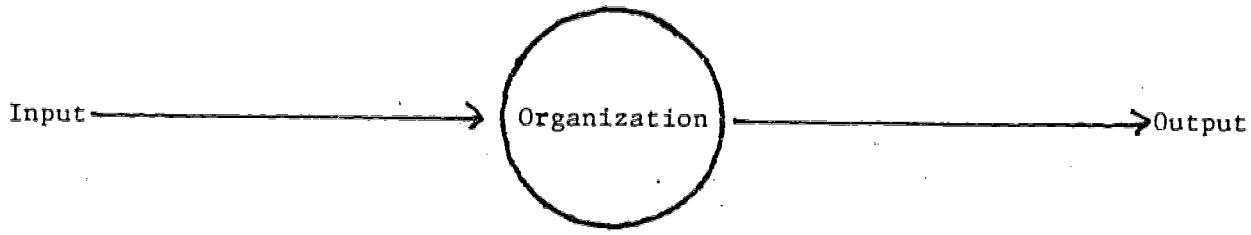
Abstract

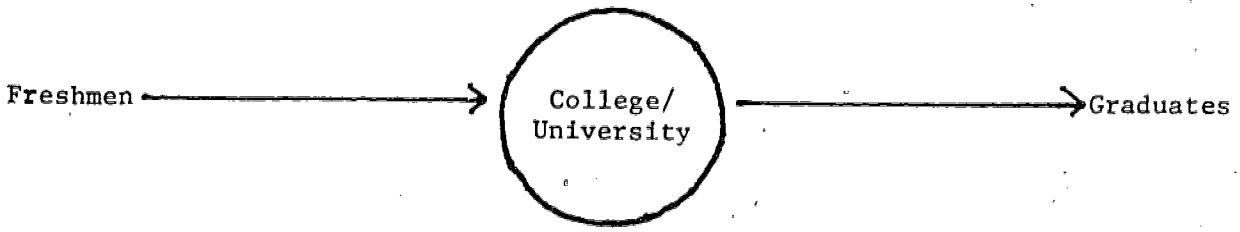
This study used black and white students in the freshman class that entered a major research university in 1974 to explore the possibility of computing predicted graduation equations for use by Admissions. Sex, race, residency, major, high school rank, high school size, SAT scores, and predicted grade point average were used as predictor variables in multiple regression and discriminant analyses. The percentage of variance explained was 14.4% for blacks, 4.9% for whites, and 7.4% for blacks and whites. Discriminant analyses yielded correct predictions for 64.5% of the blacks, 57.65% of the whites, and 64.78% of both races. While the results are not impressive, they do support continued research in the area.

Predicting College Graduation for Black and White Freshman Applicants

Katz and Kahn (2) develop a perspective of open system theory which offers a useful framework for analyzing organizations of all types and, in simplified form, provides a basic model for reviewing graduation data for students who enter institutions of postsecondary education. Succinctly characterized as input/output (I/O), this model represents the major operation of colleges and universities; freshmen are admitted and seniors graduate. While this simplified I/O model sacrifices much of the detail of open system theory and of the diversity of most colleges, it does provide a useful and convenient backdrop for research into predicting eventual graduation of new freshmen.



Open System Theory



I/O Model Applied to Graduation Data

Note: Preliminary discussion of this research took place at the annual meeting of the Southern Association for Institutional Research, October, 1980, (5).

The model holds that the output is just as important as the input because of the open system theory postulate that input is dependent upon output in a cyclical fashion for constant renewal. Negative Entropy is an organizational concept which denotes the need for organizations to input more energy than they expend as output, and the term neatly if somewhat esoterically summarizes the concerns of admissions offices which struggle to enroll full classes. Unfortunately, and here is one spot where theory may help practice, the focus in admissions seems to ignore the cyclical nature of the process as the descriptive terms -- New Clientele, Non-Traditional Students, Older Student -- imply that only new sources are tapped for input. Yet, admission's officers of residential, liberal arts colleges have long recognized the cyclical feedback of family ties in college-going behavior which bring generation after generation back to the same institution. In short, output influences input either positively or negatively whether one recognizes the link or not.

On more practical grounds, most admission's decisions do not include information on students' likelihood of persisting until graduation simply because no data exist to make such consideration possible. If reasonably accurate predictors of graduation for freshman applicants were available, college admissions would be among the first to use the information produced by such new techniques.

The Study

The purpose of this study is to relate graduation data for a given freshman class to data available at the time that class applied for admission in order to calculate predicted graduation equations (PGE) which can be used for future freshman applicants. The request for this research originated in the Office of Undergraduate Admissions after they had seen and examined our basic persistence to graduation rate data (6;7). The Admission' Staff appeared interested for two

reasons: first, they are always eager to utilize new techniques which either improve their ability to recognize student abilities or expand the range of data on applicants which is available to them; and, second, they desire to strengthen their capability to evaluate minority applicants whose traditional scholastic records may not appear to reflect their ability to succeed in college. For these reasons and because of our own interest in this area (3) and in making further use of these data, the Office of Institutional Research embarked on the study reported here.

