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Predicting Success in the Master of Business Administration Program at the University of New Mexico

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MASTER OF BUSINESS ADMINISTRATION

PREDICTING SUCCESS IN THE MASTER OF BUSINESS ADMINISTRATION PROGRAM AT THE UNIVERSITY OF NEW MEXICO

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PREDICTING SUCCESS IN THE MASTER OF BUSINESS ADMINISTRATION PROGRAM AT THE UNIVERSITY OF NEW MEXICO

BY
JAMES DEE ROSE
B.S., Nevada Southern University, 1968

THESIS

Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Business Administration
in the Graduate School of
The University of New Mexico
Albuquerque, New Mexico
June 1970

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PREDICTING SUCCESS IN THE MASTER OF BUSINESS ADMINISTRATION PROGRAM AT THE UNIVERSITY OF NEW MEXICO

BY
James Dee Rose

ABSTRACT OF THESIS

Submitted in Partial Fulfillment of the
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ABSTRACT

The purpose of this study was to determine whether or not success in the Master of Business Administration (M.B.A.) program at the University of New Mexico could be predicted from known variables. These variables were both intellective and non-intellective and included such things as:

1. Undergraduate grade point average (g.p.a.)
2. Upper-division g.p.a.
3. Major g.p.a. for business majors.
4. Score on Admissions Test for Graduate Study in Business (A.T.G.S.B.).
5. Age.
6. Graduate g.p.a.
7. Undergraduate major.
8. Type of undergraduate institution and whether or not it was the University of New Mexico.
9. Student status (part-time or full-time).
10. Marital/veteran status.

The total sample consisted of 216 students who entered the M.B.A. program at the University of New Mexico between June 1, 1964, and June 1, 1969, and who earned at least three hours of graduate credit. There were 54

successes, 115 failures, and 47 students in progress. The in progress students were included only when the A.T.G.S.B. was being considered.

Through the use of multiple step-wise regression, it was determined that the A.T.G.S.B. had a higher correlation with the graduate g.p.a. (r = .36) than did either the undergraduate or upper-division g.p.a. The set of variables which yielded the highest multiple correlation coefficient consisted of the undergraduate and upper-division g.p.a.'s, the A.T.G.S.B., and age (R = .415).

Analysis of variance was used to determine whether or not significant statistical differences existed between the sub-groups of the category variables based on each of the continuous variables. It was determined that when certain continuous variables are being considered, some category sub-groups should be considered as being heterogeneous.

Multiple discriminant analysis was used to assign members of the sample to either the success or failure group based on one or more of the following variables: undergraduate g.p.a., upper-division g.p.a., and A.T.G.S.B. score. While there were not sufficient data available to conclude that the A.T.G.S.B. is more accurate in predicting either success or failure in the M.B.A. program than the undergraduate g.p.a., it appears to be at least as good as the g.p.a.

In conclusion, the findings of this study suggest that if the criteria for admission into the M.B.A. program are to be aimed at admitting as many potential successes as possible, non-intellective variables as well as intellective variables must be considered. In particular, it was found that full-time students were more likely to be successful than were part-time students; and married veterans and single non-veterans were more likely to be successful than were single veterans or married non-veterans.

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Chapter 1

INTRODUCTION

As the number of applicants to graduate schools increases,[1] the question as to which students are to be admitted becomes increasingly more difficult to answer. And, since graduate facilities are generally rather limited, it becomes of the utmost importance that these limited resources be allocated in the most efficient manner.

Thus, the problem facing administrators of graduate schools today is that of determining which students are most likely to be successful in graduate school, i.e., earn an advanced degree. The problem of predicting success is further complicated in the case of Master of Business Administration (M.B.A.) programs, since most of these programs are designed for holders of bachelor's degrees in any field of study. It is not at all uncommon to find persons holding undergraduate degrees in such diversified fields as history, math, engineering, foreign languages, education, economics, and, of course, business, pursuing the M.B.A. degree.

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[1]Neva A. Carlson, "Statistics of the Month: Bachelor's and Higher Degrees Conferred, 1958 to 1968," American Education, V (June-July, 1969), 29.

While there have been some studies made dealing with the prediction of academic success on the graduate level, most of these studies have been done in those areas where undergraduate and graduate areas of concentration have been the same. Thus, it is questionable whether the results of such studies can be generalized to M.B.A. programs.

Statement of the Problem

The problem with which this paper will deal is that of determining the possibility of predicting success in the M.B.A. program at the University of New Mexico on the basis of selected data available at the time of admission.

Theoretical Considerations

The underlying theory of this study is that man possesses an innate motivation toward competence.[2] Ruch calls this innate motivation the need for achievement and defines it "operationally as behavior which shows effort to do one's best, to do better than others, or, in general, to accomplish something."[3]

Furthermore, as discussed in Chapter 2, it is theorized that known levels of achievement can be used to predict future levels of achievement. In this respect,

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[2]R. W. White, "Motivation Reconsidered: The Concept of Competence," Psychological Review, LXVI (1959), 297-333.

[3]F. L. Ruch, Psychology and Life (7th ed.; Glenview, Illinois: Scott Foresman, 1967), p. 398.

achievement becomes a positive motivator for higher levels of achievement. Morgan, in discussing the role of achievement as a motivator, states that "how strong the motive is depends, in part, on how successful one has been." Morgan also suggests that achievement is a very powerful motivator in the culture of the United States.[4]

Another theory involved in this study is that of prediction. In simple terms, the theory of prediction states that if a particular relationship between an independent variable (X) and a dependent variable (Y) is known to exist for one group, then Y can be predicted for a second group with similar characteristics simply by knowing X.[5]

The relationship between the two variables can be expressed as "a measure of the tendency of two things to vary together, to be associated or correlated." This measure is called the correlation coefficient. While the correlation coefficient is not "directly translatable into any other coefficient or estimator," one can, by the magnitude and slope of the coefficient, get some idea about the relationship it describes.[6]

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[4]Clifford T. Morgan, Introduction to Psychology (2nd ed.; New York: McGraw-Hill, 1961), pp. 96-97.

[5]W. S. Ray, Basic Statistics (New York: Appleton-Century-Crofts, 1968), p. 104.

[6]K. Hope, Elementary Statistics: A Workbook (New York: Pergamon Press, 1967), pp. 4-7.

Furthermore, one can, through the technique of multiple regression analysis, determine the relationship between "a single variate on the one hand and the sum of two or more variates on the other..."[7] Thus, multiple regression analysis can be used to determine which group of independent variables is most related to a particular dependent variable. The underlying aim of the multiple regression technique is to compile a multiple correlation coefficient (R) that is larger than, and, consequently, a better predictor than, a simple correlation coefficient (r).

The theories of prediction and need for achievement, then, suggest that future academic success can be predicted from measured levels of past academic achievements and related variables.

Purpose and Significance

The purpose of this study is to determine whether or not a significant statistical relationship exists between selected background variables and academic success in the M.B.A. program at the University of New Mexico.

If a positive relationship between any of these variables and academic success does exist, these variables can then be used as predictors of success. Such predictors would be of significant value to administrators faced with the task of deciding whom should be admitted to a M.B.A.

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[7]Philip H. DuBois, Multivariate Correlational Analysis (New York: Harper and Brothers, 1957) p. 191.

program. Not only should such predictors lead to greater accuracy and, therefore, greater confidence in the selection process, but knowing which key variables to consider should lead to a great savings in time.

Even a cursory examination of the application form used by the Graduate School of the University of New Mexico reveals that most questions or requests for information are for identification and record-keeping purposes rather than for evaluation of the applicant's qualifications for admission. It would, then, be valuable to know which of the requested bits of information, if any, merit attention in the screening process for admission.

Moreover, this study also seeks to determine whether or not the entrance requirements now in effect are, indeed, related to success in the M.B.A. program at the University of New Mexico. If there is no significant statistical relationship between background variables and success in the M.B.A. program, then steps should be taken to develop a more meaningful and accurate set of criteria for admission into the program.

Through the use of multiple linear step-wise regression, it is possible not only to determine the relationship between a group of independent variables and a criterion variable, but also to determine which combinations of the independent variables account for most of the variance between the independent and criterion variables. An example of this would be where the multiple correlation coefficient

($\underline{R}$) between $\underline{X}_2$, $\underline{X}_3$, $\underline{X}_4$, $\underline{X}_5$, and $\underline{X}_1$ is .65. Depending upon the cost (in terms of either time or money, or both) of gathering the information represented by $\underline{X}_4$ and $\underline{X}_5$ relative to the value of that information in terms of the marginal amount of variance explained, one may choose to use only the $\underline{R}$ found by $\underline{X}_2$ and $\underline{X}_3$.

Hypothesis

There will be a significant statistical relationship between certain background variables and success in the M.B.A. program at the University of New Mexico.

Definitions

By academic success is meant the earning of the M.B.A. degree. Failures will be those students who have failed to earn the degree, either as a result of (1) failing the final comprehensive or oral exams, (2) being disqualified from the program for academic reasons, (3) exceeding the five year time limitation, or (4) not maintaining continuous enrollment during the Spring Semester of 1969. Those students enrolled during the Spring Semester of 1969 but who have not yet earned the M.B.A. degree will be considered as "in progress."

All grade point averages (g.p.a.'s) will be expressed on a scale of A = 4.0, B = 3.0, C = 2.0, D = 1.0, and F = 0.0.

Population and Sample

The population will be all students who have been admitted to the M.B.A. program at the University of New Mexico between June 1, 1964, and June 1, 1969.

The sample will include all members of the population who have earned credit in the M.B.A. program except:

1. Foreign students: those students who did not receive at least two years of high school education in the United States (this does not apply to dependents of American military personnel).
2. Students holding more than one bachelor's degree.
3. Students already holding an advanced degree.
4. Students who were originally admitted to the Graduate School for a program other than the M.B.A. program, but who subsequently changed to the M.B.A. program.

Scope and Limitations

As stated earlier, the purpose of this study is to determine whether a significant statistical relationship exists between selected background variables and success in the M.B.A. program at the University of New Mexico. The aim of this study, then, is to provide those persons responsible for making decisions as to whether or not to admit students to the Graduate School with information which will be useful in the majority of cases.

Since most applicants for admission are those holding only a bachelor's degree, this study will limit itself to those students who have earned only one bachelor's degree and who have not already earned an advanced degree. It is felt that those persons holding more than one bachelor's degree or an advanced degree would, because of their achievements, necessarily have to be evaluated in a different light than the more typical applicant who holds but one bachelor's degree and has not yet earned a master's degree.

Furthermore, this study will not include those students who enrolled for classes but subsequently withdrew prior to earning any graduate credit. Even though it is recognized that these "non-earners" are germane to the problem at hand, i.e., the efficient allocation of resources, it is felt that an attempt to analyze their performance is beyond the scope of this study. In examining student records there was no case encountered where a student was given the grade "WF" (withdrew while failing), and, consequently, any conjecture about why the student withdrew or his ability to do graduate work would be almost entirely subjective.

However, the problem of the "non-earner" is not one to be ignored. Indeed, the School of Business and Administrative Sciences should consider this as a priority research project, since classroom scheduling, faculty teaching loads, etc., are all based on enrollment figures and not the number of students who complete the courses.

