SELECTION CRITERIA AND PROCEDURES FOR PREDICTING THE SUCCESS OF INDUSTRIAL EDUCATION DOCTORAL APPLICANTS

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ABSTRACT

SELECTION CRITERIA AND PROCEDURES FOR PREDICTING THE SUCCESS OF INDUSTRIAL EDUCATION DOCTORAL APPLICANTS

By

Charlie Harris

The selection of a potential doctoral student is usually based on all the estimates of student quality that are available. The purposes of this selection study were:

1. To investigate the selection criteria and procedures being used in certain industrial education departments.

2. To test the effectiveness of certain predictor variables (criteria) that industrial educators in selected Big Ten universities can use in selecting industrial education doctoral students.

3. To contribute to the development of a selection model that allows industrial educators in selected Big Ten universities to predict the success of potential industrial education doctoral students.

The sample included seventy-five former doctoral students who were identified by seven industrial education

department representatives from selected Big Ten universities. Fifty-four of these subjects were graduates and twenty-one were drop-outs.

Fourteen independent variables were used as the initial set of predictors to discriminate between students who had graduated from or dropped out of the doctoral program. Success was the criterion variable for this study.

Instruments for collecting data included the personal interview and the questionnaire. An interview was conducted with seven industrial education department representatives to collect data pertaining to the selection criteria and procedures used in their departments. These data assisted in choosing the initial set of predictor variables. The data collected on the fourteen predictors were compiled from the questionnaires.

The procedures for collecting data included telephone calls and letters to department representatives from the seven departments. Data were screened for missing values before statistical application; the overall mean for a variable was substituted for missing values.

The SPSS RAO stepwise discriminant analysis method was employed to test the hypotheses; the discriminant analysis classification equation was considered to be a selection model and a procedure for validation.

The decision to reject or accept the null hypothesis was based on the chi-square statistics. The null

hypothesis was rejected since the chi-square value was significant ($\chi^2 = 34.23791$; $df = 14$; $P < .002$). Rejecting the null hypothesis indicated that the alternative was accepted.

By accepting the alternative hypothesis, the researcher implied that the following predictors were relevant for the selection of industrial education doctoral students:

1. Number of years taken to complete the master's program
2. Graduate Record Examination Quantitative score
3. Age at the time of application to the doctoral program
4. Overall undergraduate grade-point average
5. Marital status at the time of application to the doctoral program
6. Overall master's grade-point average
7. Miller Analogies Test score
8. Number of dependents at the time of application to the doctoral program
9. Number of publications listed on the application for the doctoral program
10. Years of relevant professional education work experience
11. Undergraduate grade-point average for the last two years

12. Last employment before admittance to the doctoral program
13. Master's grade-point average for courses taken in industrial education
14. Graduate Record Examination Verbal score

A further inspection of the F-to-enter from the computer output sheet revealed that the first nine predictors were most effective with the selection process ($\chi^2 = 34.680$; df = 9; $P < .000$). Therefore, these nine variables would be best suited for developing a selection model. It must be stressed, however, that these variables only accounted for 37.25 percent of variance in the criterion variable. This implies that 62.75 percent of variance could be found in other predictor variables.

Finally, variables number one, three, five, and nine had not officially been used with the selection process; therefore, their inclusion in a selection model would be an improvement over what had been done in the past.

SELECTION CRITERIA AND PROCEDURES FOR PREDICTING THE SUCCESS OF INDUSTRIAL EDUCATION DOCTORAL APPLICANTS

By

Charlie Harris

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CHAPTER I

STATEMENT OF THE PROBLEM

Background and Need for the Study

The selection of a potential doctoral student is usually based on all the estimates of student quality that are available. The findings of a study by Heiss in 1970 implied that there is a body of research on estimates of student quality, such as early culture and motivation, personality, interest, grade-point average, class rank, and scores on the Graduate Record Examination or the Miller Analogies Test. These predictors and others often provide some degree of accuracy for forecasting the success of students.[1]

Most industrial education doctoral programs specify that to obtain a degree the candidate should: (1) satisfy a residence requirement, (2) master the requirements of a series of courses and seminars, (3) successfully complete a written and an oral qualification examination, (4) secure the approval of a faculty committee on the choice of a research topic and the method to be used in the study, and (5) write and defend the results of the research in a form

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[1]Ann M. Heiss, Challenges to Graduate Schools (San Francisco: Jossey-Bass, Inc., Publishers, 1970), pp. 92-93.

approved by the faculty committee. Each of these requirements should contribute to the student's scholarly development; therefore, any independent or dependent variable used as part of a selection procedure should reflect these requirements.[2]

The modern industrial educator has many job requirements or expectations. The concern of colleagues, students, administrators, and even members of the community tends to have a great influence upon the impact of these expectations, some of which include:

1. Teaching undergraduate and graduate industrial education courses
2. Advising students in the industrial education department
3. Selecting students who will succeed in industrial education
4. Serving on local, state, and national committees
5. Conducting or encouraging research to improve the quality of industrial education
6. Attending local, state, and national conferences and conventions on industrial education
7. Acting as a consultant for other educational institutions and in industry
8. Performing administrative functions

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[2]Ibid., p. 109.

Chaplin and others, in their national status study of 1974, provided an insight into how industrial education professors spend their time:

> Of the responding institutions, 81 percent indicated that staff members spent 70 percent or more of their time teaching. Only five institutions indicated that less than 39 percent of faculty time went to teaching. Nearly 75 percent of the colleges reported that less than 5 percent of faculty time was alloted to research.
>
> . . . Approximately 75 percent of the colleges reported that less than 10 percent of staff time went to administration, 10 percent to departmental and university meetings, 5 percent to national professional organizations, and 5 percent to assisting master's and doctoral graduates. Of possible concern is the fact that less than 10 percent of staff time was given to student counseling.[3]

The national status study revealed the proportion of time professors allocate to many of their job requirements, such as selecting, teaching, and advising doctoral students. These expectations demand much of the professor's time and effort; therefore, the results of the present study should enable the professor to use his time most profitably by:

1. Becoming more accurate in selecting doctoral students while minimizing the number of predictor variables used in the selection process.

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[3]Jack Chaplin, Ronald Todd, and John Gradwell, "Industrial Arts Teacher Education: Myths and Realities," Man/Society/Technology; A Journal of Industrial Arts Education 34 (Winter 1974): 93-94.

2. Becoming more adept at advising students concerning their probability of graduating from or dropping out of the industrial education doctoral program.
3. Focusing on the possible relationship between independent and dependent variables that are used in selecting industrial education doctoral students.

Investigating the current selection criteria and procedures and testing the effectiveness of predictor variables used in the selection process is one way of attempting to develop a model for selecting industrial education doctoral students within Big Ten universities. The results of this study could add precision to the selection of successful industrial education doctoral students.

In addition, a review of the literature revealed that few recent studies have dealt with the selection of industrial education doctoral students; therefore, the paucity of research generates interest in conducting this study.

Finally, interviews conducted with several industrial education professors revealed that they are interested in knowing more about common elements of the selection criteria and procedures being used by other Big Ten departments. They are also concerned with gaining insight about students who complete or drop out of industrial education doctoral programs. The results of this study may

provide information about the relationship among selection criteria and procedures.

Purposes and Objectives of the Study

This study was designed to carry out the following purposes and objectives:

1. To investigate the selection criteria and procedures being used by certain industrial education departments.

2. To test the effectiveness of certain predictor variables (criteria) that industrial educators in selected Big Ten universities can use in selecting industrial education doctoral students. The predictor variables are: (1) overall undergraduate grade-point average, (2) undergraduate grade-point average for the last two years, (3) overall master's grade-point average, (4) master's grade-point average of courses taken in industrial education, (5) years of relevant professional education work experience, (6) Graduate Record Examination Verbal score, (7) Graduate Record Examination Quantitative score, (8) the Miller Analogies Test score, (9) the number of publications listed on the application for the doctoral program, (10) age at the time of application to the doctoral program, (11) number of years taken to complete the master's degree program, (12) number of dependents at the time of application to the doctoral program, (13) marital status at the time of application to the doctoral program,

and (14) last employment before admittance to the doctoral program.

3. To contribute to the development of a selection model that allows industrial educators in selected Big Ten universities to predict the success of potential industrial education doctoral students.

Hypotheses

The hypotheses relate to a set of predictor variables that can discriminate between industrial education students who will graduate from or drop out of the doctoral program. A null hypothesis is applicable, which implies an alternate hypothesis.

> Null Hypothesis: There is not a set of independent variables (predictors) that can discriminate between industrial education students who will graduate from or drop out of the doctoral program (criterion).
>
> Alternative Hypothesis: There is a set of independent variables (predictors) that can discriminate between industrial education students who will graduate from or drop out of the doctoral program (criterion).

Definition of Terms

Criterion variable--The criterion variable refers to a dependent variable that assumes scores from independent variables are "criterion measures" for the criterion variable. Success is the criterion variable for this study. For classification purposes, success relates to two categories: (1) students who graduate from the

industrial education doctoral program and (2) students who drop out of the program.

Predictor variables--Predictor variables refer to independent variables that provide information about the criterion variable.

Former doctoral students--Former doctoral students are those who graduated or dropped out and had an industrial arts and/or trade and industrial education major during enrollment in the doctoral program.

Drop-outs--Drop-outs are former students who surpassed the number of years departments allow to complete degree requirements and/or former students defined by departments as drop-outs for other reasons.

Industrial education--Industrial education is a generic term that refers to industrial arts, vocational-industrial, and technical education.

Department representatives--Department representative refers to a chairman or coordinator of an industrial education program within the Big Ten universities selected for the present study.

Delimitations of the Study

This study has two major limitations, which relate to: (1) variables to be used in the selection of doctoral students and (2) the population for the study. The variables include predictor and criterion variables, which are associated with three sources: (1) variables that are

currently used by Big Ten departments in the selection process, (2) predictor and criterion variables that have been reported in related literature studies, and (3) variables that have been suggested by professors in selected Big Ten departments.