As background information on the general nature of the persistence to graduation rates of entering freshmen at UNC-Chapel Hill, Table 1 shows rates for the 1967-76 classes at four, five, six, and ten years after original enrollment. The rates have not fluctuated wildly, but they did increase substantially after the 197Q low point to the 1974 high point after which they have declined slightly. Additional data on graduation rates across sex, race, SAT scores, and PGA (Predicted Grade Point Average) are included in Figures 1-4 to give some indication of the basic relationship between the dependent variable (graduation status) and some of the independent variables used in this study.

The Data

Data on graduation rates have been collected by the Office of Records and Registration of The University of North Carolina at Chapel Hill for all freshman classes since 1967. Each cohort is established at the conclusion of the registration period for fall semester, and the cohort remains intact with date of graduation being recorded as each individual member of the cohort graduates. Students who leave the university but return to earn their degree remain a part of their original cohort, but data are not available to differentiate between students who graduate after a period of continuous enrollment and those who drop out for a time and return to get their degree.

Table 1

Graduation Rates for Freshmen Classes
Entering UNC-CH, 1967-76

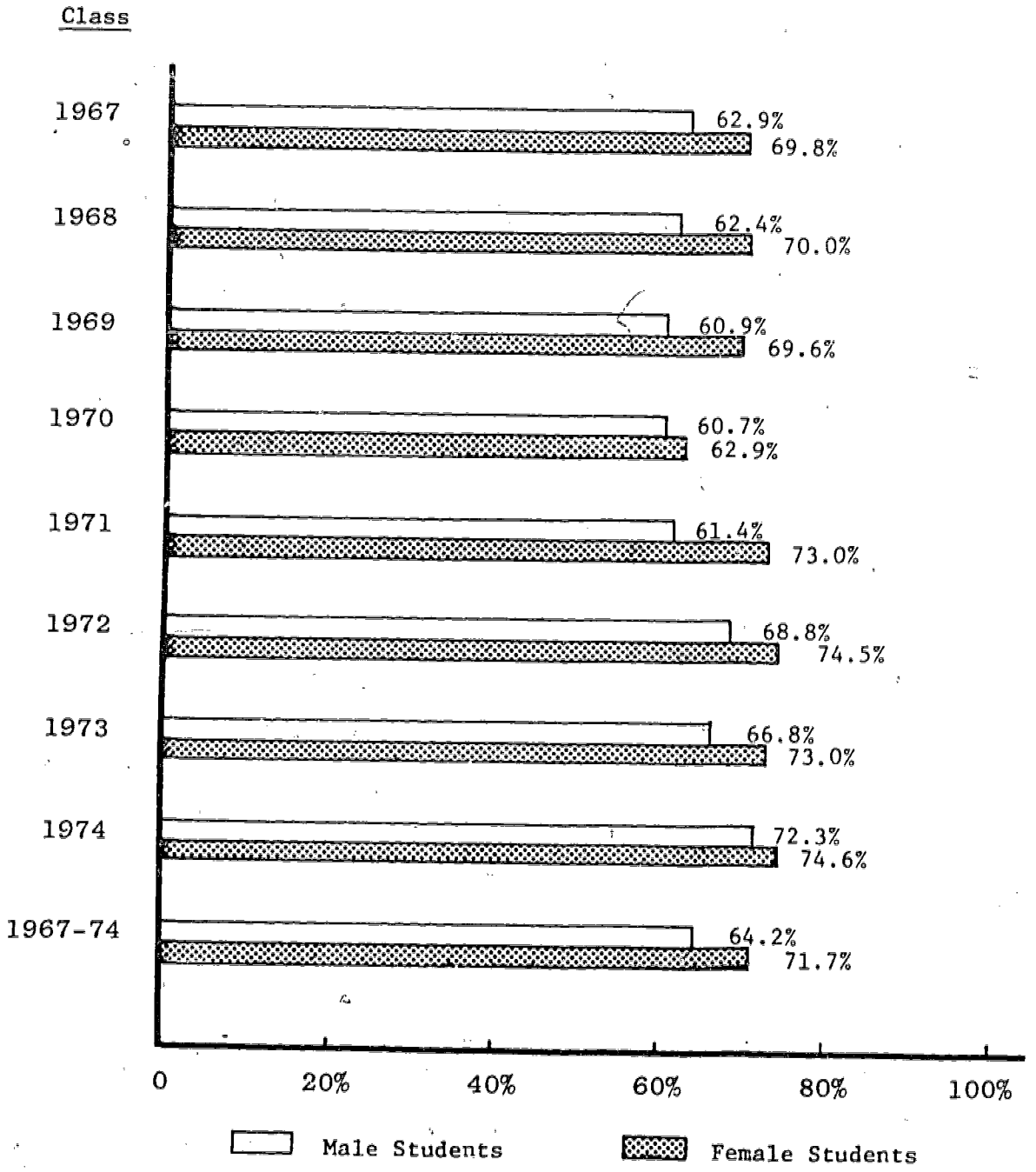
Classes Entering	After Four Years # Graduated	%		After Five Years # Graduated	%
1967	1,281	50.1		1,644	64.3
1968	1,071	50.6		1,348	63.7
1969	1,248	52.1		1,502	62.7
1970	1,351	46.6		1,778	61.7
1971	1,512	48.9		2.016	65.2
1972	1,479	51.9		2,024	71.0
1973	1,657	51.7		2,227	69.4
1974	1,585	54.9		2,118	73.4
1975	1,580	53.4		2,103	71.1
1976	1,524	52.6	1967-75	16,760	67.1
1967-76	14,288	51.3			