Finally, this study will not include foreign students, even though they, too, pose a definite problem to the faculty of the M.B.A. program. It would seem that a standardized battery of admission tests such as the Admissions Test for Graduate Study in Business and the Test for English as a Foreign Language would be helpful in determining a foreign student's abilities and qualifications for pursuing an advanced degree in business administration.

Chapter 2

REVIEW OF THE LITERATURE

While there has been a considerable amount of work done in the field of predicting academic success, the bulk of it has been aimed at predicting success at the undergraduate level; relatively little has been done in the way of predicting success at the graduate level. The studies that have been conducted were aimed at predicting success from measured intellective or non-intellective variables by use of statistical analysis.

This review, then, will be aimed at examining the literature in terms of which criterion (dependent) variables were used, the types of independent variables (intellective or non-intellective) used, the samples used, and the statistical tools used.

Criterion Variables

The choice of the criterion variable is extremely important in studies which seek to determine correlation between certain independent variables and a criterion, or dependent, variable. In this particular area of study, the criterion variable can be expressed either in the simple dichotomy of success and failure, i.e., either receiving or not receiving the graduate degree, or a multi-step

gradation can be used.

In a study by Bundy, where success was defined as receiving the doctorate, selected variables such as age, g.p.a. in master's program, location of bachelor's and master's institutions, types of those institutions, areas of study in the bachelor's and master's programs, etc., were found, through the use of multiple regression analysis, to have no significant relationship with success.[1]

But, in other studies which measured degrees or levels of success, some of these variables were found to be related to the higher levels of success. Thus, if key variables which can be used as predictors of graduate academic success are to be determined, it is critical that the criterion of success be adequately defined.

Most attempts to gradate success have used g.p.a. as the yardstick against which achievement levels are measured. Some studies, however, have attempted to supplement this with another dependent variable. Three of these studies, by Owens and Roaden; Platz, McClintock, and Katz; and Nunnery and Aldmon, used both g.p.a.'s and advisor or faculty ratings

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[1]S. M. Bundy, "Prediction of Success in the Doctoral Program of the School of Education of the University of Southern California," Dissertation Abstracts, XXVIII (1968), p. 4523-A.

as dependent variables.[2] The validity of the latter variables is somewhat suspect, though, since they are highly susceptible to personal biases and rater inconsistency. It is probably for these reasons that the large majority of studies used only the g.p.a. as the measure of success.

In addition to properly defining the criterion variable, it is equally important that the problem be well defined, and in such a manner that that which is proposed to be tested is tested. Watley illustrated the importance of carefully defining the problem when he showed that "divergent results can be obtained when the problem is stated differently."[3]

Independent Variables

Studies which have sought to determine which background variables are related to success in undergraduate work have generally concluded that high school g.p.a.'s are closely

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[2]T. R. Owens and A. L. Roaden, "Predicting Academic Success in Master's Degree Programs in Education," Journal of Education Research, LX (1966), 124-26; A. Platz, C. McClintock, and D. Katz, "Undergraduate Grades and MAT as Predictors of Graduate Success," American Psychologist, XIV (1959), 285-89; M. Y. Nunnery and H. E. Aldmon, "Undergraduate Grades as Indicators of Success in Master's Degree Programs in Education," Personnel and Guidance Journal, XLIII (1964), 280-86.

[3]D. J. Watley, "Note on the Problem of Determining the Most Effective Predictor Variables in Multiple Regression," Journal of Experimental Education, XXXII (1964), 307.

related to undergraduate g.p.a.'s. It was only natural, then, that when attempts to predict academic success on the graduate level were made, undergraduate g.p.a.'s were used as predictor variables.

Not surprisingly, several studies have confirmed this relationship. But the researchers seemed hesitant (and rightly so) to accept such evidence as being conclusive. They sought to determine the influence of other variables, both intellective and non-intellective, upon graduate performance. The results of these efforts have generally shown that the undergraduate g.p.a. accounts for more of the variance in graduate g.p.a.'s than any other single variable.

The Roaden and Owens study, using multiple regression analysis, sought to determine whether there were any statistically significant correlations between such background variables as total undergraduate g.p.a., upper-division undergraduate g.p.a., score on the Ohio State University Psychological Test, score on the Watson-Glaser Critical Thinking Appraisal Test, size of the undergraduate institution, type of undergraduate institution (public or private), whether or not the undergraduate degree was taken from the same institution as the master's, and graduate g.p.a.'s and advisor ratings. The sample consisted of 171 students who earned master's degrees in education at Ohio

State University during the school year 1962-1963.[4]

The results of this study revealed that there was a direct proportional increase between the levels of undergraduate and graduate g.p.a.'s (r = .33). The difference between the total undergraduate g.p.a. and that computed only for upper-division courses was very slight. Thus, the single most useful predictor for graduate academic success was the undergraduate g.p.a.[5]

Other studies, however, have shown that there may be some value in using either the g.p.a. for upper-division work or for work in the major field to predict graduate success. One study found that while the total undergraduate g.p.a. distinguished between the highest and lowest graduate g.p.a. achievers, those students with the higher g.p.a.'s tended to also have significantly higher upper-division undergraduate g.p.a.'s (F = 16.21, significant beyond the .01 level of confidence).[6]

A later study found that the best predictor for success in graduate work in psychology was the g.p.a. for undergraduate work in the field of psychology (r = .52).

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[4]Owens and Roaden, "Predicting Academic Success," pp. 124-26.

[5]Ibid.

[6]Nunnery and Aldmon, "Undergraduate Grades," pp. 280-86.

The conclusion drawn by this study was that the reason this particular g.p.a. was better than scores on the Graduate Record Examination was that the latter test merely indicated aptitude, whereas the former variable was an indication of actual achievement.[7]

There are, however, cases where aptitude or ability test scores are better predictors than any measured levels of achievement. Boring, for instance, found that the Army General Classification Test was much more useful in predicting success in tank-mechanics school during World War II than was the number of grades completed in school.[8] In this particular case, the activity being predicted (performance in tank-mechanic school) was not directly related to the activity being used as the predictor (performance in school). The classification test, on the other hand, was an intelligence (ability) test designed especially for the Army.

Inasmuch as performance on an ability test is, in itself, an act of achievement, the ability test becomes essentially a sampling technique. The aim of the ability

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[7]G. Stricken and H. T. Huber, "GRE and Undergraduate GPA as Predictors of Success in Graduate School," Journal of Education Research, LX (1967), 466-68.

[8]E. G. Boring, Psychology for the Armed Services, (Washington, D.C.: Combat Forces Press, 1945), p. 242, cited by C. T. Morgan, Introduction to Psychology, p. 429.

test is to measure levels of various skills and experiences (achievement) and to express the results as an index which is meaningful for prediction purposes.

In a discussion of the difference between the concepts of ability and achievement tests, Morgan said:

> . . . ability refers to something a person can do, not necessarily what he has done or will do. The word achievement, on the other hand, refers to what he has done . . . . The distinction, then, between ability tests and achievement tests is a subtle one. Both measure achievement, but the ability test is designed and interpreted as a prediction of future achievement, whereas the achievement test is used to measure present knowledge or accomplishments.[8]

This does not, however, preclude using achievement tests or, in the case of a g.p.a., a composite of a number of achievement tests as predictors of future achievement. In fact, in cases where the activity being predicted is similar to the activity being used as the predictor, it is logical that past achievement would be as good (or better) a predictor of future achievement than would an index of ability, since, as pointed out earlier, the ability index is nothing more than a sampling of past achievements.

The primary consideration for ability or aptitude tests is, of course, whether or not they are valid, i.e., do they measure what they claim to measure. But even if an aptitude or ability test is valid, it should be determined whether or not the test contributes to the predictive process.

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[9]Morgan, Introduction to Psychology, p. 437.

Eckhoff, through the use of step-wise multiple regression analysis, found that the undergraduate g.p.a. was more related to graduate academic success than either the Graduate Record Examination or the Miller's Analogies test. Eckhoff's study, which sought to determine which pair of variables was the best predictor for a group of secondary education majors and a group of elementary education majors, found that the undergraduate g.p.a. was part of the optimum result in both samples, even though the results were not the same.[10]

When the undergraduate g.p.a. and scores on both the Graduate Record Examination and Miller's Analogies Test were used, a correlation coefficient of .52 was obtained for the group of 185 secondary education majors. However, when just the g.p.a. and Miller's Analogies Test score were used, the correlation coefficient decreased to only .51. For the group of 111 elementary education majors, the correlation coefficient was .30 whether all three variables were used or only the g.p.a. and Graduate Record Examination.[11]

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[10]C. M. Eckhoff, "Predicting Graduate Success at Winona State College," Education and Psychological Measurement, XXVI (1966), 483-85.

[11]Ibid.

Another study of 175 graduate students at Utah State University found that "the Graduate Record Examination has little predictive validity for a relatively unstructured sample of graduate students in education."[12]

There also appear to be grounds for not using scores of Miller's Analogies Tests for predicting academic success at the graduate level. Platz, McClintock and Katz found that in a sample of 124 psychology students taking the doctorate, the best single indicator of success was the g.p.a. for undergraduate courses in science and math (r = .49, significant at the .01 level of confidence). The Miller's Analogies Test scores showed little correlation with success using Pearson product moment and multiple correlation.[13]

When considering the M.B.A. program, the question of which student will perform best, the one with the business or non-business background, presents itself. While it would seem that the student with a background in business would do better work at the graduate level in business, at least one study has found this not to be the case.

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[12]W. R. Borg, "GRE Aptitude Scores as Predictors of GPA for Graduate Students in Education," Education and Psychological Measurement, XXIII (1963), 379.

[13]Platz, McClintock, and Katz, "Predictors of Graduate Success," pp. 285-89.

Harris constructed a model for predicting success in a M.B.A. program. Using twelve variables which were a part of the application form, he sought to answer the following questions: "(1) What is the likelihood that this applicant could successfully complete the M.B.A. program and graduate?", and "(2) What would be the extent of the applicant's success in the program?" The results of this study of Michigan State students showed that the M.B.A. student with a non-business undergraduate education was likely to be more academically successful than the student with a business background. Other variables which were measured and found to be related to academic success were: undergraduate g.p.a., score on Admissions Test for Graduate Study in Business, whether or not undergraduate work was done at Michigan State, age, marital status, and whether or not the student delayed before beginning the M.B.A. program.[14]

In an effort to validate his results, Harris categorized those students entering the program after 1966 according to his earlier findings and then checked to see if his predictions came true. When a particular level of academic performance was predicted, Harris was accurate in 53.2 percent of the cases. However, when students were

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[14]R. G. Harris, "A Classification Model for Predicting Academic Performance for the Master of Business Administration Students at Michigan State University," Dissertation Abstracts, XXIX (1968), 1710-A.

predicted as being either graduates or withdrawals, the rate of accuracy increased to 78.9 percent.[15]

Statistical Analysis

Seven of eight studies reviewed used the statistical tool of multiple regression while the eighth used the F-test statistic and Kramer's extension of Duncan's Multiple Range Test.[16] Another study found that Hotelling's canonical correlation "does not provide more adequate prediction of academic achievement, nor is it more logically defensible" than multiple correlation.[17]

Summary

Based on findings in the literature, the most useful way to further classify the dependent variables of success and failure (completion and non-completion of the degree) is on the basis of graduate g.p.a.