The population for the study included subjects from seven departments within Big Ten universities that had industrial education doctoral programs. The population included one more department than university because one university had two separate industrial education departments, and each of the other universities had one such department. Originally, it was anticipated that data would be collected on ten doctoral graduates and five drop-outs from each of the industrial education programs. However, using only former students as subjects restricted the sample range; nothing could be done about this since the departments did not have information on applicants who had not been admitted to the doctoral program.

Theory and Design for the Study

Research is a systematic process that provides solutions to problems. These problems usually take the form of questions or hypotheses. Generally, the three types of research that educators often use are descriptive, historical, and experimental.[4]

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[4]Ralph H. Jones, Methods and Techniques of Educational Research (Danville: The Interstate Printers and Publishers, Inc., 1973), p. 7.

Since the present study has most of the characteristics of descriptive research, it is logical to classify it as descriptive.[5] Such research can determine present conditions, and can provide for the description, analysis, and investigation of specific problems. Descriptive research can determine trends, so that predictions can be made about the future.

In this study the personal interview and the questionnaire were used to collect data. The personal interview was used to elicit information from the industrial education department representatives of Big Ten departments, whereas the questionnaire was used to record data pertaining to subjects in the study.

The statistical method for this study was the SPSS RAO stepwise discriminant analysis. Such analysis was used to test the effectiveness of predictor variables that can be used to classify students as graduates or drop-outs of the industrial education doctoral program. The RAO stepwise discriminant analysis classification equation is appropriate for categorizing industrial education doctoral applicants as graduates or drop-outs. The same classification equation is suited for a validation procedure.

The study had three purposes, each of which required a different treatment. The purposes and their treatments are:

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[5]Ibid., p. 6.

1. To investigate the selection criteria and procedures being used by certain industrial education departments. This purpose was accomplished by conducting personal interviews with industrial education department representatives from seven Big Ten universities.

2. To test the effectiveness of certain predictor variables (criteria) that industrial educators in selected Big Ten universities can use in selecting industrial education doctoral students. The questionnaire was the instrument used to collect data pertaining to variables. However, the SPSS RAO stepwise discriminant analysis method is appropriate for testing the effectiveness of the variables.

3. To contribute to the development of a selection model that allows industrial educators in selected Big Ten universities to predict the success of potential industrial education doctoral students. A visual inspection of the F-to-enter from the computer output reveals the most effective predictor variables for classifying doctoral students.

Overview of the Study

The remainder of this research includes a Review of Literature, Research Design and Method, Evaluation of Data, and Summary and Conclusions. The review of literature encompasses selection studies in industrial education and general selection studies. Described in the Research Design and Method chapter are the sources of data, the

variables for the study, the data-collection instruments and procedures, the hypotheses, and the data-analysis procedures. The fourth chapter, Evaluation of Data, includes a report of the results of interviews with seven department representatives, a description of the sample, an interpretation of the hypotheses test, and a discussion of a selection model developed for the study. The final chapter, Summary and Conclusions, relates a summary of the study, conclusions, discussion, and recommendations for further research.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Numerous studies have been focused upon the selection of students; however, many of them do not pertain to the industrial education doctoral student. This review of literature was undertaken to investigate the strengths and the weaknesses of existing selection studies. The studies represent the major areas of research that pertain to the selection of students during the past two decades. The relevant studies fall into two main categories: (1) selection studies in industrial education and (2) general selection studies. The studies in industrial education include those that will help one comprehend principles employed in selecting industrial education students. The general studies include those that will help with the overall organization of the study and with the choice of predictor and criterion variables.

Selection Studies in Industrial Education

In 1951 Belman and Evans studied the selection of undergraduate students transferring from other schools

within Purdue University into the trade and industrial education curriculum.[1]

Data were obtained from orientation tests, student records, and other test scores of 107 students. Six tests were employed during the selection of students for the trade and industrial education curriculum: the Purdue Adaptability Test, an English orientation test, the How to Supervise Test (Form M), grades earned before transfer, grades earned in the course entitled Introduction to Trade and Industrial Education, and a question Belman and Evans considered important. The response to the question was considered relevant if the student indicated the option of transferring to the trade and industrial education curriculum was definite.[2]

The criterion variable was grade-point index after transfer to the trade and industrial education curriculum. This variable was correlated with predictors by using the multiple correlation coefficient method.

The investigators concluded that the scholastic success of students entering an industrial education curriculum could be predicted if certain data were available. This conclusion was based upon correlations ($P < .01$) for several predictors with the criterion. The correlations

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[1]H. S. Belman and R. N. Evans, "Selection of Students for a Trade and Industrial Education Curriculum," Journal of Educational Psychology 42 (Winter 1951): 56.

[2]Ibid.

were: (1) Purdue Adaptability .4120, (2) Purdue English .2995, (3) How to Supervise .2893, (4) Purdue mathematics .3441, and (5) index before transfer (GPA) .4982. These correlations probably would have been lower if students with low scores had not been eliminated during the selection for other schools within the university. Thus, the spread of the sample range had been restricted before selection for the trade and industrial education curriculum.[3]

Benson completed a study at Wayne State University in 1958 that was designed to (1) identify objective and subjective factors used in the selection of doctoral candidates specializing in industrial education; (2) establish, insofar as possible, the importance of measurable factors in predicting success for advanced graduate work; and (3) identify methods, techniques, or procedures that had been used to help students successfully complete degree requirements.[4]

Data were collected from student records, research literature, and personal interviews. Information from each student's record and the research literature available

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[3]Ibid., p. 58.

[4]William A. Benson, "Measurable and Observable Factors in the Selection Retention of Doctoral Candidates With Special Implication for Industrial Education" (Ann Arbor, Michigan: Xerox University Microfilm, #ED 11611, 1958), p. 8.

at Wayne State University was related to objective and subjective factors previously used in the selection of industrial education doctoral students. The personal interview was used to collect data pertaining to methods and procedures used by nine department chairmen to aid students in the completion of degree requirements.[5]

The criterion variable for the study was success. Data for the criterion came from students who had graduated or withdrawn from the degree program. Some predictors utilized in the study were undergraduate grade-point average, graduate grade-point average, Miller Analogies Test, and the Graduate Record Examination Verbal and Quantitative scores.

Discriminant analysis was the statistical method applied. This analysis revealed no significant difference between the undergraduate grade-point averages of the successful and unsuccessful groups. However, scores achieved on the Miller Analogies Test and the Graduate Record Examination by the successful group were significantly higher than scores achieved by the unsuccessful group. The latter two tests provided a basis for distinguishing between potential industrial education students who would complete degree requirements and those who would become drop-outs. From these results it can be inferred

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[5]Ibid., p. 9.

that systematic and continuous evaluation of the process of selecting doctoral students is needed.

A study conducted by Johnson in 1949 was designed to (1) determine current admission practices in industrial arts teacher education programs throughout the nation, (2) discover background interests of students, (3) develop profiles of students and other graphic analysis of the findings of various factors that would be helpful in determining the probable potential of students as prospective industrial arts teachers, and (4) offer suggestions and recommendations for improving a selection and guidance program at the State Teachers College in Cheyney, Pennsylvania. The researcher intended that the results of the study be made available to other schools with similar programs.[6]

Johnson used a questionnaire as a data-collection instrument. He collected information on a sample of forty freshman and sophomore industrial arts students who were enrolled from 1947 through 1949. Mean and frequency distributions were the statistical methods employed to determine the effectiveness of tests used in the selection process.[7]

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[6]Rufus C. Johnson, "A Study of Selection and Guidance Procedures for Students in the Program of Industrial Arts Teacher Education at the State Teachers College" (Ann Arbor, Michigan: Xerox University Microfilms, #ED 11616, 1949), p. 9.

[7]Ibid., pp. 4-5.

Actually, the findings of Johnson's study added little to the selection process. However, it was suggested that entrance tests should be administered to all students. The results of these tests could be used in planning programs to meet individual needs.[8]

A study reported by Jarvis in 1953 was concerned with student survival factors at Stout Institute. The intent of the study was (1) to determine the relationship that might exist between entrance test, high school rank, selected high school subjects offered at college entrance, and scholarship in freshman-level technical courses; and (2) to determine whether these entrance tests, high school rank, and selected high school subjects helped to identify students who would complete the requirements for a B.S. degree in four years.[9]

Data were collected on 393 entering freshman industrial arts or vocational-industrial education students who had not taken college work before the entrance examination. The information was obtained from college entrance tests and high school records of students who had enrolled during the school years 1947-48 through 1950-51.[10]

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[8]Ibid., pp. 142-41.

[9]John Jarvis, "Student Survival Factors in the Stout Institute: A Statistical Study of High School Records, Entrance Test Scores, College Course Grades, and Other Measures With Relation to Survival in the Graduation by a College Teacher Training Type-Male Student" (Ann Arbor, Michigan: Xerox University Microfilms, #ED 11615, 1953), p. 3.

[10]Ibid., pp. 7-9.

The multiple regression method was employed with predictor and criterion variables; test measures were used as predictors of the criterion. Whether a student graduated or failed to graduate was the criterion variable. This variable was called success, for statistical application purposes.

The study revealed that tests administered to entering students at Stout Institute were of little value in predicting the success of students enrolled in technical courses in industrial arts or vocational-industrial education. Students who later graduated from Stout Institute could not be identified by their scores on: (1) the American Council on Education Psychological Examination for College Freshmen or (2) the Cooperative English and Myers-Ruch School Progress Test, Form AM. Actually, there was a significant difference between the graduate and the nongraduate in terms of high school rank. This was the only predictor variable that provided relevant information for the selection process. These findings suggested that it would probably have been better to include predictor variables that were not based on formal testing.[11]

In 1963 Torres completed a study that was concerned with determining the relationship between intellectual variables and first- and third-semester achievement of industrial arts students in the industrial, the general,

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[11]Ibid., p. 97.

and the total academic program at Long Beach State College. The study also sought to determine the extent to which the intellectual variables could be used to predict achievement.[12]

Two hundred male junior college students who had enrolled at Long Beach State College and majored in the industrial arts program between 1957 and 1960 were included in the study. These students had to have completed the college entrance tests and three or more consecutive semesters of full-time study at the college.[13]

Data pertaining to predictor and criterion variables were collected from the testing office, the office of the registrar, the records and admissions office, and from industrial arts department records at the college. The predictor variables were the results of the Owen-Bennet Test of Mechanical Comprehension, Form CC; the Minnesota Paper Form Board Test, Series MA; the Cooperative English Ability Test, Form AA; and the junior year college grade-point average. The criterion variables were grade-point average for the first and third semesters in industrial arts, the first- and third-semester grade-point

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[12]Leonard Torres, "A Study of the Relationship Between Selected Variables and the Achievement of Industrial Arts Students at Long Beach State College" (Ann Arbor, Michigan: Xerox University Microfilms, #ED 11620, 1963), p. 6.