Classes Entering	After Six Years # Graduated	%		After Ten Years # Graduated	%
1967[1]	1,688	66.0		Not available	
1968	1,383	65.4		1,566	74.0
1969	1,549	64.7		1,758	73.4
1970	1,856	64.0		-	
1971	2,131	68.9		-	
1972	2,098	73.6		-	
1973	2,325	72.5		-	
1974	2,205	76.4	1968-69	3,324	73.7
1967-74	15,235	69.2			

[1]As of December, 1972 graduation (5 2/3 years)

Figure 1

GRADUATION RATES OF STUDENTS ENTERING UNC-CH AS FRESHMEN, BY SEX, 1967-74, AFTER FIVE YEARS

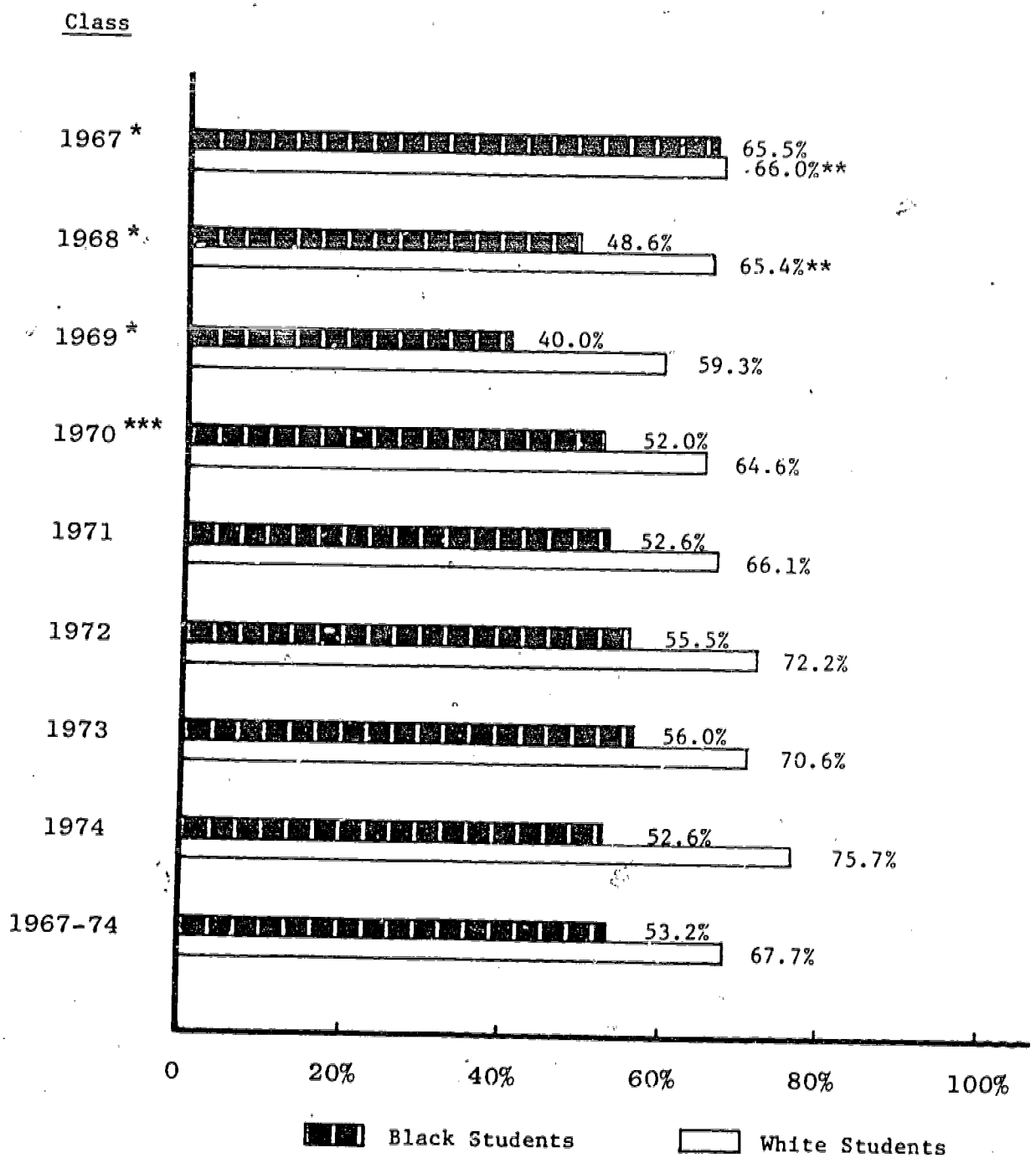


Note: For the freshman classes, 1967-74, the total graduation rate after five years is 66.6%.