Among the more important independent variables to be considered are undergraduate g.p.a., upper-division g.p.a.,

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[15] Ibid., p. 1711-A.

[16] Nunnery and Aldmon, "Undergraduate Grades," pp. 280-286.

[17] A. H. Bayes, "An Application of Hotelling's Canonical Correlation to Academic Prediction," Dissertation Abstracts, XXIX (1969), 2512-A.

undergraduate major, age, type of undergraduate institution, and whether the graduate degree is earned at the same school as the undergraduate degree. Furthermore, intellective variables are more closely related to academic success than are non-intellective variables.

The best predictions of academic performance apparently are those obtained through multiple regression analysis. However, multiple discriminate analysis can be useful in predicting merely whether a student is most likely to fail or succeed.

The review of literature has revealed that the undergraduate g.p.a. is generally the best single predictor of academic success at the graduate level. In some cases, correlation coefficients of a sufficient magnitude to reasonably improve prediction were found. However, due to the somewhat contradictory findings of other studies, the results of the former cannot be generalized to populations in general. In fact, it appears that the field of higher education consists of many heterogeneous populations rather than a few homogeneous populations.

For example, the "field" of education can (and must) be broken down in terms of elementary education, secondary education, etc. And, as pointed out by the Stricken and Huber and the Platz, McClintock, and Katz studies, program content can cause heterogeneous populations to occur within an otherwise homogeneous field (population).

Therefore, even though some of the studies reviewed found correlation coefficients which could be considered valid for prediction purposes, they were probably valid only for specific populations. And, several of the studies reviewed obtained correlation coefficients which were only marginally valid for prediction, if at all.

Furthermore, the review of literature has shown that the majority of work done in this field has been done by students in colleges of education about students in colleges of education. The question which now must be answered is whether or not these findings apply to graduate schools of business.

Chapter 3

RESEARCH DESIGN

Introduction

This study seeks to answer three basic questions:

1. Are certain intellective variables related to graduate g.p.a., and, if so, to what extent are they related?

2. Are selected non-intellective variables related to the achievement of the M.B.A. degree?

3. Can success in the M.B.A. program at the University of New Mexico be predicted from known intellective variables?

Attempts will be made to answer these questions either in whole or in part, by analyzing selected data using various statistical techniques. In essence, this study will try to determine whether or not certain dependent and independent variables are related and, if so, the extent to which they are related.

Variables Considered

Data were gathered about eight or more of thirteen different variables for each member of the population. The variables for which measurements were obtained are:

1. Overall undergraduate g.p.a.

2. Upper-division undergraduate g.p.a.; the g.p.a. for approximately the last sixty semester hours or ninety quarter hours.

3. Undergraduate g.p.a. in the major field for business graduates only.

4. Graduate g.p.a. for students earning nine or more hours of graduate credit.

5. Combined scores for the Admissions Test for Graduate Study in Business (A.T.G.S.B.).

6. Age at the time of admission to the Graduate School at the University of New Mexico.

7. Undergraduate major; categorized as (a) business, (b) engineering, and (c) other.

8. Type of undergraduate institution; public (state supported) or private.

9. Whether or not the undergraduate institution was the University of New Mexico.

10. Marital status at time of admission; classified as either "married" or "single." Divorces were considered as "single."

11. Veteran or non-veteran; students currently on active duty as well as those with prior military service were classified as "veterans."

12. Full-time or part-time student; full-time students were those students who earned at least one half of their graduate credit hours at the rate of nine or more hours per semester.

13. Whether or not the student was a "success" or "failure" in the M.B.A. program, or is still "in progress."

Continuous and Category variables. In order to lend themselves to statistical analysis, data need to be expressed as either continuous or category variables. Continuous variables are those which can be stated as certain values along a known continuum, such as g.p.a.'s or age.

Category variables, on the other hand, are sets containing two or more mutually exclusive elements. The "yes-no" case is an example of a category variable; the variable can be classified as either yes or no, but not both.

The six continuous variables used in this study are: (1) undergraduate g.p.a., (2) upper-division undergraduate g.p.a., (3) g.p.a. in major subject for students who were undergraduate business majors, (4) graduate g.p.a., (5) A.T.G.S.B. scores, and (6) age.

Five category variables were used in this study. They are as follows:

1. Whether the undergraduate institution was (a) the University of New Mexico, (b) not the University of New Mexico, but public, or (c) not the University of New Mexico and private.

2. Whether the undergraduate major was (a) business, (b) engineering, or (c) other.

3. Whether or not the student was (a) married and a veteran, (b) married and a non-veteran, (c) single and a

veteran, or (d) single and a non-veteran.

4. Whether the student was (a) a full-time student, or (b) a part-time student.

5. Whether the student was (a) a success, (b) a failure, or (c) in progress.

Intellective and non-intellective variables. In general, the variables for which data were collected can be classified as either intellective or non-intellective. Intellective variables are those related to scholastic achievement or ability. In other words, they are measures of performance. Non-intellective variables, on the other hand, are those which are not affected (at least directly) by a student's intellectual ability or performance.

The intellective variables used in this study are:

1. Undergraduate g.p.a.
2. Upper-division undergraduate g.p.a.
3. Business graduates' undergraduate g.p.a.
4. A.T.G.S.B. score.
5. Graduate g.p.a.
6. Success or failure.

While it can be argued, and rightly so, that non-intellective variables should not be used to predict specific intellective results, such as g.p.a.'s, they can, nevertheless, be useful in predicting general results such as success and

failure.[1] Hopefully, the non-intellective variables considered will be helpful in extending the predictive validity of the intellective variables.

In other words, the role of the non-intellective variables is to compile a profile of favorable and unfavorable characteristics about the sample. All other things being equal, students with more favorable characteristics would be admitted to the Graduate School before students with fewer favorable characteristics.

The non-intellective variables are:

1. Type of institution and whether it was the University of New Mexico.
2. Undergraduate major.
3. Age.
4. Marital status.
5. Veteran or non-veteran.
6. Full-time or part-time student.

Dependent and independent variables. The last way in which the selected variables are divided is in terms of whether they are dependent (criterion) variables or independent (predictor) variables. The dependent variables are the graduate g.p.a. and whether the student was a success or failure. All the other data are used to try to predict the criterion variables.

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[1]Harris, "Classification Model for Predicting Academic Performance," p. 1710-A.

Analysis of Data

Various statistical techniques were used in analyzing the data. General statistics, including the mean, standard deviation, and number were computed for all continuous variables.

Simple regression analysis produced Pearson product correlation coefficients for the continuous variables. Multiple linear step-wise regression was used to compile a battery of predictor variables which could be used for predicting graduate g.p.a.'s.

One-way analysis of variance was used to determine whether or not the members of the sample probably came from the same parent population, based on the category variables. Analysis of variance tests the differences between or among continuous variables, based on category variables, to determine whether or not the means of the sub-groups are equal.

Analysis of variance was also applied to the various regression equations in an effort to determine whether or not the relationship between the independent and dependent variables being used in the regression equation was statistically significant.

Multiple discriminant analysis was used to predict whether a person was likely to be either a success or failure, based on knowledge of certain variables.

Chapter 4

FINDINGS

Introduction

The purpose of this chapter is to report the findings of the investigation. Therefore, this chapter represents a nonevaluative analysis of the data.

The total sample for this study consisted of 216 students who had enrolled in the M.B.A. program at the University of New Mexico between June, 1964, and June, 1969, and who earned at least three hours of graduate credit. The sample was made up of 54 "successes," 115 "failure," and 47 students "in progress."

The bulk of the analysis deals only with the categories of success and failure. The "in progress" category is used as part of the study only when the A.T.G.S.B. scores are being considered. The reason for this is because A.T.G.S.B. scores have only recently begun to be required for admission to, and continued participation in the M.B.A. program. Therefore, it was necessary to include the scores of the in progress students in order to have a sufficient number of scores to analyze.

Category Variables

Members of the sample were categorized according to five category variables. Two of these categories were associated with the undergraduate backgrounds of the sample, and the remaining three reflected information about their graduate careers.

Table 4.1 gives a breakdown of the sample population according to the two categories associated with undergraduate backgrounds. The two variables are: (1) the type of undergraduate institution attended and whether or not it was the University of New Mexico, and (2) the undergraduate major.

Table 4.1. Undergraduate Backgrounds of Students in the M.B.A. Program at the University of New Mexico, 1964-1969

Category	Success N=54	Failure N=115	Total N=169
Undergraduate School and Type			
U.N.M.	30	33	63
Public/not U.N.M.	13	50	63
Private	11	32	43
Undergraduate Major			
Business	34	82	116
Engineering	10	17	27
Other	10	16	26

Further analysis of the data from which Table 4.1 was compiled reveals the following information:

1. Of the 63 graduates of the University of New Mexico who entered the M.B.A. program, 30, or about 47 percent, earned the M.B.A. degree.

2. Of the 82 non-University of New Mexico graduates who entered the program, only 24, or about 29 percent, earned the M.B.A. degree.

3. Graduates of the University of New Mexico accounted for 55 percent of the success group, but only 37 percent of the total sample.

4. Over 68 percent of the total sample consisted of business majors, but only 63 percent of the successes came from this group.

5. Of the 30 University of New Mexico graduates who were successes, 21 (70 percent) were business majors.

A breakdown of the sample according to the three background variables related to graduate school is presented in Table 4.2. The three variables are: (1) marital/veteran status, (2) student status (full-time or part-time), and (3) the dependent variables of success and failure.

Table 4.2. Graduate Backgrounds of Students in the M.B.A. Program at the University of New Mexico, 1964-1969

Category	Success N=54	Failure N=115	Total N=169
Marital and Veteran Status			
Married/Veteran	18	32	50
Married/Non-Veteran	9	45	54
Single/Veteran	6	12	18
Single/Non-Veteran	21	26	47
Student Status			
Full-time	44	27	71
Part-time	10	88	98

Closer analysis of the data presented in Table 4.2 reveals that of the 44 successes who were full-time students, 33, or 75 percent, were either single non-veterans (21) or married veterans (12). In addition, 24 of the 44 (54 percent) were graduates of the University of New Mexico; and of those 24, 16 (67 percent) were business majors.

Continuous Variables

Measurements for three or more of the six continuous variables were recorded for each member of the sample population. The means ($\bar{X}$), standard deviations (s), and number (N) in each sub-group of the five categories are presented in the following tables.

Table 4.3 presents the means and standard deviations for the undergraduate g.p.a. and the upper-division g.p.a. for the two categories related to undergraduate backgrounds.

Table 4.3. Means and Standard Deviations of Undergraduate and Upper-Division GPA for M.B.A. Students at the University of New Mexico, 1964-1969, Based on Undergraduate Background Variables

Category	N	$\bar{X}$ UGPA	s	$\bar{X}$ UDGPA	s
School and Type					
U.N.M.	63	2.61	.37	2.76	.38
Public	63	2.70	.39	2.82	.42
Private	43	2.61	.30	2.76	.35
Undergraduate Major					
Business	116	2.68	.39	2.86	.39
Engineering	27	2.54	.32	2.61	.39
Other	26	2.63	.29	2.74	.34

Table 4.4 presents the means and standard deviations of the same continuous variables for the three category variables associated with the students' graduate careers.