[13]Ibid., p. 33.

average for all general courses, and the grade-point average for the total academic program at Long Beach State College.[14]

The regression equation and the multiple correlation were the statistical methods applied; significant relationships were found between predictor and criterion variables. A statistical method was not used to select predictor variables for the study; therefore, this could have had some influence on the relationship between variables.

The review of selection studies in industrial education provided some clues about the weak and strong points to consider when studying the selection of doctoral students. Additional insight was obtained by reviewing other selected studies; these research efforts are discussed in the following section.

General Selection Studies

Chase, Ludlow, and Pugh completed a study at Indiana University in 1964, which was designed to describe characteristics of master's degree students in the school of education and to investigate the utility of admissions tests and personal history data as predictors of success.[15]

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[14]Ibid., pp. 25-27.

[15]Clinton I. Chase, Glenn H. Ludlow, and Richard C. Pugh, Predicting Success for Master's Degree Students in Education (Bloomington: Bureau of Educational Studies and Testing, 1964), p. 1.

A questionnaire was used to collect data pertaining to predictor and criterion variables from about one thousand subjects. Predictor variables for the study were scores on the Cooperative English Test, the Concept Mastery Test, and the numerical ability portion of the Differential Aptitude Test. Data on sex, experience, race, and previous institution attended were also used as predictors of the grade-point average. The multiple correlation coefficient was the statistical method employed in the study.[16]

Data were divided into four subgroups for statistical application. The groups were men, women, Native Negro, and Native White. The Concept Mastery total for men was correlated .30 with grade-point average. However, the Cooperative English Reading and Differential Aptitude Tests were correlated .64 for women. Both of these correlations were large enough to improve the prediction of grade-point average over selection by chance.[17]

Data pertaining to the Native Negro group were analyzed using the vocabulary score from the reading comprehension test. The correlation with grade-point average was .52; this test alone seemed to predict grade-point average as well as a variety of other tests.[18]

Madaus and Walsh conducted a study at a New England university during 1965. The research concerned the

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[16]Ibid., p. 4. [17]Ibid., p. 20. [18]Ibid.

predictive efficiency of the Graduate Record Examinations, and used Graduate Record Examination scores of beginning graduate students who had been involved in an educational testing program from 1961 through 1963. Data pertaining to predictor and criterion variables were collected for 569 students, by department. The criterion variable for the study was grade-point average at the end of a semester of graduate study. The multiple regression analysis was used to select predictor variables in the order of their contribution to the selection process.[19]

Correlations on the subjects' Graduate Record Examination Verbal and Quantitative scores were .19 and .18, respectively. The correlation of Graduate Record Examination scores with grade-point average ranged from 0 to .69 for all departments ($P < .01$). The low correlations could have been a result of the use of a single-category predictor variable. The use of a statistical method to select predictor variables to be applied in the study was a step toward determining the relevancy of predictor variables that were being used in selection studies.[20]

Chase completed a study in 1960 that utilized the records of undergraduate students from Hunter College

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[19]George F. Madaus and John J. Walsh, "Departmental Differentials in the Predictive Validity of the Graduate Record Examination Aptitude Test," Educational and Psychological Measurement 25 (Winter 1965): 1106.

[20]Ibid., p. 1107.

who later earned a doctoral degree, and compared their validity with a random sample of records of the whole student body.[21]

During the fall of 1957 the Office of Scientific Personnel of the National Research Council forwarded Hunter College a list of its graduates who had been awarded the doctorate degree by other institutions between 1936 and 1956. Other data for 294 of these students were collected from their records at Hunter College. The result was that the average of the undergraduate records of the doctoral group was higher than the average of the records of a random sample of nondoctoral graduates, with a difference of .48 ($P < .001$).[22]

Another objective of the research was to determine whether the undergraduate records of students who later received a doctoral degree revealed significant differences in terms of the particular disciplines in which the degrees were received. The records included grades for courses in biological science, arts and humanities, psychology, social sciences, and education. The only significant difference was found in education.[23]

The average of cumulative indices of students who later received a doctorate degree in education was different

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[21]Edith B. Chase, "A Study of Undergraduate Records of Graduates From Hunter College Who Later Earned Doctorates," Journal of Experimental Education 29 (Fall 1960): 59.

[22]Ibid., p. 54. [23]Ibid., p. 59.

from that of the noneducation group, with a significant correlation of .47 ($P < .001$). The cumulative and first-term indices (grades) were found to be useful as predictors of achievement in graduate school. The correlation between first-term grades and cumulative average was .86 for the doctorate degree recipients and .71 for the random sample. A significant correlation (.66) was reported between high school and college averages of the future doctoral recipients.[24]

Finally, the average of the grades earned in the future-doctorate-related major area was higher than the general average. Thus, a review of the academic performance of a potential doctoral student during undergraduate studies might reveal the area in which he is most likely to succeed as a doctoral student.

A study completed by Kooker in 1971 was designed to predict the grade-point average of potential doctoral students enrolled in a required statistics course in the school of education. Data were collected on sixty-nine students identified by the counseling center at North Texas University, even though not all of them had been screened for graduate school. The predictor variables applied in

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[24] Ibid.

the study were the Watson-Glaser (W-G) and the Miller Analogies Test (MAT).[25]

The Watson Glaser Thinking Appraisal, Form AM was administered to students while they were taking the statistics course. This appraisal was designed to measure the students' capacity to comprehend statistics. The criterion measure represented the performance of students on three tests administered during a semester; this score was obtained by totaling the three scores and dividing by the highest total in the class and converting the quotient to a percentage.[26]

The multiple correlation coefficient and the Pearson correlation coefficient were the statistical methods employed with predictor and criterion variables. The correlation between the MAT and the test scores was not significant (.21). However, the correlation between the W-G and the test scores was .37, which was significant ($P < .01$). The multiple correlation coefficient was used to correlate the MAT and the W-G with the criterion; it did not reveal a significant increase over the correlation between the W-G and the test scores.[27]

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[25]Earl W. Kooker, "The Relationship Between Performance in a Graduate Course in Statistics and the Miller Analogies Test and the Watson-Glaser Thinking Appraisal," Journal of Psychology 77 (Spring 1971): 166.

[26]Ibid. [27]Ibid., p. 167.

Actually, the MAT did not reveal a significant multiple correlation coefficient (.38) when used with the W-G. The Watson-Glaser Thinking Appraisal accounted for 14 percent of the variance in test scores. Thus, including in the study students whose applications had not been screened for admittance purposes allowed for less restriction of the sample range than in many previous selection studies. Many studies have revealed a low relationship between performance on the MAT and performance in graduate school when grade-point average was the criterion. This might imply that the MAT should always be employed with other predictor variables when selecting students.

During 1969 Mehrabian reported a study that considered the relationship among a series of predictor variables that could be used with the selection of students in graduate psychology programs. The study further characterized ability factors based on the criteria employed in selecting candidates for graduate school and the relationships between various selection criteria and graduate performance.[28]

Data were collected from the admissions files of 260 potential UCLA graduate psychology students. Using a regression analysis, an admissions committee used the data to assess the validity of thirteen predictor variables.

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[28]Albert Mehrabian, "Undergraduate Ability Factors in Relationship to Graduate Performance," Educational and Psychological Measurement 29 (Summer 1969): 409.

Some of the variables used for projecting the academic success of graduate students were Graduate Record Examination scores, grade-point averages, Miller Analogies Test, number of mathematics and logics courses taken, rating of the department the student had attended as an undergraduate, the amount of research experience as an undergraduate student, sex, and grade-point improvement in the last two years.[29]

Six of the thirteen factors accounted for 75 percent of the total variance; the order of their importance was: Graduate Record Examination and Miller Analogies Test percentiles; research orientation; grade-point averages (overall, junior, and senior years); sex; grade-point improvement in the last two years; and mathematical training.[30]

Finally, the collection of data on students before admittance to the graduate psychology program was an asset of the study because it helped to eliminate some of the restriction on the sample range. Furthermore, the determination of predictor variables in the order of their contribution to the selection process could have given an indication of predictors that could have been eliminated from the selection process because they had little predictive value.

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[29]Ibid., p. 411.

[30]Ibid., p. 414.

A study reported by Merenda and Reilly in 1971 investigated the effectiveness of a set of predictor variables in determining the success of graduate students. Data were collected on seventy-five students admitted to graduate study in psychology at the University of Rhode Island between 1964 and 1968.[31]

Predictors for the study were total undergraduate grade-point average in psychology, overall undergraduate grade-point average (based on a 4.00 grading system), Graduate Record Examination Verbal score, Graduate Record Examination Quantitative score, Graduate Record Examination Advanced score, and the rating of the college at which the baccalaureate degree had been earned. The last was a subjective rating by the instructor. The criterion applied was success, as depicted by the following three categories: (1) students who had earned degrees or were working toward eaning a degree without delay, (2) students who had earned degrees or who had been delayed, and (3) students who had failed to earn degrees because of scholastic failure or for other reasons. The first category accounted for forty of the subjects, whereas the second and third categories accounted for nineteen and eighteen subjects, respectively.[32]

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[31]Peter F. Merenda and Raymond Reilly, "Validity of Selection Criteria in Determining Success of Graduate Students in Psychology," Psychology Report 28 (Winter 1971): 265.

[32]Ibid., p. 261.