DATA SOURCE: Office of Records & Registration
PREPARED BY: Office of Institutional Research, 2/18/80

Figure 2

GRADUATION RATES OF STUDENTS ENTERING UNC-CH AS FRESHMEN, BY RACE, 1967-74, AFTER FIVE YEARS



* Not five years after entering; figures as of December 1973 graduation.

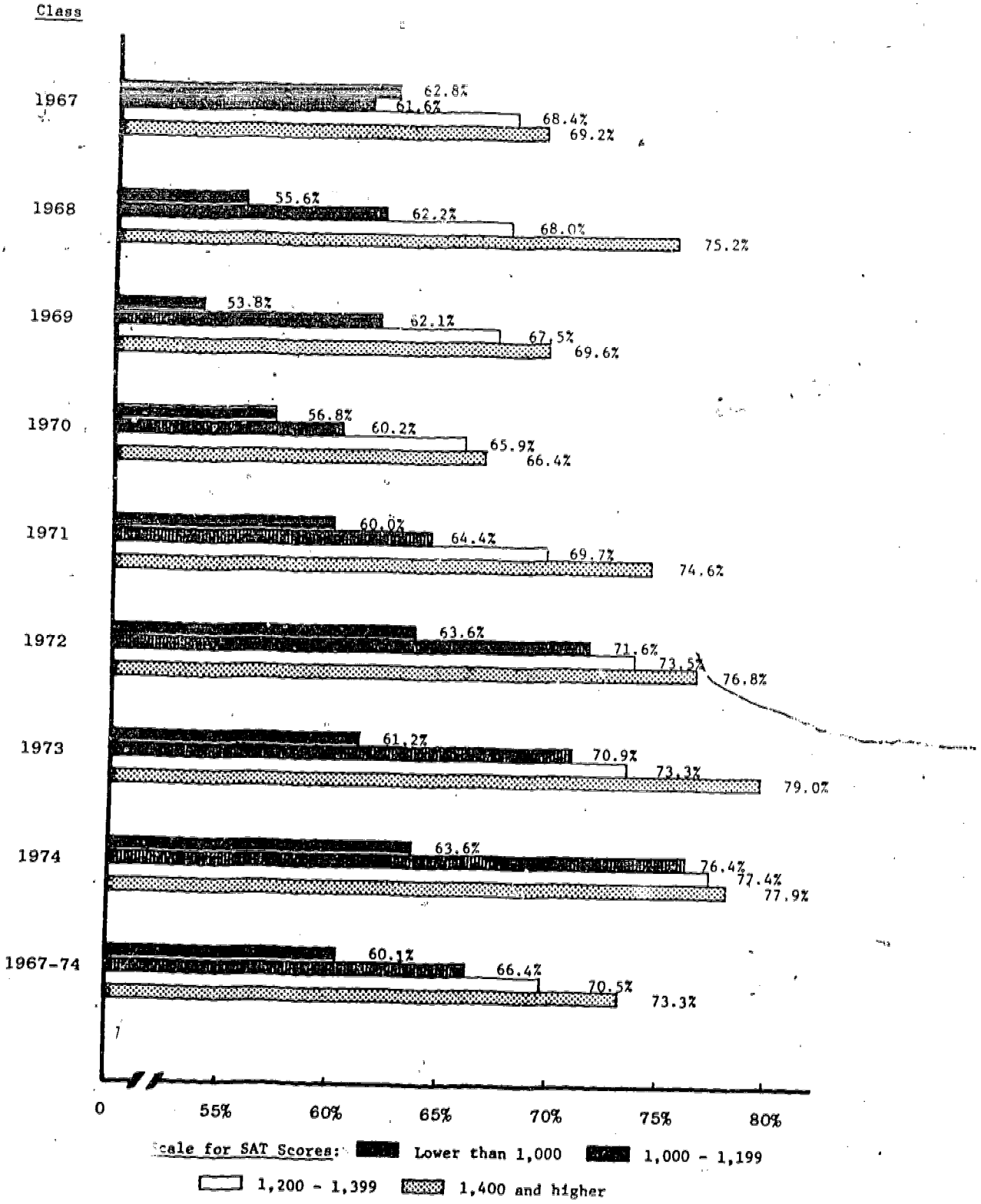
** Figures for white students in 1967 and 1968 include minorities other than black.