Table 4.4. Means and Standard Deviations of Undergraduate and Upper-division GPA for M.B.A. Students at the University of New Mexico, 1964-1969, Based on Graduate Background Variables

Category	N	$\bar{X}$ UGPA	s	$\bar{X}$ UDGPA	s
Marital/Veteran Status					
Married Veteran	50	2.67	.36	2.83	.43
Married Non-veteran	54	2.64	.39	2.82	.38
Single Veteran	18	2.57	.31	2.70	.26
Single Non-veteran	47	2.65	.36	2.78	.40
Student Status					
Full-time	71	2.62	.36	2.72	.39
Part-time	98	2.67	.36	2.85	.38
Dependent Category					
Success	54	2.67	.36	2.74	.41
Failure	115	2.63	.36	2.83	.38

The mean undergraduate g.p.a. for the total sample was 2.65 (N = 169, s = .36), and the mean upper-division g.p.a. was 2.80 (s = .39). Of the 169 successes and failures, 116 were business majors. Means and standard deviations for this group are presented in Table 4.5.

Table 4.5. Means and Standard Deviations of GPA in Major Field for Business Majors in the M.B.A. Program at the University of New Mexico, 1964-1969

Category	N	$\bar{X}$ BGPA	s
School and Type			
U.N.M.	47	2.74	.38
Public	45	2.97	.44
Private	24	2.76	.33
Marital/Veteran Status			
Married Veteran	28	2.93	.43
Married Non-veteran	40	2.88	.39
Single Veteran	11	2.61	.26
Single Non-veteran	37	2.77	.42
Student Status			
Full-time	53	2.74	.40
Part-time	63	2.91	.39
Dependent Category			
Success	34	2.83	.40
Failure	82	2.84	.41

The mean business g.p.a. for all business majors was 2.83 (N = 116, s = .40).

The ages of the students ranged from 21 to 59 with the mean age for the total group being 27.3 (N = 169, s = 7.07). Breakdown of the mean ages per category are presented in Table 4.6.

Table 4.6. Mean Ages for Different Groups of M.B.A. Students at the University of New Mexico, 1964-1969

Category	N	$\bar{X}$ Age	s
School and Type			
U.N.M.	63	26	5.60
Public	63	27	7.17
Private	43	28	8.63
Undergraduate Major			
Business	116	26	6.25
Engineering	27	30	8.05
Other	26	28	8.89
Marital/Veteran Status			
Married Veteran	50	31	7.91
Married Non-veteran	54	28	7.57
Single Veteran	18	25	3.11
Single Non-veteran	47	22	1.43
Student Status			
Full-time	71	25	6.59
Part-time	98	28	7.22
Dependent Category			
Success	54	25	4.93
Failure	115	28	7.79

Of the 169 students in the sample of successes and failures, 112 earned 9 or more hours of graduate credit, and graduate g.p.a.'s were computed for these persons. Of these same 169 students, only 41 (21 successes and 20 failures) had taken the A.T.G.S.B. Therefore, the A.T.G.S.B. scores for 39

students in progress were included in the sample for calculations including the A.T.G.S.B. scores. General statistics for these two variables, based on the two undergraduate background variables, are presented in Table 4.7.

Table 4.7. Means and Standard Deviations of Graduate GPA and ATGSB for M.B.A. Students at the University of New Mexico, 1964-1969, Based on Undergraduate Background Variables

Category	N	$\bar{X}$ GGPA	s	N	$\bar{X}$ ATGSB	s
School and Type						
U.N.M.	52	3.10	.59	33	507	87
Public	35	3.06	.59	27	510	76
Private	25	3.08	.56	20	494	98
Undergraduate Major						
Business	76	3.01	.58	51	485	76
Engineering	20	3.29	.47	18	553	89
Other	16	3.12	.64	11	515	96

General statistics for the graduate g.p.a.'s and A.T.G.S.B. scores of the sub-groups of the three category variables dealing with graduate work are presented in Table 4.8.

Table 4.8. Means and Standard Deviations of Graduate GPA and ATGSB for M.B.A. Students at the University of New Mexico, 1964-1969, Based on Graduate Background Variables

Category	N	$\bar{X}$ GGPA	s	N	$\bar{X}$ ATGSB	s
Marital/Veteran Status						
Married Veteran	34	3.28	.47	28	510	86
Married Non-veteran	28	2.93	.69	17	487	89
Single Veteran	12	2.87	.58	11	482	88
Single Non-veteran	38	3.07	.55	24	522	82
Student Status						
Full-time	67	3.16	.55	44	508	78
Part-time	45	2.95	.60	36	500	95
Dependent Category						
Success	54	3.35	.26	21	516	64
Failure	58	2.82	.67	20	455	69
In Progress[a]	--	--	--	39	525	94

[a] ATGSB scores only

The mean graduate g.p.a. for all 112 successes and failures was 3.07 (s = .58) and the mean A.T.G.S.B. score was 505 (N = 80, s = 85.5).

Summary

Thus far, it has been determined that:

1. Most successes were graduates of the University of New Mexico and had undergraduate degrees in business.

2. Students with undergraduate degrees in either engineering or another non-business field were more likely to be successful than were business majors.

3. A greater number and percentage of married veterans and single non-veterans were successes than were

either married non-veterans or single veterans.

4. A far greater number of successes were full-time graduate students, and, conversely, a far greater number of failures were part-time students.

5. Mean undergraduate and upper-division g.p.a.'s were somewhat below the standards recommended by the Graduate School of the University of New Mexico.

6. In all cases, the mean upper-division g.p.a.'s were higher than the mean undergraduate g.p.a.'s.

7. There was essentially no difference between the mean undergraduate major g.p.a. of business majors who were successful in earning the M.B.A. than for those who were not.

8. Married veterans were the oldest group, and single non-veterans were the youngest group.

9. Full-time students were younger than part-time students and successes were younger than failures.

10. There was little difference among graduate g.p.a.'s of the University of New Mexico graduates and those of other schools, both public and private, but there were marked differences among the graduate g.p.a.'s of business majors, engineering majors, and other majors.

11. Married veterans had the highest graduate g.p.a.'s, followed by single non-veterans, married non-veterans and single veterans, in that order.

12. Full-time students had higher graduate g.p.a.'s than did part-time students, and, of course, successes had higher graduate g.p.a.'s than failures.

13. Engineering majors had the highest A.T.G.S.B. scores and business majors the lowest.

14. Single non-veterans had higher A.T.G.S.B. scores than married veterans, married non-veterans, or single veterans, in that order.

15. Successes had higher A.T.G.S.B. scores than did failures, but the group of students in progress had the highest scores of all.

Chapter 5

DISCUSSION

Introduction

The preceding chapter was devoted to a non-evaluative presentation of the data collected about the sample. The current chapter is devoted to a rigorous analysis of the data in an attempt to answer the three questions posed earlier:

1. Are certain intellective variables related to graduate g.p.a.'s, and, if so, to what extent are they related?

2. Are selected non-intellective variables related to the achievement of the M.B.A. degree?

3. Can success in the M.B.A. program be predicted from known intellective variables?

Multiple regression analysis was used to try to answer the first question. The technique of multiple regression analysis is an extension of simple regression analysis and can be used to describe the relationship between a dependent variable and one or more independent variables.[1]

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[1]Thomas H. Wonnacott and Ronald T. Wonnacott, Introductory Statistics, (New York: John Wiley and Sons, 1969), p. 256.

Multiple regression analysis yields R, the multiple correlation coefficient, which "represents the maximum correlation between a dependent variable and a weighted combination of independent variables."[2] The multiple correlation coefficient can be interpreted in terms of R^2, which is the coefficient of multiple determination. R^2 signifies the proportion of variance in the dependent variable that is predicted by the entire regression equation.

The technique of one-way analysis of variance was used in an attempt to answer the second question. Analysis of variance tests the significance of the differences between two or more means. By computing the F ratio (through analysis of variance), it is possible to determine whether or not the sub-groups "could probably have arisen by random sampling from the same population of observations, or from two populations with the same variance."[3]

An attempt to answer the last question was made through multiple discriminant analysis. Discriminant analysis, by maximizing the heterogeneity between the two composite groups and minimizing the homogeneity, assigns members of a sample population to predetermined groups. In

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[2]J. P. Guilford, Fundamental Statistics in Psychology and Education, (4th ed.; New York: McGraw-Hill, 1965), p. 399.

[3]Ibid., p. 270.

addition, it also "assesses the potential adequacy of the procedure in a particular application."[4]

Multiple Regression Analysis

The objective of step-wise multiple regression analysis is to determine which set of independent variables contributes most to the variance of a particular dependent variable. It permits one to evaluate the marginal contribution of each independent variable in the computation of R^2.

In this case, the dependent variable was the graduate g.p.a., and the independent variables were the undergraduate g.p.a., the upper-division g.p.a., the major g.p.a. for business majors, the A.T.G.S.B. score, and age. An attempt was made to (1) determine which set of independent variables yields the highest R, (2) evaluate the set and isolate those variables which contribute the most to explaining the variance (from a marginal viewpoint), and (3) determine whether or not the dependent variable is related to the independent variables or if the correlation is merely one of chance.[5]

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[4]William S. Peters and George W. Summers, Statistical Analysis for Business Decisions, (Englewood Cliffs, New Jersey: Prentice-Hall, 1968), p. 402.

[5]This determination can be made by applying analysis of variance to the multiple regression.

Of the 169 students in the total sample, only 112 had earned at least 9 hours of graduate credit. Of the 112 students for whom a graduate g.p.a. was recorded, some were non-business majors and others had not taken the A.T.G.S.B. Therefore, it was necessary to perform multiple regression upon four different groups, based upon the number of variables recorded (the undergraduate and upper-division g.p.a.'s were recorded for every student).

The four groups were:

1. All students for whom a graduate g.p.a. was recorded ($N = 112$).

2. Those students having a graduate g.p.a. and an A.T.G.S.B. score ($N = 76$).

3. Those students having a graduate g.p.a. and a business g.p.a. ($N = 76$).

4. Those students having a graduate g.p.a., an A.T.G.S.B. score, and a business g.p.a. ($N = 46$).

The following statistics were computed for each multiple regression:

1. The mean ($\bar{X}$) and standard deviation (s) of each independent variable and the dependent variable.

2. The simple correlation coefficient (r) between each independent variable and the dependent variable.

3. The regression, or beta, coefficient.[6]

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[6]The beta coefficient is the weight which is applied to the raw score of the independent variables in order to derive the value for the dependent variable.

4. The standard error of the regression coefficient.[7]

5. The computed *t* value, which tests whether or not the particular simple correlation coefficient obtained is significant.

The first group to be analyzed consisted of all 112 students with graduate g.p.a.'s. In this case, only three independent variables were considered: the undergraduate g.p.a., and upper-division g.p.a., and age. Results of the multiple regression are presented in Table 5.1.