Discriminant analysis was the statistical method employed with the data. Among the three criterion categories there was a trend for the scores on the six predictor variables to be higher in the first category and lower in the third. The best predictor variables were total undergraduate grade-point average, Advanced Graduate Record Examination, and grades earned in undergraduate psychology courses. The Graduate Record Examination Verbal score assumed almost one-half of the weight for undergraduate grade-point average; undergraduate college rating assumed less weight but was significant. On the other hand, the GRE Quantitative Test assumed a slighly negative weight.[33]

One advantage of this study was that it included a discriminant analysis method that could determine the probability of an applicant's membership in a criterion group. The results of the calculation of a discriminant equation could be used to predict the category into which a subject would fall. The subject was predicted to belong to the category whose discriminant equation revealed the highest probability. This method has not often been used with the selection process; therefore, the initiation of new studies using the discriminant analysis should provide new insight for the selection process.

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[33]Ibid., p. 263.

Miller's 1973 study was concerned with the importance of admissions criteria to future performance in graduate school. Data from students' academic records were collected for five predictor variables that were to be used with the admission of behavioral science students. Predictor variables used in the study included GRE Verbal score, quality rating of undergraduate institution, grade-point average in sociology coursework, Graduate Record Examination Quantitative score, and undergraduate grade-point average.[34]

Originally, 118 students were considered for the study, but the triadic scale eliminated thirteen subjects because of insufficient data. Some predictor variables' values could not be obtained from the students' academic records; missing values were compensated for by using the overall mean for the population.[35]

The actual admission decision was determined by the use of a multivariate analysis of mean differences to determine significant group differences on the performance criteria. This instrument did indicate a significant predictive relationship for the five predictor variables. The multiple R for the five predictors was .56, with a

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[34]John J. Miller, "The Graduate Admission Process in Two Behavioral Science Departments at Michigan State University" (Ph.D. dissertation, Michigan State University, 1973), pp. 37-55.

[35]Ibid., pp. 53-61.

coefficient of determination equal to .32. The ANOVA F-test value was .0005.

Finally, the study revealed a way to account for missing variable values by using the overall mean, which is discussed in Chapter III. This approach appeared to be an equitable way to account for missing variable values.

A study designed to reveal the usefulness of undergraduate grades and the Miller Analogies Test (MAT) in predicting several measures of "success" in the graduate psychology program at the University of Michigan was undertaken by Platz, McClintock, and Katz in 1959. Data were collected from the records of 124 graduate students from 1950 through 1955. The Miller Analogies Test and undergraduate performance were used to select the population.[36]

The major predictor variables for the study were overall undergraduate grade-point average; undergraduate grade-point average in science, mathematics, and psychology courses; the Miller Analogies Test score; and an objective comprehensive examination. Three measures were also used for defining "success"; they were grade-point average in graduate courses, marks on the preliminary doctoral examination, and a faculty rating.[37]

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[36]Arthur Platz, Charles McClintock, and Daniel Katz, "Undergraduate Grades and the Miller Analogies Test as Predictors of Graduate Success," American Psychologist 14 (Summer 1959): 285.

[37]Ibid., p. 286.

The multiple correlation coefficient and the Pearson product-moment correlation were used for computational purposes. Some of the relationships were as follows: (1) The correlation between grades in gradaute courses and the combined predictors of undergraduate science grades and scores on the comprehensive achievement examination in psychology was .60; (2) The correlations between preliminary and graduate grades and faculty ratings of potential scientific contribution were .63 and .60, respectively; (3) The combination of science grades and scores on the objective comprehensive examination taken when entering the university revealed a correlation of .60; and (4) The correlation of the Miller Analogies Test, the undergraduate science grades, and graduate performance was .52.[38]

This study related how grades earned in subject areas could be used in the selection process. Several categories of predictor variables were applied; this seemed to be more logical than using just one predictor category. One category might indicate a few things about a student's potential, but several could reflect many aspects of the student's potential.

In a selection study they conducted in 1969, Roscoe and Houston used a combination of Graduate Record Examination scores and four criterion variables. The study was concerned with determining the relevancy of the Graduate

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[38]Ibid., p. 288.

Record Examination as a selection standard for doctoral students at Colorado State College.[39]

The sample was restricted to doctoral students who had graduated (231) or who had been dismissed (21) from the program during a recent three-year period. The dismissed students had to have completed a minimum of thirty quarter hours of doctoral work.[40]

The predictor variables applied in the selection study were the Graduate Record Examination Verbal and Quantitative scores. Thus, the criteria represented grade-point average in doctoral studies, graduation versus dismissal from the program, normative judgment analysis, and the ipsative judgment analysis. Data were collected from the students' records in an attempt to develop new criteria for selection purposes.[41]

The multiple correlation coefficient was the statistical method employed; in each case the predictor variables were significantly related to the criterion variables. Actually, better results probably could have been realized if more dismissed students had been included in the sample. Twenty-one dismissed students were too few to include with 231 who had graduated. A ratio of one dismissed student

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[39]John T. Roscoe and Samuel R. Houston, "The Predictive Validity of GRE Scores for a Doctoral Program in Education," Educational and Psychological Measurement 29 (Summer 1969): 508.

[40]Ibid., p. 507.

[41]Ibid., p. 508.

for every three who had graduated would have been a more logical sample.

Summary

In summary, many aspects of past selection studies had to be considered in undertaking a study that would assist in the selection of potential industrial education doctoral students. Table 2.1 displays a summary of related literature, indicating for each study the statistics, data-collection method, sample size, number of predictor variables, number of criterion variables, and the year in which the study was completed.

The survey of related literature revealed some common elements of the selection studies; the present study was based on some of those mutual characteristics. The dominant statistical method was the multiple correlation coefficient, which was used in eleven of the fourteen studies discussed in this chapter. Multiple correlation was not the most appropriate method for the present study, though, since there was a desire to test the ability of a set of predictor variables to discriminate between graduate and drop-out students. Two studies in the review of literature used discriminant analysis, and two used the Pearson correlation coefficient as statistical methods. Discriminant analysis was ideal for testing the effectiveness of predictor variables in a selection process; therefore, it was chosen as the statistical method to be used

Table 2.1.--Summary of related literature.

Author	Statistics				Data Collection					Sample Size	Predictors		Criteria	Date Study Completed
	MR	P	DA	N	SR	T	Q	I	RL		S	M		
Belman & Evans	X				X	X				107		X	GPA	1951
Benson			X		X	X		X	X	9 Dept.		X	Success	1958
Johnson				X			X			40		X	GPA	1949
Jarvis	X				X	X				393		X	Success	1953
Torres	X				X	X				200		X	GPA	1963
C. Chase et al.	X					X	X			1013		X	GPA	1964
Madaus & Walsh	X				X					569	X		GPA	1965
E. Chase	X				X					294	X		GPA	1960
Kooker	X	X			X	X				69	X		GPA	1971
Mehrabian	X				X					266		X	Success	1969
Merenda & Reilly			X							77		X	Success	1971
Millar	X				X					118		X	Performance	1973
Platz et al.	X	X			X					124		X	Success	1959
Roscoe & Houston	X				X					252	X		GPA & others	1969

Key: MR = Multiple correlation
P = Pearson correlation
DA = Discriminant analysis
X = Applicable column
M = Mean
SR = Student record
Q = Questionnaire
I = Interview
T = Test
RL = Review of literature
S = One or two
M = Many--three or more

in the present study. The Pearson correlation coefficient was not adaptable for testing the hypothesis because it only allowed for testing the relationship between one predictor and the criterion variable. The mean was employed with one study, and it showed potential for the present research.

In the studies reviewed, data were collected by using test results, student records, personal interviews, questionnaires, and a review of literature. Student records tended to be dominant and most promising, whereas tests were second in frequency of use. The personal interview and the questionnaire were often employed as data-collection instruments. Therefore, personal interviews, student records, and questionnaires were chosen as the means of obtaining data in the present study because they were economical and could provide the necessary data.

The review of literature displayed varied sample sizes, ranging from forty to over a thousand subjects. These varied sample sizes tended to be appropriate for each study.

Predictor and criterion variables also varied in number. Most studies reported in this chapter used many predictor variables; however, a few did use only one or two variables. Actually, predictor variables that were often successfully used with selection studies were:

(1) overall undergraduate grade-point average, (2) undergraduate grade-point average for the last two years of study, (3) undergraduate and master's grade-point averages in the major area, (4) first-term grade-point average (undergraduate), (5) Miller Analogies Test score, (6) Miller Analogies Test score percentiles, (7) Graduate Record Examination Verbal score, (8) Graduate Record Examination Quantitative score, (9) high school rank, (10) relevant work experience, (11) number of mathematics and logics courses taken, and (12) age of the student. Just one criterion variable was employed in most of the related studies; the dominant criterion was grade-point average. Grade-point average was not a suitable criterion for this study since there was no interest in knowing how accurately quality of scholarship could be predicted. Success was the second dominant criterion employed, and was chosen as the criterion for this study because it allowed a testing of predictors used in classifying industrial education doctoral students as potential graduates or drop-outs. The rationale for variable selection is discussed in Chapter III.

Related studies dated from 1949 through 1973. In these research efforts were found many consistent patterns worthy of consideration for future selection studies. However, a restriction of the sample range was one area of weakness in most selection studies; this occurred because

most subjects were students who had been selected for or who had completed programs. Therefore, most of the studies did not consider students who had applied and were not admitted or those who had been dismissed from doctoral programs. Finally, the strong and the weak areas in these studies helped determine the research design and method for the present study; these subjects are developed more fully in Chapter III.

CHAPTER III

RESEARCH DESIGN AND METHOD

Introduction

The Research Design and Method chapter includes discussions on the sources of data, variables, data collection, hypotheses, and data-analysis procedures. The section on sources of data comprises an identification of the population and the sample. A discussion of variables for the study includes comments on predictor and criterion variables. Covered in the data-collection section are the instruments and the procedures used. The hypotheses relate to a set of predictor variables that discriminates between industrial education doctoral students who will graduate from or drop out of the doctoral program. A section on data-analysis procedures includes the sequences for: (1) preparing data for statistical analysis, (2) testing hypotheses, and (3) visually inspecting independent variables that are used in predicting the criterion variable. A summary highlights the main components of the chapter.