*** Not five years; as of May 1976 graduation.

DATA SOURCE: Office of Records & Registration
PREPARED BY: Office of Institutional Research, 2/18/80

Figure 3

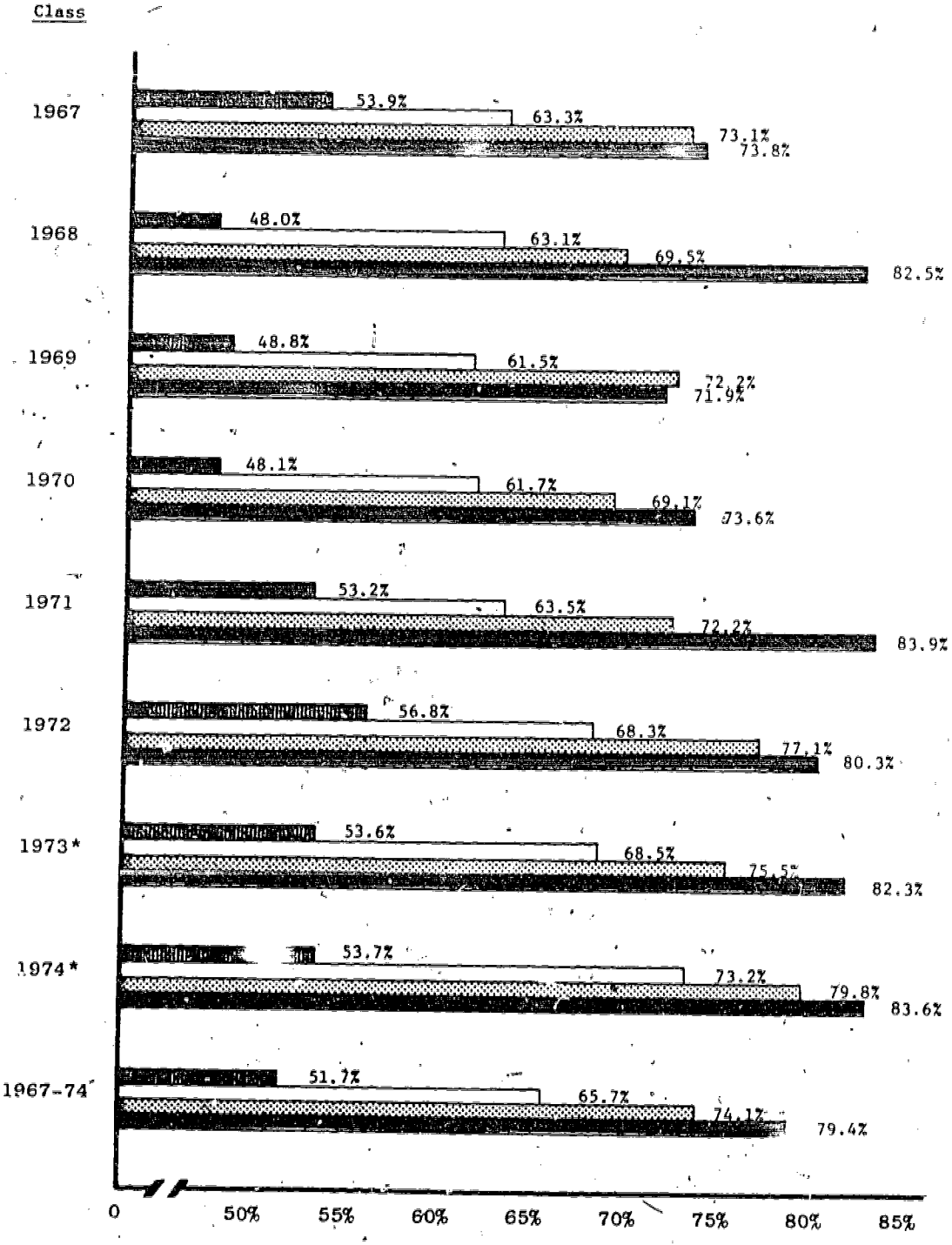
GRADUATION RATES AFTER FIVE YEARS FOR FRESHMEN ENTERING UNC-CH, 1967-74, BY SAT SCORES



DATA SOURCE: Office of Records & Registration
PREPARED BY: Office of Institutional Research, 2/19/80

Figure 4

GRADUATION RATES AFTER FIVE YEARS FOR FRESHMEN ENTERING UNC-CH, 1967-74, BY PREDICTED GRADE POINT AVERAGES



Scale for Predicted Grade Point Averages: 0.0 - 2.000 | 2.001 - 2.600 | 2.601 - 3.200 | 3.201 - 4.000

* For the 1973 and 1974 cohorts, the four PGA categories are: 0.0 - 1.999, 2.0 - 2.599, 2.6 - 3.199, 3.2 - 4.0.

DATA SOURCE: Office of Records & Registration
PREPARED BY: Office of Institutional Research, 2/20/80

Beginning with the 1974 cohort of new freshmen, the data files from which this research is conducted became available for computer analysis. Both the 1974 and 1975 freshmen were studied originally, but the 1974 class was chosen and is reported here because one more year of data was available and because the relationships among the variables were stronger. While some attempts had been made to compute correlations by hand before this, the manual process was time consuming, subject to human error, and unable to use more than two variables at a time. Computer analysis using the Statistical Package for the Social Sciences (SPSS) provides greater accuracy and permits a broader review of those variables which may be related to persistence to graduation. Obviously, the research reported here would not have been possible before computer support was available.