Table 5.1. Results of Multiple Regression Between Undergraduate GPA, Upper-division GPA, and Age and the Graduate GPA for 112 M.B.A. Students at the University of New Mexico, 1964-1969

Variables	$\bar{X}$	*s*	r_{xy}	Regr. Coef.	Std. Er. Coef.	*t*
UGPA	2.62	0.35	0.29	0.7160	0.2576	2.78
UDGPA	2.78	0.39	0.17	-0.2643	0.2330	-1.13
Age	27.07	7.50	-0.02	-0.0033	0.0071	-0.47
GGPA	3.08	0.58				

[7]The standard error of the regression coefficient can be used to test the null hypothesis that the particular independent variable in question contributes nothing to the prediction when its relationship to the other independent variables is taken into account.

The alpha coefficient for the regression equation was 2.023. The alpha coefficient represents the value at the point where the regression line crosses, or intercepts, the Y axis. It is, then, the constant value to which products of the individual independent variables multiplied by the beta coefficients are added in order to obtain the Y values. Standard error of the estimate for the regression equation was .559.

The multiple correlation coefficient between the three independent variables and the dependent variable was .309. However, when only two independent variables were used in the regression equation, the R dropped only to .306. In both cases the predictions based on knowledge of the independent variables were only about 10 percent better than if they had been made only on the basis of the known mean of the dependent variable (graduate g.p.a.). The coefficients of determination (R^2) for the two cases were .095 and .093 respectively.

Table 5.2 shows the various multiple correlation coefficients which were obtained by using different combinations of independent variables in the regression equation.

Table 5.2. Correlation Coefficients for Various Combinations of Independent Variables and the Graduate GPA for 112 M.B.A. Students at the University of New Mexico, 1964-1969

Variables	$\underline{R}$ or $\underline{r}$	$\underline{R}^2$ or $\underline{r}^2$	Std. Error Estimate
UGPA	.289	.0835	.557
UGPA, UDGPA	.306	.0936	.557
UGPA, Age	.291	.0847	.560
UDGPA, Age	.176	.0310	.576
UGPA, UDGPA, Age	.309	.0955	.559

From a marginal point of view, the most efficient predictor of graduate g.p.a. was the undergraduate g.p.a. As shown in Table 5.2, the $\underline{r}$ between the undergraduate g.p.a. and the graduate g.p.a. was .29, and, thus, it alone accounted for over 8 percent of the variance. In addition, the standard error of the estimate for the regression equation using only one independent variable was essentially the same as when three variables were used (.557 to .559 respectively).

A look at Table 5.3, which shows the inter-correlations of the independent variables, will help explain why the other two variables did not contribute much to the multiple correlation coefficient.

Table 5.3. Intercorrelations Between Three Independent Variables and the Graduate GPA for 112 M.B.A. Students at the University of New Mexico, 1964-1969

Variables	UGPA	UDGPA	Age	GGPA
UGPA		.810	.055	.289
UDGPA	.810		.012	.175
Age	.055	.012		.021
GGPA	.289	.175	.021	
$\bar{X}_x$	2.62	2.78	27.1	3.08
s_x	.35	.39	7.5	.58

According to Guilford, there are two principles concerning the size of a multiple correlation coefficient. They are as follows:

> (1) a multiple correlation increases as the size of correlations between dependent and independent variables increases and (2) a multiple correlation increases as the size of inter-correlations of independent variables decreases.[8]

As shown in Table 5.2, the intercorrelation between the undergraduate g.p.a. and the upper-division g.p.a. was a very high .810. Thus, the upper-division g.p.a. accounted for very little variance that was not already accounted for by the undergraduate g.p.a. Age added very little to the size of R because it had a very low correlation with graduate g.p.a.

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[8]Guilford, Fundamental Statistics, p. 403.

When analysis of variance was applied to the regression of undergraduate and upper-division g.p.a.'s upon graduate g.p.a.'s, the F was 5.64, which was significant at the .01 level, and, thus, indicated that the independent and dependent variables were related in a linear manner.[9] However, an even more significant relationship was found to exist when only the undergraduate g.p.a. was considered. In this case, F was 10.03. The results of this test are presented in Table 5.4.

Table 5.4. Analysis of Variance for the Regression of Undergraudate GPA Upon Graduate GPA for 112 M.B.A. Students at the University of New Mexico, 1964-1969

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Squares	F
Explained by regression	1	3.1196	3.1196	10.0
Unexplained variance	110	34.2293	0.3111	
Total	111	37.3489		

The results of the first regression analysis were consistent with those reported in earlier studies, namely, that the total undergraduate g.p.a. accounted for more of the variance of graduate g.p.a. than did any other single variable.

[9]When applied to regression, analysis of variance tests the null hypothesis that the beta coefficient is equal to zero. If the null hypothesis is rejected, the relationship between the dependent and independent variable(s) is concluded to be linear.

The simple correlation coefficient between undergraduate and graduate g.p.a.'s (r = .29) was approximately the same as found in other studies.

The next group to be analyzed was the one for which A.T.G.S.B. scores were available as well as the undergraduate and upper-division g.p.a.'s and ages. The results of the multiple regression of these four independent variables upon the dependent variable (graduate g.p.a.) are presented in Table 5.5.

Table 5.5. Results of Multiple Regression Between Undergraduate GPA, Upper-division GPA, ATGSB, and Ages and the Graduate GPA for 76 M.B.A. Students at the University of New Mexico, 1964-1969

Variables	$\bar{X}$	s	r_{xy}	Regr. Coef.	Std. Er. Coef.	t
UGPA	2.72	0.34	0.13	-0.1425	0.1959	-0.69
UDGPA	2.89	0.36	0.18	0.2352	0.1805	1.35
ATGSB	507.17	85.79	0.36	0.0018	0.0005	3.22
Age	26.93	5.67	0.13	0.0107	0.0082	1.31
GGPA	3.30	0.43				

The alpha coefficient for the regression equation was 1.749; the standard error of the estimate .404; and the multiple correlation coefficient .415. In terms of R^2, the independent variables accounted for approximately 17 percent of the variance. In other words, predictions based only on the mean of the dependent variable would be about 83 percent

as good as predictions based on all of the variables.

Multiple regression equations using different combinations of the same variables were developed to see whether a fewer number of variables could produce an R of approximately equivalent size. The results of some of these equations are presented in Table 5.6.

Table 5.6. Correlation Coefficients for Various Combinations of Independent Variables and the Graduate GPA for 76 M.B.A. Students at the University of New Mexico, 1964-1969

Variables	R or r	R^2 or r^2	Std. Error Estimate
ATGSB	.364	.132	.405
ATGSB, UDGPA	.383	.147	.404
ATGSB, Age	.388	.150	.403
ATGSB, UDGPA, Age	.409	.167	.402
ATGSB, UDGPA, UGPA, Age	.415	.172	.403

Based on the data in Table 5.6, the most efficient battery of predictors consisted of the A.T.G.S.B. score and the upper-division g.p.a. An argument against using the A.T.G.S.B. score and age could be made on the grounds that age is a non-intellective variable, and, therefore, its correlation to the intellective dependent variable is more likely to be the result of chance than would be a correlation between related intellective variables. And, furthermore, as shown in Table 5.7, the upper-division g.p.a. had a higher correlation with graduate g.p.a. than did the age.

Table 5.7. Intercorrelations Between Four Independent Variables and Graduate GPA for 76 M.B.A. Students at the University of New Mexico, 1964-1969

Variables	UGPA	UDGPA	ATGSB	Age	GGPA
UGPA		.694	.280	-.071	.125
UDGPA	.694		.167	-.072	.178
ATGSB	.280	.167		.016	.364
Age	-.071	-.072	.016		.129
GGPA	.125	.178	.364	.129	
$\bar{X}_x$	2.72	2.89	507	26.9	3.29
s_x	.34	.13	86	5.7	.43

In the case at hand, the A.T.G.S.B. score had the highest correlation with graduate g.p.a. (r = .364) and had relatively low correlations with the other independent variables. The upper-division g.p.a. had the next highest correlation with the dependent variable (r = .178), and its relatively low correlation with the A.T.G.S.B. score (r = .167) suggests that it would contribute something to the prediction process that would not already have been contributed by the A.T.G.S.B. score. Likewise, age had its largest correlation with the dependent variable (r = .129) and showed very little, if any, positive correlation with the other independent variables. Thus, it, too, should contribute something additional to the prediction.

On the other hand, the undergraduate g.p.a. had a rather low correlation with the dependent variable (r = .125)

but a very high intercorrelation with the upper-division g.p.a. (r = .694). Thus, it is doubtful whether the undergraduate g.p.a. would contribute anything to the prediction not already contributed by the upper-division g.p.a.

Analysis of variance for the regression of upper-division g.p.a.'s and A.T.G.S.B. scores upon graduate g.p.a.'s revealed that the independent variables were related well past the .01 level of significance (F = 6.26).

Table 5.8. Analysis of Variance for the Regression of Upper-division GPA and ATGSB Upon Graduate GPA for 76 M.B.A. Students at the University of New Mexico, 1964-1969

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Squares	F
Explained by regression	2	2.0489	1.0245	6.26
Unexplained variance	73	11.9396	0.1636	
Total	75	13.9885		

Based on other studies which compared the correlations between aptitude tests and graduate g.p.a. and measures of achievement (the various g.p.a.'s) and graduate g.p.a., the finding that the A.T.G.S.B. score had a higher correlation with graduate g.p.a. than did either the undergraduate or upper-division g.p.a. was somewhat of a surprise. However, even though the correlation between the A.T.G.S.B. score and graduate g.p.a. was higher than that for the other variables, it was not sufficiently high to assume that predictions made from it would be valid. A traditional rule of thumb states

that a validity (correlation) coefficient should be of the magnitude of approximately .45 to be of practical usefulness.[10]

The group of business majors for whom a graduate g.p.a. was recorded was the next to be analyzed. This group consisted of 76 students. The results of the regression using four independent variables are presented in Table 5.9.

Table 5.9. Results of Multiple Regression Between Undergraduate GPA, Upper-division GPA, and Undergraduate Business GPA for 76 Undergraduate Business Majors in the M.B.A. Program at the University of New Mexico, 1964-1969

Variables	$\bar{X}$	s	r_{xy}	Reg. Coef.	Std. Er. Coef.	t
UGPA	2.64	0.39	0.34	0.2563	0.3112	0.82
UDGPA	2.83	0.40	0.30	-0.2501	0.3539	-0.71
BGPA	2.79	0.41	0.38	0.5500	0.3421	1.61
Age	26.31	6.95	-0.03	0.0030	0.0092	-0.33
GGPA	3.01	0.58				

The alpha coefficient was 1.586, and the standard error of estimate was .55. The multiple correlation

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[10]C. L. Hull, Aptitude Testing, (Tarrytown-on-Hudson, New York: World, 1928), Ch. 8, cited in Guilford, Fundamental Statistics, p. 104.

coefficient for this regression equation was .391, which indicated (in terms of $\underline{R}^2$) that knowledge of the four independent variables improved the prediction of graduate g.p.a.'s about 15 percent over what it would have been based only on the known mean of the graduate g.p.a.'s.

According to the data presented in Table 5.10, the most efficient predictor was the business g.p.a. The knowledge of the other variables did not sufficiently increase the size of $\underline{R}$ to warrant their use.