Finally, this chapter displays a plan for accomplishing the following three purposes of the study:

1. To investigate the selection criteria and procedures being used by certain industrial education departments.
2. To test the effectiveness of certain predictor variables (criteria) that industrial educators in selected Big Ten universities can use in selecting industrial education doctoral students.
3. To contribute to the development of a selection model that allows industrial educators in selected Big Ten universities to predict the success of potential industrial education doctoral students.

Sources of Data

The Population

The population included former students identified by representatives of seven industrial education departments within selected Big Ten universities. The Big Ten Records Book 1972-73 was used to identify the Big Ten universities.[1] Subsequently, seven industrial education departments were distinguished by using the Industrial Education Directory for 1974-75.[2]

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[1]Michael McClure and Jeff Elliott, Big Ten Records Book 1972-73 (Chicago: Big Ten Service Bureau, 1972), p. 5.

[2]Industrial Education Directory (Cedar Falls, Iowa: The Wolverton Printing Company, 1975), pp. 19-58.

The Sample

The sample included former doctoral students identified by the seven industrial education department representatives. Former doctoral students were defined as those who had had an industrial arts or a trade and industrial education major while enrolled in the doctoral program and who had graduated from or dropped out of the program. The two categories of former students included: (1) the ten most recent doctoral graduates and (2) the five most recent doctoral drop-outs--former students who had gone beyond the number of years allowed to complete the industrial education doctoral program or defined by departments as drop-outs for other reasons.

The original plan called for a total of seventy doctoral graduates and thirty-five drop-outs. However, not every department had accessible data on the number of subjects needed. Table 3.1 reveals the sample distribution for each department. Seventy-five former students were included in the study, fifty-four of whom were graduates and twenty-one drop-outs. Finally, the last year of attendance for graduates ranged from 1969 through 1975, whereas the year in which official drop-out occurred ranged from 1967 through 1975.

Table 3.1.--Distribution of sample by department.

Department	Graduates	Drop-Outs	Total
1	9	5	14
2	10	5	15
3	10	5	15
4	3	2	5
5	2	2	4
6	10	2	12
7	10	0	10
Total	54	21	75

Variables for the Study

Predictor Variables

Predictor variables refer to independent variables that provide information about the criterion variable. The determination of predictor variables to be used with the selection study was a difficult task, since it was the value of predictor variables that provided a basis for predicting the criterion variable.

The review of literature revealed two procedures for selecting predictor variables; these procedures were classified as "rational" and "statistical." Rational solutions were determined logically; statistical solutions were mathematically based. This study employed both procedures.[3]

[3]Donivan J. Watley, "Factors That Influence the Selection of Predictor Variables in Multiple Regression," College and University 39 (Fall 1973): 72.

Predictor variables in the following categories were originally considered as a basis for choosing variables for the study: (1) predictor variables that were being used in the selection process by the seven Big Ten departments, (2) predictor variables employed in related literature studies, and (3) a few variables suggested by professors in selected Big Ten departments. The following predictor variables were selected for the present study:

1. Overall undergraduate grade-point average
2. Undergraduate grade-point average for the last two years
3. Overall master's grade-point average
4. Master's grade-point average of courses taken in industrial education
5. Years of relevant professional education work experience
6. Graduate Record Examination Verbal score
7. Graduate Record Examination Quantitative score
8. The Miller Analogies Test score
9. Number of publications listed on the application for the doctoral program
10. Age at the time of application to the doctoral program
11. Number of years taken to complete the master's degree program

12. Number of dependents at the time of application to the doctoral program
13. Marital status at the time of application to the doctoral program
14. Last employment before admittance to the doctoral program

All fourteen predictor variables had to be assigned at least one code before the statistical method could be employed. However, variables such as last employment before admittance to the doctoral program, marital status at the time of application, Graduate Record Examination score, Miller Analogies Test score, and grades required more than one code, as explained below.

The place of last employment before admittance to the doctoral program required the use of the following three additional codes: (1) employed by a post-secondary education system (PSED=1); (2) employed by an elementary or secondary education system (ESED=2); and (3) employed by business and industry, military, or other organization (IBMO=3). Marital status at the time of application to the doctoral program was another variable that required the use of other codes; they were: (1) married at the time of application (YES=1) and (2) not married at the time of application (NO=2).

Codes were also associated with raw scores on the Graduate Record Examination and the Miller Analogies Test.

The additional codes were needed because departments only required an applicant to report scores on either the Graduate Record Examination or the Miller Analogies Test; therefore, data on subjects were usually available for only one of the two tests. The codes used with subjects who had missing raw scores on the Graduate Record Examination or the Miller Analogies Test were: (1) Graduate Record Examination Verbal score missing (GREV=4), (2) Graduate Record Examination Quantitative score missing (GREQ=4), and (3) Miller Analogies Test score missing (MATS=4).

The value of grades may vary from one department to another or from one professor to another, but all grades used in this study were considered equivalent for research purposes. Furthermore, grades had to be converted to a numerical grading system for computational purposes; 4.00 was used as the maximum and 0.00 the minimum for the grading scale.

Criterion Variable

A criterion variable refers to a dependent variable that is assumed to be predictable from independent variables. Scores obtained from independent variables were considered "criterion measures" for the criterion variable. Some of the related studies in Chapter II employed more than one criterion variable, but the present study used a single criterion--"success"--as represented by two categories. The categories were: (1) students who had

graduated from the industrial education doctoral program and (2) those who had dropped out of the industrial education doctoral program. This criterion was appropriate since the study was concerned with selecting variables that could discriminate between students who would graduate from or drop out of the doctoral program.

A coding system had to be employed with the criterion variable before the statistical application could be completed. The coding system associated with the criterion variable (success) was: graduates=1 and dropouts=2.

Data Collection

The Instrument

A personal interview was planned and conducted with department representatives in the seven industrial education departments in selected Big Ten universities. The purpose of the interview was to gain insight into the current selection criteria and procedures employed by those departments.

An eighteen-item questionnaire was used to collect data on subjects pertaining to predictor and criterion variables. The questionnaire provided data relevant to two of the research purposes: (1) to test the effectiveness of certain predictor variables (criteria) that industrial educators in selected Big Ten universities

can use in selecting industrial education doctoral students, and (2) to contribute to the development of a selection model that allows industrial educators in selected Big Ten universities to predict the success of industrial education doctoral students.

The Procedures

The data-collection procedures varied. A telephone call was made to each of the seven department representatives requesting an appointment for a personal interview. After the appointment had been arranged, a letter containing an additional explanation of the interview was mailed to each representative. The letter was an outline for the interview, which sought to gain insight into the current selection criteria and procedures, and to obtain recommendations on new variables that might be applied in the selection process. The interview sessions were tape-recorded for future reference.[4]

A few months after the interviews, a letter and questionnaires were mailed to each department. The questionnaire was designed to collect data on each subject pertaining to predictor and criterion variables. The department representative either provided data on subjects from department files or channeled the letter and

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[4]A copy of the personal interview schedule can be found in Appendix A.

questionnaire to another source for data-collection purposes. A stamped self-addressed envelope was mailed with the letter and questionnaire to facilitate the return of raw data.[5]

Questionnaires for each department were color coded to allow for follow-up on instruments that were not returned within three weeks. The coding system also was used to identify the two categories of subjects.

Hypotheses

The hypotheses were related to a set of predictor variables that can discriminate between industrial education students who will graduate from or drop out of the doctoral program. A null hypothesis was applicable, which implies an alternative hypothesis.

> Null Hypothesis: There is not a set of independent variables (predictors) that can discriminate between industrial education students who will graduate from or drop out of the doctoral program (criterion).
>
> Alternative Hypothesis: There is a set of independent variables (predictors) that can discriminate between industrial education students who will graduate from or drop out of the doctoral program (criterion).

Data-Analysis Procedures

The data-analysis procedures included: (1) preparing the data for statistical analysis and (2) testing the hypotheses. Personal interviews and questionnaires

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[5]A copy of the questionnaire can be found in Appendix B.

were used to collect data pertaining to industrial education doctoral departments and subjects included in the study. Data collected through personal interviews were collated and screened for predictor and criterion variables that could be used in the study. After the personal interviews had been completed, data on subjects were collected by means of questionnaires. This information was related to the list of predictor and criterion variables. Before the statistical method could be employed, these data had to be screened for missing variable values. The mean for a variable was used as a substitute for missing values.[6]

The SPSS RAO stepwise discriminant analysis method was used to test hypotheses related to predictor and criterion variables. This method was a subprogram of the Statistical Package for the Social Sciences (SPSS). Nie and others explained the stepwise procedure as follows:

> The stepwise procedure begins by selecting the single best discriminating variable according to a user determined criterion. . . . A second discriminating variable is selected as the variable best able to improve the value of the discrimination criterion in combination with the first variable. The third and subsequent variables are similarly selected according to their ability to contribute to further discrimination.[7]

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[6]Norman H. Nie and others, Statistical Package for the Social Sciences (New York: McGraw-Hill Book Company, 1975), p. 456.

[7]Ibid., p. 436.

Finally, the result of the statistical method provided a listing of predictor variables in accordance with their ability to predict the criterion variable. The discriminant analysis method also provided a classification equation that arranged subjects into groups. Nie and others reported that:

> . . . By classification is meant the process of identifying the likely group membership of a case when the only information known is the case's values on the discriminating variables. . . .[8]

Even though the selection study was not statistically validated, the classification equation was considered to be a predictive model. This model related to one purpose of the study: to contribute to the development of a selection model that allows industrial educators in selected Big Ten universities to predict the success of potential industrial education doctoral students.

The relevant computer output for this study was:

1. The Wilks lambda was an inverse measure of the discriminant power in the original predictor variables that had not been removed from the discriminant function. Lambda was converted to a chi-square (χ^2) statistic to test for statistical significance.

2. Centroids were defined as the mean discriminant scores for each group on the function. When there was only one significant discriminant function, the discriminant

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[8]Ibid., p. 445.

space became unidimensional. This implied that means would be located on a single line.