Before defining the variables used here, one cautionary vote should be mentioned as a danger inherent in relying upon computers for analysis. As "number-crunchers" computers are unsurpassed, but their ability to generate lots of data with 9 digits to the right of the decimal point does not insure that the numbers are meaningful. One must be wary, therefore, in pondering the deep significance of Multiple R's, for example, which vary from each other in magnitudes less than 0.01 or smaller. Achieving statistical significance does not assure meaningful results, and the researcher must rely upon good judgment in addition to statistical analyses to interpret findings.

Definition of Variables

Briefly, the variables used here are defined as indicated below. Except for high school rank in class which is somewhat complicated, most variables are quite straightforward.

1. Graduation Status: 1 = No, 2 = Yes
2. Sex: 1 = Male, 2 = Female

3. Race: 1 = Black, 2 = White (all others excluded)
4. Residency Status: 1 = In-state for tuition purposes, 2 = Out-of-state
5. Major: 1 = Have decided on major, 2 = Undecided
6. SATV: Scholastic Aptitude Test Verbal Score, actual score used (200-800)
7. SATM: S.A.T. Mathematics actual score
8. SATT: S.A.T. total actual score
9. PGA: Predicted Grade Point Average computed from rank in class and SAT scores, range 0.0-4.0.
10. High School Size: Actual size of graduating high school class
11. High School Rank: Rank in decimals with range of 0.0-1.0; note that a low number equals a high rank (0.0-0.1 is top tenth) so that negative correlations mean positive relationships.

The Findings

Three sets of analyses were run in an attempt to derive useful predicted graduation equations (PGE), and the remainder of this paper presents these findings. First was a multiple regression on graduation status using sex, race, PGA, SATM, SATV, SATT, and high school rank as independent variables; second was an expanded regression which added three variables -- high school size, major, and residency status; last was a discriminant analysis of graduation status using the entire set of variables. At this time it should be mentioned that using a dichotomous independent variable is not the most desirable way to do regression, but it is feasible as long as one is cognizant of its limitations.

Regression I

Table 2 shows the results from the first regressions which account for the highest proportion of explained variance in regressing entering freshman characteristics on graduation status for the blacks and whites in the 1974 entering

Table 2

Multiple Regression Analyses on Graduation Status and Predicted Graduation Equations (PGE) for Black and White Freshmen Entering UNC-CH in 1974

1974 Black Freshmen

	Multiple R	R^2	r	Beta
High School Rank*	0.29828	0.08897	-0.29828	-0.26647
SATV	0.31054	0.09644	0.14835	0.05687
Sex (Female)	0.31169	0.09715	0.04727	-0.02464
PGA	0.31253	0.09768	0.25717	0.03510
SATM	0.31272	0.09779	0.13164	0.01532

Predicted Graduation Equation**

$$PGE = [1.4667 - 0.8818(HSR) + 0.0003(SATV) - 0.0245(Sex) + 0.0499(PGA) + 0.0001(SATM)]^2$$

1974 White Freshmen

	Multiple R	R^2	r	Beta
High School Rank*	0.13306	0.01770	-0.13306	-0.11158
PGA	0.14730	0.02170	0.12711	0.02764
SATM	0.14870	0.02211	0.08292	0.03258
Sex (Female)	0.14914	0.02224	0.00824	-0.01250
SATV	0.14951	0.02235	0.07771	0.01794

Predicted Graduation Equation**

$$PGE = [1.6005 - 0.445(HSR) + 0.0282(PGA) + 0.0002(SATM) - 0.0106(Sex) + 0.0001(SATV)]^2$$

1974 Freshmen (Blacks and Whites)

	Multilple R	R^2	r	Beta
High School Rank*	0.18433	0.03398	-0.18433	-0.14728
Race (White)	0.20930	0.04381	0.14024	0.07185
SATM	0.21812	0.04758	0.13742	0.04378
SATV	0.21976	0.04830	0.13024	0.03350
Sex (Female)	0.22017	0.04848	0.00850	-0.01449
PGA	0.22018	0.04848	0.18121	0.00551

Predicted Graduation Equation**

$$PGE = [1.3938 - 0.5605(HSR) + 0.1074(Race) + 0.0002(SATM) + 0.0002(SATV) - 0.0127(Sex) + 0.0054(PGA)]^2$$

*As noted in the text, High School Rank is coded in reverse and the negative signs are unimportant.

**Predicted Graduation Equation (PGE) obtained by squaring the predictive equation for the graduation status variable; the range of PGE is 1.0 to 4.0 approximately; standard errors of the predictive values of the graduation status variable are 0.4777 (blacks), 0.4210 (whites), and 0.4267 (both).

freshman class. The findings for black freshmen are more impressive (10% of variance explained) than for white freshmen (2%) or blacks and whites combined (5%), but none of the findings appear to approach a level of explanation (prediction) which would justify the use of the resulting predicted graduation equations in admissions' procedures. Further research was conducted, however, because the potential for greater success seemed evident. The PGE's shown in Table 2 for each of the three analyses produce results on a scale comparable to that of the predicted grade point average equation (PGA) except that the low end of the scale is 1.0 instead of 0.0. Hypothetical data for two imaginary students having the lowest and highest possible combinations of values for all the variables produce PGE's of 1.017 and 3.492 respectively when using the PGE for blacks and whites combined. The equations are most sensitive to fluctuations in high school rank in class (HSR); for example, changing HSR to the second tenth instead of the top tenth results in a PGE of 3.286 as compared to the 3.492 shown above while changing HSR to the second tenth instead of the bottom tenth give PGE = 2.122 instead of the 1.017 from the other example.