Table 5.10. Correlation Coefficients for Various Combinations of Independent Variables and the Graduate GPA for 76 Undergraduate Business Majors in the M.B.A. Program at the University of New Mexico, 1964-1969

Variables	$\underline{R}$ or $\underline{r}$	$\underline{R}^2$ or $\underline{r}^2$	Std. Error Estimate
BGPA	.376	.141	.542
BGPA, UGPA	.381	.145	.547
BGPA, UGPA, UDGPA	.390	.152	.549
BGPA, UGPA, UDGPA, Age	.392	.153	.553

It is interesting to note that regardless of how many variables were used in the regression equation, the standard error of the estimate remained essentially the same (approximately .55). Again, additional variables contributed very little to the prediction process.

As shown in Table 5.11, each of the g.p.a.'s had a relatively high correlation with the dependent variable.

But, since the intercorrelations among the independent variables themselves were so high, none really contributed anything more to the prediction process than what had already been contributed by another. Therefore, the most efficient predictor was the business g.p.a. by itself.

Table 5.11. Intercorrelations Between Four Independent Variables and Graduate GPA for 76 Undergraduate Business Majors in the M.B.A. Program at the University of New Mexico, 1964-1969

Variables	UGPA	UDGPA	BGPA	Age	GGPA
UGPA		.821	.817	.052	.345
UDGPA	.821		.875	.092	.304
BGPA	.817	.875		.049	.376
Age	.052	.092	.049		-.026
GGPA	.345	.304	.376	-.026	
$\bar{X}_x$	2.65	2.83	2.78	26.3	3.01
s_x	.38	.40	.41	6.9	.58

Through analysis of variance of the regression, it was found that a relationship which was significant at the .01 level existed between the dependent and independent variables ($F = 12.21$). Results of the analysis of variance are presented in Table 5.12.

Table 5.12. Analysis of Variance for the Regression of Undergraduate Business GPA on Graduate GPA for 76 Undergraduate Business Majors in the M.B.A. Program at the University of New Mexico, 1964-1969

Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Squares	F
Explained by regression	1	3.5845	3.5845	12.2
Unexplained variance	75	22.0232	0.2936	
Total	76	25.6077		

The results of this part of the study were consistent with what was to be expected based on findings in the literature. It seems only logical that undergraduate and graduate g.p.a.'s in the field of business should be related, even though business majors have lower graduate g.p.a.'s than do either engineering or other majors.[11]

The final group to be analyzed consisted of 46 business majors for whom all five variables -- undergraduate g.p.a., upper-division g.p.a., business g.p.a., A.T.G.S.B. score, and age -- were recorded. Since approximately 69 percent of the total sample (excluding those "in progress") were business majors, this was perhaps the most revealing

[11]The mean graduate g.p.a. for business majors was 3.01; for engineering majors, 3.29; and for other majors, 3.12.

part of the study. Table 5.13 presents the results of the multiple regression analysis.

Study 5.13. Results of Multiple Regression Between Five Independent Variables and the Graduate GPA for 46 Undergraduate Business Majors in the M.B.A. Program at the University of New Mexico, 1964-1969

Variables	$\bar{X}$	s	r_{xy}	Reg. Coef.	Std. Er. Coef.	t
UGPA	2.75	0.37	0.12	-0.3335	0.2873	-1.16
UDGPA	2.95	0.36	0.30	0.5862	0.3061	1.92
BGPA	2.90	0.35	0.17	-0.0639	0.3028	-0.21
ATGSB	488.37	77.09	0.30	0.0018	0.0008	2.17
Age	26.02	5.61	0.17	0.0164	0.0113	1.46
GGPA	3.25	0.44				

The alpha coefficient for the regression was 1.309, and the multiple correlation coefficient was .486. Standard error of the estimate was .40.

A regression equation using all of the independent variables except the business g.p.a. (see Table 5.14) yielded an R of .485 and even had a slightly lower standard error of the estimate (.399 compared to .403). Thus, from the point of view of determining the set of variables which would produce the highest R in the most efficient manner, this would be the most efficient set. In terms of R^2, only .10 percent more of the variance was explained with the business g.p.a. than without it.

Table 5.14. Correlation Coefficients for Various Combinations of Independent Variables and the Graduate GPA for 46 Undergraduate Business Majors in the M.B.A. Program at the University of New Mexico, 1964-1969

Variables	R	R^2	Std. Error Estimate
ATGSB, Age	.392	.154	.410
ATGSB, Age, UDGPA	.448	.201	.403
ATGSB, Age, UDGPA, BGPA	.459	.211	.405
ATGSB, Age, UDGPA, UGPA	.485	.235	.399
ATGSB, Age, UDGPA, UGPA, BGPA	.486	.236	.403

The reason that the multiple correlation coefficient stayed virtually the same when the business g.p.a. was dropped is shown in Table 5.15.

Table 5.15. Intercorrelations Between Five Independent Variables and the Graduate GPA for 46 Undergraduate Business Majors in the M.B.A. Program at the University of New Mexico, 1964-1969

Variables	UGPA	UDGPA	BGPA	ATGSB	Age	GGPA
UGPA		.775	.758	.299	-.134	.116
UDGPA	.775		.780	.253	.007	.302
BGPA	.758	.780		.206	-.012	.171
ATGSB	.299	.253	.206		.246	.297
Age	-.134	.007	-.012	.246		.175
GGPA	.116	.302	.171	.297	.175	
$\bar{X}_x$	2.75	2.94	2.90	488	26.0	3.25
s_x	.37	.36	.35	77	5.6	.44

Because of the very high intercorrelations between the business g.p.a. and the undergraduate and upper-division g.p.a.'s, the business g.p.a. contributed very little that was unique to the prediction. In fact, from a prediction point of view, the regression equation using only the upper-division g.p.a., the A.T.G.S.B. score, and the age is probably preferrable to the four-variable regression equation. The standard error of the estimate increased only .004 when the undergraduate g.p.a. was dropped.

Relationships which were found to be significant at the .05 level were found, through the use of analysis of variance for the regression, to exist for all of the groups of independent variables shown in Table 5.14 except the

group consisting of A.T.G.S.B. scores and ages. None, however, was found to be significantly related at the .01 level.

Thus, based on the results of multiple regression analysis, the answer to the first question was that certain intellective variables were related to graduate g.p.a. However, these correlations were, on the whole, not high enough to be used as valid predictors of a very high order.

Analysis of Variance

Analysis of variance is a statistical technique which can be "used to determine whether there is a statistically significant difference between two or more means."[12] In other words, analysis of variance can be used to test the null hypothesis that there is no difference between two or more groups, based on a common continuous variable.

Analysis of variance tests the differences between the variances for the groups to determine whether it is probably that the groups being compared "could probably have arisen by random sampling from the same population of observations, or from two populations with the same

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[12]Gilbert Sax, Empirical Foundations of Educational Research, (Englewood Cliffs, New Jersey: Prentice-Hall, 1968), p. 422.

variance."[13] Rejection of the null hypothesis, then, suggests that the groups under consideration are different, i.e., they come from different parent populations.

The approach used in this portion of the study was to examine one at a time, each of the continuous variables in terms of the groups for each category variable. For example, the first continuous variable to be analyzed was the undergraduate g.p.a. Analysis of variance was used to determine whether the undergraduate g.p.a.'s of the different groups of each category variable were significantly different.

Results of the one-way analysis of variance for the undergraduate g.p.a. are presented in Table 5.16.

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[13]Guilford, Fundamental Statistics, p. 191.

Table 5.16. Analysis of Variance Table for the Undergraduate GPA of M.B.A. Students at the University of New Mexico, 196401969, Based on Three Category Variables

Category and Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Squares	F
Undergraduate School				
Between groups	2	0.32	0.16	1.21
Within groups	166	21.82	0.13	
Total	168	22.14		
Undergraduate Major				
Between groups	2	0.42	0.21	1.59
Within groups	166	21.74	0.13	
Total	168	22.16		
Success/Failure				
Between groups	1	0.06	0.06	0.45
Within groups	167	22.09	.13	
Total	168	22.15		

As can be seen by Table 5.16, all of the groups within each particular category were homogeneous when compared on the basis of undergraduate g.p.a. Of particular importance is the fact that there was no difference between the undergraduate g.p.a. of successes and failures. Therefore, even though the undergraduate g.p.a. was found to be a reasonably good predictor of graduate g.p.a., it appears to be of no real value in trying to predict either success or failure.

The next continuous variable to be analyzed was the upper-division g.p.a. (see Table 5.17). In this case it was found that the mean upper-division g.p.a.'s of the three groups in the "undergraduate major" category were found to be significantly different. The means for the three groups were

as follows: business majors, 2.86 (n = 116, s = .39); engineering majors, 2.61 (n = 27, s = .39); and other majors, 2.74 (n = 26, s = .34).[14]

Table 5.17. Analysis of Variance Table for the Upper-division GPA of M.B.A. Students at the University of New Mexico, 1964-1969, Based on Three Category Variables

Category and Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Squares	F
Undergraduate School				
Between groups	2	0.40	0.20	1.31
Within groups	166	25.24	0.15	
Total	168	25.64		
Undergraduate Major				
Between groups	2	1.39	0.69	4.76[a]
Within groups	166	24.26	0.14	
Total	168	25.65		
Success/Failure				
Between groups	1	0.25	0.25	1.65
Within groups	167	25.40	0.15	
Total	168	25.65		

a. Differences significant at the .01 level.

This suggests that if the upper-division g.p.a. is to be used in predicting graduate g.p.a., some consideration should be given to the fact that a different set of beta weights should be used for each group of majors. By developing three regression equations instead of one, the

[14]The letter n is used to denote the number in the group of a category, and the letter N is used to denote the total number in the category.

standard error of the estimate could be reduced. Table 5.17 also suggests, however, that the upper-division g.p.a. is not particularly useful in predicting success and failure.

Table 5.18 presents the results of analysis of variance for A.T.G.S.B. scores. As shown in the table, there was no difference among the scores based on the undergraduate school ($F = 0.20$). However, differences which were significant at the .05 level were found to exist among the business, engineering, and other majors ($F = 4.64$), and differences which were significant at the .01 level were found to exist between the successes, failures, and students in progress ($F = 5.17$).

Table 5.18. Analysis of Variance Table for ATGSB Scores of M.B.A. Students at the University of New Mexico, 1964-1969, Based on Three Category Variables

Category and Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Squares	F
Undergraduate School				
Between groups	2	2972	1486	0.20
Within groups	77	574700	7463	
Total	79	577672		
Undergraduate Major				
Between groups	2	62080	31040	4.64[b]
Within groups	77	515600	6696	
Total	79	577680		
Success/Failure				
Betwen groups	2	68340	34170	5.17[a]
Within groups	77	509300	6614	
Total	79	577640		

a. Differences significant at the .01 level.
b. Differences significant at the .05 level.

The mean A.T.G.S.B. score for business majors was 485 ($\underline{n}$ = 51, $\underline{s}$ = 76) as compared to 553 ($\underline{n}$ = 18, s = 89) for engineering majors and 515 ($\underline{n}$ = 11, $\underline{s}$ = 96) for other majors. Differences which were significant at the .01 level were found to exist among the A.T.G.S.B. scores of successes, failures, and students in progress. The mean A.T.G.S.B. score for successes was 516 ($\underline{n}$ = 21, $\underline{s}$ = 69) and for failures the mean was 455 ($\underline{n}$ = 20, $\underline{s}$ = 69). For students in progress, the mean was 525 ($\underline{n}$ = 39, $\underline{s}$ = 94).