3. The arithmetic mean was the sum of values involved divided by the number of observations.

4. The F-to-enter represented the F ratio that related to the F distribution. The SPSS program considered 1.0 as the minimum F-to-enter, inferring that an independent variable must have a minimum F-to-enter of 1.0 to be included in an RAO stepwise discriminant analysis equation. The F distribution was defined as the ratio of an unbiased estimate of two population variances, which can be written as:

$$F = \frac{\text{Variance one (numerator)}}{\text{Variance two (denominator)}}$$

The F distribution is formed under the assumption that the larger variance is in the numerator and the smaller variance is in the denominator.[9]

The F statistic was close to 1.0 when both variances approached infinity. When the difference between the numerator and denominator variables became greater, the F statistic increased above 1.0. This suggested that any F statistic less than 1.0 would make a minute contribution toward the discrimination of industrial education

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[9]Ibid., p. 453.

students who would graduate from or drop out of the doctoral program.[10]

The following steps were taken in the statistical application of the data:

1. Data obtained from personal interviews with industrial education representatives were synthesized for predictor and criterion variables to be employed in the selection of doctoral students.

2. Data collected by means of questionnaires were coded and punched onto cards in preparation for statistical analysis.

3. The hypotheses were tested by using the SPSS RAO stepwise discriminant analysis.

The RAO stepwise discriminant analysis method was a computer program taken from the SPSS Version 6.00, dated June 23, 1975. The discriminant classification equation was also considered to be a predictive model. Finally, the CDC 6500 computer at Michigan State University in East Lansing, Michigan, was used for statistical computations.

Summary

The source of data was a sample of fifty-five graduates and twenty-one drop-outs from seven industrial education departments in selected Big Ten universities. The variables included fourteen predictors and one criterion.

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[10]Lincoln L. Chao, Statistics: Methods and Analysis (New York: McGraw-Hill Book Company, 1969), pp. 294-98.

These variables reflected items that could be assigned numerical values.

Data were collected by means of personal interviews and questionnaires. Personal interviews were used to gain insight on the current selection criteria and procedures employed within the seven industrial education departments, and the questionnaires were used to collect data on subjects, pertaining to predictor and criterion variables. Representatives from all departments assisted in data collection.

The stated hypotheses represented predictor and criterion variables. Furthermore, a discussion of the data-analysis procedures revealed how data were used in testing the hypotheses and in developing a predictive model.

In Chapter IV an evaluation of the data is applied to accomplishing the three purposes of the study: investigating selection criteria being used by selected industrial education departments, testing the effectiveness of these criteria, and developing a selection model by which to predict the success of potential industrial education doctoral students.

CHAPTER IV

EVALUATION OF DATA

Introduction

The Evaluation of Data chapter includes: (1) results of interviews with the seven industrial education department representatives, (2) a description of the sample, (3) interpretation of the test of hypotheses, (4) development of a selection model, and (5) a summary. Results of interviews with the seven department representatives give an overview of the selection criteria and procedures. A description of the sample delineates the characteristics of subjects included in the study. The interpretation of the test of the hypotheses expresses the results of a test for the discriminating power of predictor variables, and a discussion of a selection model as it relates to a determination of the most effective predictor variables. The latter discussion also presents a plan for validating the study. Finally, a summary closes the chapter.

Results of Interviews With Seven Department Representatives

Interviews conducted during July, October, and December, 1974, with seven industrial education department

representatives revealed information pertaining to selection criteria and procedures used in their respective departments. The purpose of the interviews was to investigate the selection criteria and procedures being used by certain industrial education departments. The interviews focused on selection criteria, selection processes, features of doctoral degree programs, availability of subjects, and data-collection procedures.

Selection Criteria

The following predictor variables were considered by one or more of the departments during the selection of students: (1) undergraduate grade-point average, (2) master's grade-point average, (3) Graduate Record Examination score, (4) Miller Analogies Test score, (5) years of professional education work experience, (6) marital status, (7) age at the time of application, (8) letter of recommendation, (9) industrial arts teacher certification, (10) vocational teacher certification, and (11) baccalaureate or master's degree from a different school. Table 4.1 shows the selection criteria used by the seven departments.

All departments used the undergraduate grade-point average as a selection criterion. It was implied that the grade-point average for the last two years of undergraduate class work was sometimes more important than an overall

undergraduate grade-point average. Since many students need the first two years to select a major and adjust to the new environment, serious class work often occurs after this period. Department representatives also expressed a belief that the overall grade-point average provided an indication of performance over a longer period of time, which could reflect the student's stability. Only one department utilized a cut-off grade-point average.

Table 4.1.--Summary of selection criteria.

Criteria Required	Department						
	1	2	3	4	5	6	7
Undergraduate GPA	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Master's GPA	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GRE score	Yes	Yes	Yes	No	No	No	Yes
MAT score	No	No	No	Yes	Yes	Yes	No
Educ. work exp.	Yes	Yes	Yes	Yes	Yes	No	No*
Marital status	X	X	X	X	X	X	X
Age at time of application	X	X	X	X	X	X	X
Letter of recomm.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Indust. arts certif.	No	Yes	No	No	No	No	No
Vocational certif.	No	No	No	No	Yes	No	No
Degree from a different school	No	No	Yes	No	No	No	No*

Yes = required
No = not required
* = recommended
X = not a formal criterion for selection but sometimes considered

The master's grade-point average was a part of the selection criteria for each department. Interviewees generally agreed that the grade-point average for the overall program better represented the student's potential than did the grade-point average for courses taken in industrial education, since the doctoral program represented course work in many different departments. However, the grade-point average for courses taken in the major area was sometimes considered along with test scores as a selection measure.

The Graduate Record Examination and the Miller Analogies Test scores were also components of the selection criteria. Four departments used the Graduate Record Examination and the other three used the Miller Analogies Test. Department representatives indicated that many applicants provided scores on nonrequired tests, i.e., the Miller Analogies Test in lieu of the Graduate Record Examination, when applying for the doctoral program. These scores were often considered along with the required score or until the required score was available. One department required an additional set of test scores, but these tests were administered after the applicant had been admitted. The result of the scores was used for advising students while the program was being planned.

Three departments required applicants to have or be able to obtain two years of relevant professional

education work experience, and two others required applicants to have three years of experience. Another department recommended educational work experience but no one was rejected for lacking it. One department did not require work experience; however, most applicants did have some experience. Generally, it was agreed that professional education work experience before admittance to the program was important.

Marital status at the time of application to the doctoral program was not considered a formal criterion for selection, even though it was indicated this information could be helpful under certain conditions. For example, an applicant who was married and had little financial support could be a poor risk when compared with a single applicant with little financial support. It was expressed that marital status alone should not be used in the selection of students.

Age at the time of application to the doctoral program was perceived as a factor in the selection process, but it was not a stated criterion for selection. Some departments were hesitant to admit applicants over forty years of age. The older applicant would not have long to make a contribution in the field; therefore, admittance might be a poor investment for the department. The older applicant was dealt with by discussing the positive and negative aspects of admittance during a personal interview.

In many instances, the applicant decided to withdraw his application or to pursue a different program.

The letter of recommendation was another component, and its importance varied with departments. The concern was for the validity of the recommendation instead of the number required. In most instances, a telephone call to the person who had written the letter provided additional information that helped in making the selection decision.

One of the departments required the applicant to have an industrial arts teaching certificate before being admitted to the doctoral program, and another required the applicant to have or be able to obtain a vocational teacher certificate before graduation. The other departments did not relate any stipulation regarding teacher certification.

Just one department required the applicant to have a baccalaureate or master's degree from a different school. The rationale was that a student who obtained a doctorate should be exposed to different points of view and methods of personal development. The other department representatives indicated that most of their students had obtained degrees from other universities and there was no formal provision in the selection process for this criterion. Finally, if the applicant had received both degrees from the same university, course work might be required at other universities.

Selection Process

Generally, the inquiry letter was the initial step in becoming aware of people who might have an interest in the graduate school. An application form and other data were then forwarded to the potential student. If the application was returned, the selection process continued.

One department representative implied that a partial recruiting process was operating in his department. This process was carried out through graduates who were working at other colleges and universities. For example, a former student might recommend the name of a potential applicant to the department, and a representative from the department would then contact that person.

Interviewees indicated their departments used several procedures to collect data about applicants. One department was directly involved in collecting data, even though the graduate college office usually provided some information. Two other departments received selection data from the Office of Graduate Studies, which collected and compiled all information pertaining to applicants and forwarded it to the appropriate department. Data on applicants for the other four departments were collected by the graduate college office and forwarded to the appropriate department for action. These varied procedures did not appear to weaken the quality of data collection or impede the admittance of qualified applicants.

The actual selection decision process followed several patterns, but the staff always played a major role. In all but one instance, the applicant's completed file was forwarded to the department from the graduate college office or the Office of Graduate Studies. The faculty members of the department usually met as a committee and made selection judgments. They would then return their recommendation to the graduate college office or the Office of Graduate Studies for implementation.

Some of the departments circulated the applicant's file to each staff member, with a sheet of paper attached for ratings and/or comments. When this procedure was followed, no comments were revealed until the file had been circulated to all staff members involved. After the file had been circulated, a faculty representative tabulated the results, and, if necessary, a general meeting of the staff was held to make a final decision. The final departmental decision was sent back to the graduate college office or the Office of Graduate Studies as a recommendation.

The department that was directly involved with collecting data completed all files and periodically circulated them among staff members. The members wrote comments on an attached form before returning the file to the department representative. A committee meeting of

the staff for final decision making often preceded the representative's recommendation to the graduate college office.

Factors other than an indication of probable success in the doctoral program also entered the selection process. The availability of faculty members seemed to be of great concern, since a student could have the necessary qualifications and still not be admitted if faculty members already had their quota of advisees. The unwillingness of faculty members to serve as an applicant's advisor was also a factor in nonadmittance, since each new student was expected to have a temporary advisor upon admittance to the doctoral program.

It was inferred that the number of graduate students who would be ready to write their dissertations at a given time could help determine the number of new students with whom the staff could work. This was because students needed additional assistance from the staff while writing their dissertations.

The availability of a fellowship was considered to be important when making decisions on applicants who needed financial assistance. In many instances, applicants were admitted under such circumstances, even though they probably would not enroll.