Regression II

In an attempt to improve the predictive power of the PGE's calculated in the first set of equations, three variables -- high school size, major field of study, and residency status -- were added to the regression. In all honesty these three variables were selected because they were readily available on the retention data file, but there is some theoretical justification as well. High school size (actually size of the graduating class) was chosen because one could theorize that students from larger high schools might do better at a large university because large high schools tend to be more cosmopolitan and to encourage more responsibility in their students; both factors would seem likely to relate positively

to success at a large university. Major (intended) hinges on the certainty of the students' academic goals, and one might hypothesize that students' who are fairly certain of their major would be more likely to succeed in college. Finally, residency status for tuition purposes is really a proxy for two student characteristics which may be related to eventual graduation. First, because competition for admission is much keener among out-of-state residents, these students tend to have better academic records on the average, so the first proxy characteristic is ability. Second, out-of-state students appear to be somewhat more sophisticated than native students which suggests a better chance of success in college; hence, sophistication is the second proxy.

Results from the second set of regressions are shown in Table 3, and they do explain more of the variation in graduation status than do the first equations. For blacks the percentage of variance explained became 14.4% instead of 9.8% while the percentages for whites became 4.9% instead of 2.2% and for both races became 7.4% instead of 4.8%. Certainly these changes represent a notable improvement and further examination of Table 3 suggests that residency status is the primary contributor to the difference although all three new variables are significant in the regressions. Perhaps the residency proxy is a viable combination of student characteristics which are related to success in (graduation from) college.

Discriminant Analysis

As mentioned above, the discriminant analyses were run using the same set of variables as the second set of regression analyses. Five variables were significant for all three groups of the 1974 freshmen with race also entering in when blacks and whites were combined. Table 4 shows the results of these analyses. Note that the discriminant analyses were run on an updated retention file so

Table 3

Expanded Multiple Regression Analyses on Graduation Status and Predicted Graduation Equations (PGE) for Black and White Fresh-Entering The University of North Carolina at Chapel Hill in 1974

1974 Black Freshmen

Variables	Multiple R	R^2	r	Beta
High School Rank	0.29828	0.08897	-0.29828	-0.28633
Residency Status (out)	0.34010	0.11567	0.13454	0.16781
Major (undecided)	0.35333	0.12484	-0.09887	-0.10365
High School Size	0.36556	0.13363	-0.11275	-0.09498
SATV	0.37602	0.14139	-0.14835	0.06240
Sex (female)	0.37844	0.14321	0.04727	-0.04212
SATM	0.37927	0.14385	0.13164	0.02617
PGA	0.37934	0.14390	0.25717	0.01651

$$PGE = [1.367 - 0.947(HSR) + 0.384(RES) - 0.145(MAJOR) - 0.0003(HSS) + 0.0004(SATV) - 0.042(SEX) + 0.0002(SATM) + 0.023(PGA)]^2$$

1974 White Freshmen

Variables	Multiple R	R^2	r	Beta
Residency Status (out)	0.14283	0.02040	0.14283	0.16105
High School Rank	0.21253	0.04517	-0.13306	-0.15181
High School Size	0.21721	0.04718	0.07199	0.04572
Major (undecided)	0.21885	0.04789	-0.04485	-0.02795
Sex (female)	0.22023	0.04850	0.00824	-0.02482
SATV	0.22069	0.04870	0.07771	0.01494

(PGA & SATM not significant)

$$PGE = [1.585 + 0.201(RES) - 0.605(HSR) + 0.0001(HSS) - 0.031(MAJOR) - 0.021(SEX) + 0.0001(SATV)]^2$$

1974 Freshmen (Blacks & Whites)

Variables	Multiple R	R^2	r	Beta
High School Rank	0.18433	0.03398	-0.18433	-0.18927
Residency Status (out)	0.25319	0.06410	0.14914	0.15972
Race (white)	0.26577	0.07063	0.14024	0.07582
Major (undecided)	0.26762	0.07162	-0.04684	-0.03322
High School Size	0.26914	0.07243	0.05336	0.02826
Sex (female)	0.27053	0.07319	0.00850	-0.02609
SATV	0.27119	0.07354	0.13024	0.03023
PGA	0.27122	0.07356	0.18121	-0.02457
SATM	0.27133	0.07362	0.13742	0.01418

$$PGE = [1.364 - 0.720(HSR) + 0.210(RES) + 0.113(RACE) - 0.038(MAJOR) + 0.0001(HSS) - 0.023(SEX) + 0.0001(SATV) - 0.024(PGA) + 0.0001(SATM)]^2$$

Notes:
1. High School Rank is coded in reverse so the negative signs are of no importance.
2. PGE computed by squaring the predictive equation for the graduation status variable; standard errors of the predictive equations are 0.46809 (blacks), 0.41528 (whites), and 0.42121 (both combined).