Based on these findings, the A.T.G.S.B. score could be used for predicting either success or failure. In the earlier section on multiple regression analysis it was determined that the A.T.G.S.B. score was usually rather useful in predicting graduate g.p.a. Thus, the A.T.G.S.B. score may well be the best single predictor of overall success in the M.B.A. program at the University of New Mexico.

The continuous variable age was analyzed for the three categories of marital/veteran status, whether the student was a full-time or part-time graduate student, and whether the student was a success or failure. The results of these analyses are presented in Table 5.19.

Table 5.19. Analysis of Variance Table for Age of M.B.A. Students at the University of New Mexico, 1964-1969, Based on Three Category Variables

Category and Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Squares	F
Marital/Veteran Status				
Between groups	3	2046.00	681.90	17.68[a]
Within groups	165	6363.00	38.57	
Total	168	8409.00		
Full-time/Part-time				
Between groups	1	313.60	313.60	6.47[b]
Within groups	167	8095.00	48.48	
Total	168	8408.60		
Success/Failure				
Between groups	1	203.60	203.60	4.14[b]
Within groups	167	8205.00	49.13	
Total	168	8408.60		

a. Differences significant at the .01 level.
b. Differences significant at the .05 level.

As shown in Table 5.19, the differences among the ages of the four groups in the marital/veteran status category were significantly different at the .01 level ($F = 17.68$). The mean ages for the four groups were as follows: married veterans, 31.5 ($n = 50$, $s = 7.91$); married non-veterans, 28.3 ($n = 54$, $s = 7.57$); single veterans, 25.5 ($n = 18$, $s = 3.11$); and single non-veterans, 22.6 ($n = 47$, $s = 1.43$).

Differences which were significant at the .05 level were found to exist between the ages of the full-time students and part-time students ($F = 6.47$) and also between the ages of the success and failure groups ($F = 4.14$). The

The mean age for full-time students was 25.7 ($\underline{n}$ = 71, $\underline{s}$ = 6.59), and for part-time students the mean age was 28.5 ($\underline{n}$ = 98, $\underline{s}$ = 7.22).

The mean age for the success group was 25.7 ($\underline{n}$ = 54, $\underline{s}$ = 4.93), and the mean for failures was 28.1 ($\underline{n}$ = 115, $\underline{s}$ = 7.79). The great similarity between the means for full-time successes and part-time failures was to be expected since, as Chapter 4 pointed out, 44 of the 54 successes were full-time students. However, one cannot summarily conclude that young students are necessarily more apt to earn the M.B.A. degree than are older students. Other factors must be considered.

For example, of the 44 full-time successes, 21 were single non-veterans, the youngest group of the marital/veteran status category. But 12 of the full-time successes were married veterans, the oldest group of the category. Thus, before a prediction of either success or failure can be made based on age, other factors must also be considered.

When the analysis of variance was based on graduate g.p.a. (Table 5.20), only the differences between successes and failures were significant ($\underline{F}$ = 29.71, significant at the .01 level).

Table 5.20. Analysis of Variance Table for Graduate GPA of M.B.A. Students at the University of New Mexico, 1964-1969, Based on Five Category Variables

Category and Source of Variation	Degrees of Freedom	Sum of Squares	Mean of Squares	F
Undergraduate School				
Between groups	2	0.03	0.02	0.05
Within groups	109	37.32	0.34	
Total	111	37.35		
Undergraduate Major				
Between groups	2	1.36	0.68	0.05
Within groups	109	35.99	0.33	
Total	111	37.35		
Marital/Veteran Status				
Between groups	3	2.63	0.88	2.73[b]
Within groups	108	34.72	0.32	
Total	111	37.35		
Full-time/Part-time				
Between groups	1	1.16	1.16	3.53
Within groups	110	36.19	0.33	
Total	111	37.35		
Success/Failure				
Between groups	1	7.94	7.94	29.71[a]
Within groups	110	29.41	.27	
Total	111	37.35		

a. Differences significant at the .01 level.
b. Differences significant at the .05 level.

As would be expected, the mean graduate g.p.a. for the success group was significantly higher than for the failure group. The mean graduate g.p.a. for the successes was 3.35 (n = 54, s = .26), and the mean for failures was 2.82 (n = 58, s = .67). Likewise, the graduate g.p.a.'s of the four groups in the marital/veteran status category were also found to be significantly different (F = 2.73, significant

at the .05 level). The mean graduate g.p.a. for each of the groups was as follows: married veterans, 3.28 (n = 34, s = .47); married non-veterans, 2.93 (n = 28, s = .69); single veterans, 2.87 (n = 12, s = .58); single non-veterans, 3.07 (n = 38, s = .55).

In addition, it was also determined that differences which were significant at the .05 level were found to exist for the following:

1. A.T.G.S.B. scores for business majors, engineering majors, and other majors.
2. Ages of full-time and part-time students.
3. Ages of successes and failures.
4. Graduate g.p.a.'s of the marital/veteran status groups.

While it is beyond the scope of this paper to determine the precise implications and causes of these results, some conjecture seems appropriate. In particular, an attempt will be made to describe the successes and failures as heterogeneous groups.

First of all, consider the fact that the ages of the two groups were significantly different. Next, consider the fact that full-time students were younger than part-time students. So far, it appears that the successes were young, full-time students. However, it has already been established that the "young" group of success included a substantial number of "old" married veterans.

Thus, the critical factor related to success appears to be the ability to pursue the degree on a full-time basis. There are two factors which seem to be of importance here: (1) the amount of time that elapses between undergraduate and graduate work, and (2) the financial ability or living situation which permits full-time graduate work.

Since the single non-veteran, with an average age of 22, usually begins graduate work immediately after his undergraduate work, his living situation is such that he can continue school on a full-time basis assuming, of course, that the student pursued his undergraduate degree on a full-time basis. This seems to be a valid assumption for at least two reasons: (1) in order to be graduated by the age of 22, the student would have to have been a full-time student, and (2) as a part-time student, the student would have been subject to the draft and thus would not have been a "single non-veteran" graduate student.

The married veteran, on the other hand, has the advantage over both the married non-veteran and single veteran. Being married, he has the potential for additional financial resources from his spouse's employment to supplement G. I. Bill benefits. Neither of the other two has both of these sources of income.

Furthermore, the average married non-veteran does not begin his graduate work until age 28, or approximately 6 years after being graduated. This means that his life style has probably changed to the point that full-time

graduate studies are a financial impossibility. The average single veteran begins his graduate work at age 25, approximately 3 years, or one tour of military duty, after receiving his bachelor's degree. This interruption is apparently very disruptive to the single veteran, as this group accounts for only 10 percent of the total sample.

The pattern for success, then, appears to be to start in graduate school either immediately after undergraduate school or to be a married veteran whose wife can work to help send him to graduate school on a full-time basis.

While the reasons given in the preceding discussion were only hypothetical, the basic facts are real. And the findings of the analysis of variance section can aid in evaluating the correlations and predictions discussed in the section on multiple regression analysis of the data.

The most interesting inferences presented thus far are that neither the undergraduate nor upper-division g.p.a. are particularly useful in predicting graduate success, either in terms of a particular graduate g.p.a. or earning or not earning the M.B.A. degree. Yet, the former was the primary criterion for admitting students to the Graduate School at the University of New Mexico, and the latter is currently being used.

Multiple Discriminant Analysis

Multiple discriminant analysis was used to test the conclusion that undergraduate and upper-division g.p.a.'s are not particularly useful in predicting success or failure

in the M.B.A. program at the University of New Mexico. Multiple discriminant analysis was also used to test whether or not the A.T.G.S.B. score is a useful predictor of success or failure.

Stated in null form, the two hypotheses tested were: (1) the undergraduate and upper-division g.p.a.'s were the same for both successes and failures, and (2) the A.T.G.S.B. scores of successes and failures were the same. Had the respective scores for the two groups been equal, the discriminant function would not have been exceptionally accurate in assigning the sample members to the group to which they belonged. The reason being that multiple discriminant analysis "is a technique for weighting a linear set of variables so that discrimination between groups is maximized and heterogeneity within groups is minimized."[15]

When there is little heterogeneity between the discriminating variables being used, the probabilities for assigning a person to the right group are scarcely higher than chance assignments (50-50 probability where two groups are concerned). In other words, if the discriminating variables (the undergraduate and upper-division g.p.a.'s and A.T.G.S.B. scores) for the two groups (success and failure) are equal, assignment of sample members to one group or the other using a discriminant function would be no more accurate than assigning them by flipping a coin.

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[15]Sax, Educational Research, p. 308.

As mentioned earlier, multiple discriminant analysis can be used to assess the potential adequacy of assigning members of a sample to a specific population or group. Figure 5.1 illustrates the proportion of successes and failures that would be incorrectly assigned when the cutting point is arbitrarily set at the midpoint between the means of the two groups.

In the diagram, the area a represents the proportion of successes that would have been rejected because their scores (either the A.T.G.S.B. score, one or more g.p.a.'s, or a combination) were below the cutting point (c.p.). This area is expressed as a z score which, by using the table of areas under the normal curve, can be interpreted as a proportion of the total population or area under the curve. Similarly, area b represents the proportion of failures who scored above the cutting point and thus would have been accepted.

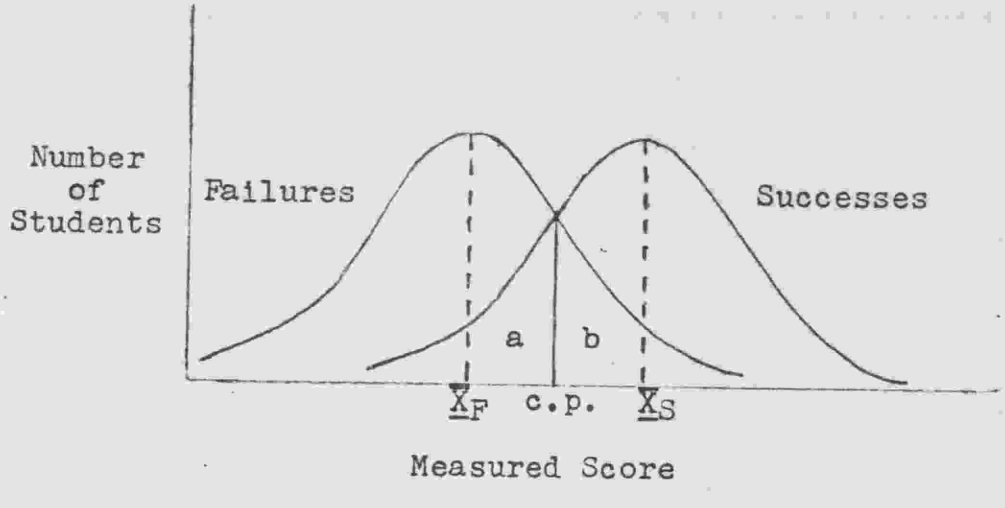

Figure 5.1. Probability of Making Either a Type I or Type II Error through Multiple Discriminant Analysis

In the language of statistics, the rejection of a potential success would be a Type I error, and the acceptance of a potential failure would be a Type II error. By lowering the critical point (or cutting score), one could reduce the probability of making a Type I error but in doing so would increase the probability of a Type II error. And, conversely, by raising the cutting score, the probability for a Type I error would be increased; but the probability of a Type II error would be decreased. For the purpose of this study a cutting score which is midway between the means of the two groups is used.