None of the departments had undergone recent major changes in the selection process, although there had been minor changes in program content.

Features of Doctoral Degree Programs

Four of the departments conferred Ph.D. or Ed.D. degrees, and three granted only a Ph.D. degree. Four departments allowed the student five years from the time of admittance to complete the doctoral program. Another department granted five years to complete the degree requirements after the student had passed the comprehensive examination. In the latter case, the student had to be enrolled at least three terms each school year during the five years, or else he would be dismissed. One department allowed seven years from the time of admittance to complete degree requirements. Students in the remaining department had eight years to complete the program from the time they were admitted. However, they had to pass the comprehensive examination within five years, and all other work for the doctoral degree had to be completed within three years after passing the examination. The number of years allowed to complete the degree program was based on normal circumstances; any student could request and be granted additional time.

Availability of Subjects

Representatives from all departments revealed that they could probably identify ten graduates, but were not sure they could identify and provide the necessary data for five drop-out students.

Data Collection

Five interviewees revealed that their departments could obtain information directly from the graduate office. The remaining two departments collected data pertaining to students from the Office of Graduate Studies.

Description of the Sample

This section provides an overall review of data collected on predictor variables. Two of the predictors--last employment experience before admittance to the doctoral program and marital status--were treated as having an either-or type of data. For the former variable, data were recorded in three categories. For instance, 59 percent of all subjects had been employed by a post-secondary education system; 37 percent had been employed by an elementary or secondary education system; and the remaining 4 percent had been employed by industry, business, military, or other organizations. It was inferred that the majority of subjects had had professional education work experience. The second predictor variable was marital status at the time of application to the doctoral program.

Ninety-one percent of all subjects were married; 9 percent were not married. These findings indicated that most of the former students admitted to the industrial education doctoral program had been married.

The remaining twelve predictors were treated as continuous variables. This inferred that data on predictor variables provided values on the range of real numbers. Table 4.2 presents the means of the twelve continuous variables. The overall mean for each continuous variable was used as a basis for characterizing all subjects.

As Table 4.2 shows, the first four means pertained to grade-point averages. These means revealed that there was an improvement in performance (GPA) from the baccalaureate to the master's level. However, this was misleading since a higher minimum grade-point average was required to receive a master's than a baccalaureate degree.

The next three means were derived from test scores. The mean for the Graduate Record Examination Quantitative score was higher than the one for the Graduate Record Examination Verbal score. Actually, the average student had a total Graduate Record Examination mean of approximately nine hundred. The third mean was the Miller Analogies Test score; this mean was approximately fifty-six, a middle-range score.

A mean score for the years of relevant professional education work experience revealed that most of the students

had had at least seven years of professional education work experience before admittance to the doctoral program.

Table 4.2.--Mean for each continuous predictor variable.

Predictor Variables	Means
Overall undergraduate grade-point average	2.9568
Undergraduate grade-point average for the last two years	3.1427
Overall master's grade-point average	3.5659
Master's grade-point average of courses taken in industrial education	3.7171
Graduate Record Examination Verbal score	429.5067
Graduate Record Examination Quantitative score	491.8800
Miller Analogies Test score	55.7733
Years of relevant professional education work experience	7.2133
Number of publications listed on the application for the doctoral program	.8667
Age at the time of application to the doctoral program	32.3600
Number of years taken to complete the master's degree program	1.9733
Number of dependents at the time of application to the doctoral program	1.9733

A further inspection of means revealed that most students had listed less than one publication on the application for the doctoral program. It was assumed that these students were not prolific writers.

The average age for students at the time of application was over thirty-two; this was expected since most students had had more than seven years of professional education work experience before applying for the graduate program.

The number of years taken to complete the master's degree was less than two. This was expected since it usually takes a full-time student one school year to complete the degree program and many of these people were part-time students. The final mean referred to the number of dependents at the time of application to the program. The average student had nearly two dependents; since most of the students were married, it was expected that the average would be about two dependents.

To summarize, most of the characteristics reinforced the results of the interviews with the seven industrial education department representatives. These findings also gave an indication of what might be expected from an interpretation of the hypotheses.

Interpretation of the Hypotheses

The interpretation of the hypotheses was directly related to the second purpose of the study: to test the effectiveness of certain predictor variables (criteria) that industrial educators in selected Big Ten universities can use in selecting industrial education doctoral students. The hypotheses referred to predictor and criterion

variables employed in the study. The SPSS RAO stepwise discriminant analysis was the statistical method employed; it formed one or more linear combinations of the fourteen independent variables. The analysis provided a statistical test for measuring the degree to which the independent variables discriminated between groups when combined into a discriminant function. The number of functions was one because the maximum number of functions was considered one less than the number of groups or equal to the number of independent variables. The latter was true only if there were more groups than independent variables. Actually, the function was formed to maximize the separation of the two groups for this study.[1]

The decision to reject or accept the hypotheses was based on the Wilks lambda value provided by the computer output for the discriminant analysis method. Lambda was an inverse measure of the discriminating power of the predictor variables. Wilks lambda can be transformed into a chi-square statistic for a test of statistical significance. It is possible to make a type I or a type II error when testing hypotheses. The type I error occurs if the null hypothesis is true but rejected. The type II error occurs if the null hypothesis is false but accepted. This study was concerned with not rejecting a true null hypothesis;

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[1]Nie and others, Statistical Package for the Social Sciences, p. 435.

therefore, the level of significance was set at .05, which meant that the probability of making the correct decision was .95.[2] Furthermore, the null hypothesis was applicable, which implies an alternative hypothesis.

> Null Hypothesis: There is not a set of independent variables (predictors) that can discriminate between industrial education students who will graduate from or drop out of the doctoral program (criterion).
>
> Alternative Hypothesis: There is a set of independent variables (predictors) that can discriminate between industrial education students who will graduate from or drop out of the doctoral program (criterion).

RAO stepwise discriminant analysis was computed and a value of .59989 was observed for Wilks lambda, which was significant ($\chi^2 = 34.23791$; $df = 14$; $P < .002$). Therefore, the null hypothesis was rejected and the alternative was accepted.

A similar conclusion can be reached by visually inspecting the group centroids. The means on all functions were referred to as group centroids. Centroids from a single group were the most logical location of a case from that group in the discriminant function space. Since there was only one significant discriminant function for this study, the discriminant space was unidimensional. This inferred that group centroids were located on a single line. A visual comparison of the group centroids displayed how well independent variables could discriminate between groups. Table 4.3 displays the group centroids.[3]

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[2]Ibid., p. 442.

[3]Ibid., p. 443.

Table 4.3.--Group centroids.

Group 1 (Graduates)	Group 2 (Drop-Outs)
.50246	-1.29204

The difference between the two centroids revealed that the set of predictor variables could be used to discriminate between industrial education students who would graduate from or drop out of the doctoral program.

In addition, an interpretation of the canonical correlation indicated the relationship between the predictor variables and the criterion variable. The canonical correlation indicated how closely the function and the criterion variable were related. However, when the canonical correlation was squared it represented the proportion of variance in the discriminant function that was explained by the groups.[4] The computed value for the canonical correlation was .63254, which indicated that 40.011 percent of variance in the criterion variable was explained by the set of predictor variables.[5]

Rejection of the null hypothesis implied that there was a statistically significant relationship between predictor and criterion variables. Therefore, the next step was to explore the relevancy of this finding.

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[4]Ibid., p. 442.

[5]A copy of selected output data generated for the SPSS RAO stepwise discriminant analysis is included in Appendix C.

Development of a Selection Model

A model designed to help select industrial education doctoral students can be developed by employing the predictor variables that were considered most effective in selecting industrial education doctoral students. This section is related to the third purpose of the study: to contribute to the development of a selection model that allows industrial educators in selected Big Ten universities to predict the success of potential industrial education doctoral students. A visual inspection of the F-to-enter for each predictor associated with the discriminant function was undertaken as a cut-off technique to determine independent variables that were most effective in the selection process; any other association of these F-to-enter values with this study could be misleading. The minimum F-to-enter was set at 1.0. This cut-off point was based on the rationale presented in Chapter III, which indicated that any predictor variable with an F-to-enter value less than 1.0 would make a minute contribution toward the discrimination of industrial education students who would graduate from or drop out of the doctoral program. Therefore, any independent variable that made only a minute contribution should be deleted from the set of predictors.

The F-to-enters for the fourteen predictors are presented in Table 4.4. These variables are listed in descending order, based on Wilks' lambda scores reported

Table 4.4.--F-to-enter summary table.

	Abbreviation	Description	F-to-Enter
1	*NYMS	Number of years taken to complete the master's degree program	16.18407
2	*GREQ	Graduate Record Examination Quantitative score	6.28823
3	*ATAD	Age at the time of application to the doctoral program	2.05146
4	*OGPA	Overall undergraduate grade-point average	1.50742
5	*MTAP	Marital status at the time of application to the doctoral program	1.50782
6	*OMGP	Overall master's grade-point average	2.38890
7	*MATS	Miller Analogies Test score	1.79002
8	*NDEP	Number of dependents at the time of application to the doctoral program	1.65142
9	*NPUB	Number of publications listed on the application for the doctoral program	1.64670
10	YRWE	Years of relevant professional education work experience	.95161
11	GPAL	Undergraduate grade-point average for the last two years	.54363
12	LEMP	Last employment before admittance to the doctoral program	.51549
13	MMGP	Master's grade-point average of courses taken in industrial education	.56103
14	GREV	Graduate Record Examination Verbal score	.25371

*F-to-enter greater than 1.0.

in Appendix C. Actually, only the first nine predictor variables revealed an F-to-enter equal to or greater than 1.0. Therefore, they were considered most effective in selecting industrial education doctoral students who would graduate from or drop out of the doctoral program. These nine predictors accounted for 37.250 percent of variance in the criterion variable. The five predictor variables that were deleted only accounted for an additional 2.761 percent of variance in the criterion variable. This implied that each of the five deleted predictors accounted for less than 1 percent of the variance, which was not an effective amount of contribution toward the selection process. Table 4.5 reveals a summary of the discriminating power of the nine predictor variables; it is not an attempt to validate the selection model.