Table 4

Discriminant Analyses of Graduation Status of Black and White Freshmen Entering The University of North Carolina at Chapel Hill in 1974

1974 Black Freshmen

Significant Variables	Unstandardized Coefficients
Sex (female)	0.52170
Residency Status (out)	-2.16520
Major (undecided)	1.03106
High School Size	0.00149
High School Rank	6.19064
(Constant)	-1.34874

Classification Results:

			Predicted Graduation Status	
	Graduation Status	#	Non-Graduates	Gradautes
1.	Non-Graduates	111	68 (61.3%)	43 (38.7%)
2.	Graduates	151	50 (33.1%)	101 (66.9%)

Overall Percentage of Correct Predictions is 64.5%.

1975 White Freshmen

Significant Variables	Unstandardized Coefficients
Sex (female)	0.37073
Residency Status (out)	-2.34225
Major (undecided)	0.27842
High School Size	0.00096
High School Rank	6.54670
(Constant)	1.52991

Classification Results:

			Predicted Graduation Status	
	Graduation Status	#	Non-Graduates	Graduates
1.	Non-Graduates	549	342 (62.3%)	207 (37.7%)
2.	Graduates	1966	858 (43.6%)	1108 (56.4%)

Overall Percentage of Correct Predictions is 57.65%.

1974 Freshmen (Blacks & Whites)

Significant Variables	Unstandardized Coefficients
Sex (female)	0.34444
Race (white)	-1.13410
Residency Status (out)	-1.94310
Major (undecided)	0.31536
High School Size	0.00047
High School Rank	6.03855
(Constant)	3.04532

Classification Results:

			Predicted Graduation Status	
	Graduation Status	#	Non-Graduates	Graduates
1.	Non-Graduates	660	322 (48.8%)	338 (51.2%)
2.	Graduates	2117	640 (30.2%)	1477 (69.8%)

Overall Percentage of Correct Predictions is 64.78%.

that six years of data are included rather than the five years reflected in the regression analyses; for preliminary purposes, which this entire study represents, this does not seem to be a significant difference.

Discriminant analysis was chosen both because it is a different way of looking at the data which seems more suited than regression to a dichotomous dependent variable and because it readily computes the success rate of the derived prediction equations. This latter feature is the focus of this discussion.

As seen in Table 4 the percentage of correct predictions when applied to the same basic data from which the predictions were derived vary from 57.65% for whites to 64.78% for blacks and whites combined (percentage for blacks alone is 64.5%). While these percentages suggest an improvement over sheer chance prediction, they may not be as helpful as they seem at first glance because 76% of all students had graduated and one might have obtained a higher percentage of correct choices merely by guessing that everyone graduated. Thus, the results do not suggest that the predictive graduation equations are of much practical use for admission's offices, at least as represented here.

Conclusions

As stated above the results from this study do not offer much help to admission's officers as they attempt to evaluate applicants for the freshman class. They do, nevertheless, reinforce strongly the general applicability of the criteria used by admission's offices in deciding which students to admit as they tend to demonstrate that high school rank in class and SAT scores are positively related to success in college and actual completion of the bachelor's degree.

Three reasons can be advanced to attempt to explain the failure of this research to provide useful predicted graduation equations. First, the variables selected to explain variation in who graduates may not be the ones which really

make a difference. The variables used were chosen primarily because they were readily available and, while they make sense from a theoretical perspective, they are not all-inclusive and a number of other factors could be suggested as possibly related to persistence to graduation. Along this line we are in the midst of a long range study which includes other factors which we hope will be related to eventual graduation; these data, however, will not be available for study until 1983 at the earliest.

The second possible reason for the poor predictive performance of these findings is the pre-selection of the population studied. Not only were these students some of the most able high school graduates in the state and nation, but they also had been vigorously screened and selected by the admission's office so that the study examined only those students who already had a high chance of graduation. If one could arrange an experimental design situation in which a group of students were admitted randomly, then one would probably find a much more reliable set of predictors of graduation.

Third and finally, the findings suggest that graduation from college may be the result of a wide range of factors and experiences which vary greatly from student to student and which are impossible to predict in simple, straightforward fashion. Studies (2,4) of the reasons students give for leaving college before graduation generally have not unearthed any clear, consistent rationale explaining the phenomenon, and this may be why we are not able to predict with any high degree of success just who will graduate or who will drop out.

An inability to predict who will graduate from college does not negate either the validity of the I/O model and its significance for college admissions or the need for further research in this area. As input becomes scarcer over the next decade, retaining students will become a viable tactic for maintaining enrollment

levels (8) and retention efforts will be aided by any indicator of eventual graduation. Colleges and universities should be cautious of adopting predicted graduation equations of marginal validity, but even a modest predictive capability will provide the institution with more information about freshman applicants than it currently possesses.

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