The sample used in the multiple discriminant analysis portion of the study consisted of those students for whom undergraduate and upper-division g.p.a.'s, an A.T.G.S.B. score, and a graduate g.p.a. were recorded. This group consisted of 21 successes and 16 failures. Because of the rather limited size of the sample, generalized conclusions from the results obtained through discriminant analysis in this study should not, and will not, be made. However, these analyses do represent a starting point and an indication of what might be expected from future studies using larger samples.

The first step was to assign the sample members to either the success or failure group on the basis of undergraduate g.p.a. The mean g.p.a. for successes was 2.7857, and the mean for failures was 2.5637. The two means were .686 standard deviations apart, and the estimated probability

for either a Type I or Type II error was .37. In actuality, the results very closely approximated the estimate. Of the 37 members of the sample, 13, or 35 percent, were incorrectly assigned. Fourteen of the 21 successes (67 percent) and 10 of the 16 failures (62 percent) were correctly assigned.

The next step was to assign the sample on the basis of the combined undergraduate and upper-division g.p.a.'s. The means for each of the variables are presented in Table 5.21.

Table 5.21. Mean Undergraduate and Upper-division GPA's Used in Discriminant Analysis for Successes (N = 21) and Failures (N = 16) in the M.B.A. Program at the University of New Mexico, 1964-1969

Group	UGPA	UDGPA
Success	2.7857	2.7814
Failure	2.5636	2.8119

The z score indicates how many standard deviations the means of the two groups are from each other. Since multiple discriminant analysis maximizes the differences between groups, it is also useful to determine which set of variables are the most different. This can be determined by solving the following equation:

$$z = \frac{\bar{X}_1 - \bar{X}_2}{s}. \qquad (1)$$

In the equation, $\bar{X}_1$ represents the net difference between the undergraduate g.p.a.'s of the two groups, $\bar{X}_2$ represents the net difference between the upper-division g.p.a.'s, and s represents the standard deviation. Solving the equation, we find that

$$z = \frac{1.1436 - .2108}{1.0151}$$

$$z = 1.124 - .206$$

$$z = .918.$$

This means that the use of the upper-division g.p.a.'s in the discriminant function decreased the adequacy of the classification process. This is because the upper-division g.p.a.'s are very close together and thus cause the combined averages to be closer together.

The results of discriminant analysis based on g.p.a. suggests that g.p.a. can be reasonably useful in predicting either success or failure. It is interesting to note that if an overall undergraduate g.p.a. of near 3.00 were required (as suggested in the Graduate Bulletin of the University of New Mexico), virtually all of the potential failures would have been eliminated but, unfortunately, so too would many of the successes.

In an effort to determine whether the above findings were valid, discriminant analysis was applied to the total sample population of successes (N = 54) and failures (N = 115). The mean undergraduate g.p.a.'s for the two groups were very close together (s = .109). And, as mentioned earlier, when

the groups being considered are relatively homogeneous, the probability for properly assigning members of the sample to the correct group is hardly better than .50.

Given a $\underline{z}$ of .106, and a critical point of .053 $\underline{z}$, the estimated probability for correctly assigning the sample to the appropriate groups was .52. When the sample was assigned by the discriminant function, 56 percent of the sample was correctly assigned. Twenty-seven (50 percent) of the successes and 68 (59 percent) of the failures were correctly assigned.

When the upper-division g.p.a. was added to the discriminant function, the estimated probability for error was reduced from .48 to .42. When the sample was classified according to the discriminant function, the error rate was 40 percent. The combined means for the two groups were .429 standard deviations apart compared to only .106 standard deviations when just undergraduate g.p.a. was used.

Turning to the A.T.G.S.B. scores, we find that the means for the two groups of successes and failures were 516.95 and 452.63 respectively. These means were .927 standard deviations apart, and, assuming the midpoint between the two means (488) to be the cutoff score, an estimated 33 percent of each group would be misclassified.

This is very close to the probabilities for misclassifications obtained when the sample was assigned by the discriminant function. Of the 21 successes, 15 were classified correctly and 9 of the 16 failures were so classified. Thus,

of the 37 members of the sample, 24, or 65 percent, were assigned correctly, and only 35 percent were incorrectly classified.

The next logical step was to determine whether or not the prediction process could be improved by considering both the A.T.G.S.B. scores and the g.p.a.'s. The sample was first classified on the basis of a multiple discriminant function using both the A.T.G.S.B. scores and the undergraduate g.p.a. The means for the two groups are presented in Table 5.22.

Table 5.22. Mean ATGSB Scores and Undergraduate GPA's Used in Multiple Discriminant Analysis for Successes ($\underline{N}$ = 21) and Failures ($\underline{N}$ = 16) in the M.B.A. Program at the University of New Mexico, 1964-1969

Group	ATGSB	UGPA
Success	515.95	2.7857
Failure	452.63	2.5637

Consideration of the second variable (undergraduate g.p.a.) decreased the estimated probability for making either a Type I or Type II error from 33 percent to 29 percent. In this case, the real error rate decreased from 35 percent when just the A.T.G.S.B. score was considered to 30 percent when both the variables were included in the discriminant function.

In solving the equation for $\underline{z}$, we find that

$$\underline{z} = .7403 + .4120$$

$$\underline{z} = 1.15.$$

Or, the relative difference between the A.T.G.S.B. scores is greater than that between the undergraduate g.p.a.'s and therefore contributes more to the discriminant function.

When the upper-division g.p.a. was considered in conjunction with the A.T.G.S.B. score and the undergraduate g.p.a., the discriminant function yielded the same results as when only the latter two variables were considered: 15 of 21 successes and 11 of 16 failures were correctly assigned. However, the combined means of the two groups were further apart (1.31 standard deviations as compared to 1.15); and, consequently, the estimated probability for misclassification decreased from .29 to .26.

Thus, while it would be inappropriate to conclude from the limited data available that the A.T.G.S.B. score is a significantly better predictor of success or failure than are g.p.a.'s, the above findings do suggest that this possibility be further explored.

Chapter 6

SUMMARY

The purpose of this study was to determine whether or not significant statistical relationships, which could be used for prediction purposes, existed between certain background variables and success in the M.B.A. program at the University of New Mexico. More specifically, the study sought to answer three questions.

The first question asked whether or not certain intellective variables were related to graduate g.p.a., and, if so, the extent to which they were related. When considering all 112 students for whom a graduate g.p.a. was recorded, it was found that all of the intellective variables were correlated with graduate g.p.a., though none had an r greater than .29. When the multiple correlations between more than one independent intellective variable and the dependent variable were computed, R's in the neighborhood of .31 were obtained.

Correlation coefficients of this magnitude are hardly sufficient for valid prediction purposes. However, when that portion of the sample for which A.T.G.S.B. scores were recorded was analyzed, correlation coefficients of a much greater magnitude were obtained. The r between A.T.G.S.B.

scores and graduate g.p.a. was .36 while the multiple R between undergraduate g.p.a., upper-division g.p.a., and A.T.G.S.B. score and graduate g.p.a. was .39.

In the case of undergraduate business majors, a multiple R of .49 was obtained when undergraduate, upper-division and business g.p.a.'s, A.T.G.S.B. scores, and age were correlated with graduate g.p.a.

The second question asked whether or not selected non-intellective variables were related to achievement of the M.B.A. degree. The findings in this study indicate that the earning of the M.B.A. degree is a function of two things: (1) intellectual capacity, and (2) time required to complete the degree, in terms of both the number of credit hours required and the number of semesters required to complete the requirements. And of these two factors, little difference was found to exist for the first one. Certain g.p.a.'s were required for admission to the Graduate School, and thus the measures of intellectual capacity (or, perhaps more correctly, intellectual achievement) were essentially the same.

The second factor was not as equal for all students. Students who were business majors as undergraduates were normally able to complete degree requirements with 30-36 hours of graduate work. Non-business majors, on the other hand, were normally required to complete 50 to 57 hours of graduate work.

Full-time students were, of course, able to complete the degree requirements more quickly than were their part-time counterparts (44 of 54 successes were full-time students). And a student's marital/veteran status seemed to determine whether he could pursue his graduate work on a full-time basis, i.e., single non-veterans and married veterans were much more apt to be full-time students (and therefore successes) than were either single veterans or married non-veterans.

The answer to the last question, which asked whether or not success in the M.B.A. program could be predicted from known intellective variables, was perhaps the most enlightening. Using multiple discriminant analysis to assign members of the sample population to either the success or failure groups, error rates ranging from a low of 30 percent to a high of 35 percent were incurred, depending upon which, and how many, variables were considered. The estimated probabilities for misclassification ranged from a low of 26 percent to a high of 37 percent.

The estimated probabilities associated with correct assignment based upon either the A.T.G.S.B. score or the undergraduate g.p.a. were 67 percent and 63 percent respectively. When assignments were actually made using each of these variables, 65 percent of the sample was correctly assigned in both cases. The two cases did, however, differ in respect to the number of Type I and Type II errors obtained.

Using only the A.T.G.S.B. scores, 15 (or 71 percent) of the successes were correctly assigned, and this represented the minimum for Type I errors. However, only 9 (or 56 percent) of the failures were correctly assigned, and this represented the maximum for Type II errors. When only the undergraduate g.p.a. was used, Type I errors increased, but Type II errors decreased. Specifically, the number of successes correctly assigned dropped to 14, and the number of failures correctly assigned increased to 10.

When the larger sample of 169 successes and failures was considered, the discriminant ability of the undergraduate g.p.a. decreased to a rate of only 56 percent correct assignments: 27 of 54 successes and 68 of 115 failures.

The implications of this study for the decision-makers, i.e., those responsible for deciding who is or is not to be admitted into the M.B.A. program at the University of New Mexico, are several. First of all, the current admissions criteria should be re-evaluated since, in the case of M.B.A. students, they are not necessarily related to success.

The use of a single index such as g.p.a. only serves to increase the homogeneity of the total population, and, therefore, makes discrimination between probable successes and failures more difficult. Although there were not sufficient data available to conclude that there are better predictors of success and failure than the undergraduate or upper-division g.p.a., this study does suggest that other

factors should be considered.

Based on the findings of this study, a more equitable and efficient set of admissions criteria would include such things as the A.T.G.S.B. score, whether the student would be pursuing his graduate work on a full-time or part-time basis, the student's marital status, whether or not he is a veteran, and his undergraduate major. In particular, the potential value of the A.T.G.S.B. score as a criterion for admission has profound implications.

It represents a potential single and universal measure by which students from different universities can be evaluated. It does not, however, appear to be capable of comparing students from different academic majors or backgrounds on an equal basis. The A.T.G.S.B. appears to be biased towards those students with math-oriented backgrounds. However, if this bias is real, it can be controlled in the comparison and admission process.

In conclusion, the findings of this study suggest that, due to the fact that students from all disciplines are eligible for admission into the M.B.A. program at the University of New Mexico, admissions criteria different from those used for admitting students into other programs are needed for evaluating applicants to the M.B.A. program.

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