Table 4.5.--Discriminating power of nine predictor variables.

Actual Group	Number of Cases	Predicted Group Membership	
		Group 1	Group 2
Group 1 (Graduates)	54	51 68%	3 4%
Group 2 (Drop-Outs)	21	9 12%	12 16%

84.0 percent of known cases correctly classified
Chi square = 34.680 Significance = .000

The first, third, fifth, and ninth predictor variables listed in Table 4.4 had not officially been used by the seven departments included in this study as part of their selection process. These findings suggested that the four predictors made an effective contribution to the selection process.

The classification equation that follows represented a method of identifying a subject's likely group membership when only raw values on predictor variables were known. A series of classification functions can be used to determine group membership. Two classification equations would be computed for each subject. One equation would be computed to determine the classification score for the applicant as a graduate, and the other would be computed to determine the classification score for the applicant as a drop-out. The applicant would then be assigned to the group for which the higher score was recorded.

An equation that can be employed with the classification process would be stated as $C_1 = c_{i1}V_1+c_{i2}V_2+ \ldots+_{ip}V_p+c_{i0}$. C_i is a representation of the score i, the $c_{ij's}$ indicate the classification coefficients, and c_{i0} represents the constant. The V's symbolize the raw scores on discriminating variables.[6] Actually, the validation

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[6]Nie and others, Statistical Package for Social Science, p. 445.

results should be similar to the data reported in Table 4.5.

Summary

The interviews with Big Ten industrial education department representatives provided information on current selection criteria and procedures. These data were used to assist in making the initial choice of predictor variables for the study.

The description of the sample provided an overall review of characteristics for the data collected on predictor variables. Two of the predictors provided either-or types of data, and twelve others provided continuous data.

The hypotheses for this study were tested by using the SPSS RAO stepwise discriminant analysis. The null hypothesis was rejected, and the alternative was accepted. Accepting the alternative hypothesis inferred that it was appropriate to investigate further the most effective predictor variables.

A selection model was designed by employing the nine most effective predictor variables. The RAO stepwise discriminant analysis classification equation was considered to be a procedure for validating the selection model. The findings discussed in this chapter are developed more fully in the summary and conclusions, which follow in Chapter V.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The selection of industrial education doctoral students has usually been based on the best available predictor variables. The industrial educator usually has employed these predictors when making selection decisions. Therefore, as a way of providing the best set of predictor variables to be used in the selection process, the study had the following purposes:

1. To investigate the selection criteria and procedures being used by certain industrial education departments.
2. To test the effectiveness of certain predictor variables (criteria) that industrial educators in selected Big Ten universities can use in selecting industrial education doctoral students.
3. To contribute to the development of a selection model that allows industrial educators in selected Big Ten universities to predict the success of potential industrial education doctoral students.

The review of literature revealed that many studies have pertained to the selection of students. However, not

many studies have been concerned with the industrial education doctoral student. Many aspects of past selection studies were considered in developing this study. For example, common characteristics of the studies were: (1) use of multiple regression analysis, discriminant analysis, and Pearson correlation as the statistical methods; (2) collection of data by means of student records, test results, personal interviews, and questionnaires; (3) variation in sample sizes; and (4) variation in the number of predictor and criterion variables. Most studies employed many predictor variables and one criterion variable. Some common predictors were grade-point average, Graduate Record Examination score, and the Miller Analogies Test score.

The restriction of the sample range was a weakness of most selection studies. This occurred because consideration was not given to applicants who had applied for a program and not been admitted, or to former students who had been dismissed from a program.

The chapter on research design and methodology encompassed discussions on sources of data, variables, data collection, hypotheses, and data-analysis procedures. The sample included seventy-five former doctoral students identified by seven industrial education department representatives. Fifty-four of these subjects were graduates and twenty-one were drop-outs.

Fourteen independent variables were used as the initial set of predictors to discriminate between students who had graduated from or dropped out of the doctoral program. The criterion variable was success, which represented two categories: (1) students who graduated from the industrial education doctoral program and (2) students who dropped out of the industrial education doctoral program.

Data-collection instruments used in the present study were the personal interview and the questionnaire. An interview was conducted with seven industrial education department representatives to collect data pertaining to the selection criteria and procedures. This information assisted in making the initial choice of a set of predictor variables. The data collected on the fourteen predictors were compiled from the questionnaires.

The data-collection procedures also included telephone calls and letters to representatives from the seven departments. Data had to be screened for missing values before statistical application; the overall mean for a variable was substituted for missing values.

The SPSS RAO stepwise discriminant analysis method was employed to test the hypotheses, whereas the discriminant analysis classification equation was considered to be a selection model and a procedure for validation.

The evaluation of data chapter included the results of interviews with seven department representatives, a description of the sample, an interpretation of a test for hypotheses, and a discussion of a selection model. Interviews with department representatives revealed independent variables that could be used to determine the best set of predictors for discriminating between industrial education students who would graduate from or drop out of the doctoral program. The department representatives expressed the belief that the trend was for the industrial educator to be involved with the selection decision.

Description of the sample provided an overall characterization of data collected on predictor variables. Two variables provided an either-or type of data and the others provided continuous data. It was discovered that a majority of the subjects had common characteristics; for example, 96 percent of the subjects had professional education work experience and 91 percent were married. Mean scores further revealed that:

1. The average of the four grade-point means was greater than 3.00.
2. The mean scores for the three tests were mid-range.
3. The average student had over seven years of professional education work experience.

4. The average student listed less than one publication on his application.
5. The average student was over thirty-two years of age.
6. The average student completed the master's program in less than two years.
7. Most subjects listed fewer than two dependents on their applications.

An interpretation of the hypotheses was directly related to whether a set of predictor variables could discriminate between students who would graduate from or drop out of an industrial education doctoral program. The decision to reject or accept the null hypothesis was based on the chi-square statistics. The null hypothesis was rejected since the chi-square value was significant ($\chi^2 = 34.23791$; $df = 14$; $P < .002$). A similar conclusion was made by visually inspecting group centroids and the canonical correlation. Rejection of the null hypothesis indicated that the alternative was accepted. By accepting the alternative hypothesis, it was inferred that a further investigation of the most effective predictors was in order.

A selection model was considered a device that would aid in discriminating between industrial education students who would graduate from or drop out of the doctoral program. The model included the most effective independent variables as components of the selection

process. These variables were chosen by visually inspecting the F-to-enter from the computer output. The minimum F-to-enter for a variable to be included in a discriminant function was set at 1.0. It was concluded that only the first nine predictor variables were relevant for the selection process ($\chi^2 = 34.680$; df = 9; $P < .000$). These variables are listed in the conclusions. The selection model represented a method of identifying the subject's likely group membership when only raw values on predictor variables were known.

Conclusions

An analysis of the results revealed that a set of predictor variables can be used to discriminate between industrial education students who will graduate from or drop out of the doctoral program. The following predictors represented the set of variables, based on Wilks' lambda scores:

1. Number of years taken to complete the master's program
2. Graduate Record Examination Quantitative score
3. Age at the time of application to the doctoral program
4. Overall undergraduate grade-point average
5. Marital status at the time of application to the doctoral program

6. Overall master's grade-point average
7. Miller Analogies Test score
8. Number of dependents at the time of application to the doctoral program
9. Number of publications listed on the application for the doctoral program
10. Years of relevant professional education work experience
11. Undergraduate grade-point average for the last two years
12. Last employment before admittance to the doctoral program
13. Master's grade-point average for courses taken in industrial education
14. Graduate Record Examination Verbal score

Even though the set of fourteen predictor variables was significant ($\chi^2 = 34.23791$; $df = 14$; $P < .002$), it was also necessary to determine the most effective variables. Therefore, the F-to-enter from the computer output revealed that the first nine predictors within the list were better suited as an optimal set of independent variables than were the other five predictors.

Discussion

A test for the effectiveness of fourteen predictor variables revealed that they were useful in the selection of doctoral students who would graduate from or drop out

of an industrial education program. However, some variables made a greater contribution to the selection process than others. For instance, by visually inspecting the F-to-enter value from the computer output, it was discovered that the first nine predictors listed on pp. 81-82 were most effective in the selection process. This implied that these nine variables would be an optimal set for the selection process. These variables accounted for 37.25 percent of variance in the criterion variable. Finally, these variables could be used with a discriminant analysis classification equation as a selection model.

Four of the nine independent variables had not officially been used in the selection process; therefore, their inclusion in a selection model would be an improvement over what had been done in the past. The four independent variables were:

1. Number of years taken to complete the master's degree program
2. Age at the time of application to the doctoral program
3. Marital status at the time of application to the doctoral program
4. Number of publications listed on the application for the doctoral program

Based upon the Wilks' lambda value, the number of years taken to complete the master's degree program was the

most important single predictor for selecting industrial education students who would graduate from or drop out of the doctoral program. The second variable, age at the time of application to the doctoral program, was the third most important single factor included in the set. Marital status at the time of application to the doctoral program and number of publications listed on the application for the doctoral program ranked seventh and ninth, respectively.

Just as four important criteria were not officially being employed in the selection process, four criteria presently being used in the seven departments were found to be of little value. According to this study, the following criteria made little contribution to the selection of doctoral students when considered with the set of fourteen factors:

1. Years of relevant professional education work experience
2. Undergraduate grade-point average for the last two years
3. Master's grade-point average for courses taken in industrial education
4. Graduate Record Examination Verbal score

Surprisingly, these four predictors were rated tenth, eleventh, thirteenth, and fourteenth, respectively, within the set of fourteen variables.

An inspection of mean scores for predictor variables on both graduate and drop-out students revealed some interesting facts. The industrial educator could use this information while visually inspecting raw data on applicants. It would be helpful to know whether to expect a potential graduate student to have a higher Miller Analogies Test score than would a drop-out. However, if inferences are made based on these predictor variables, it must be remembered that the statistical method treated them as a set and no implications should be made about each variable separately. Table 5.1 reveals data that allow for the following inferences:

1. Graduate doctoral students usually needed a little more than one and one-half years to complete the master's program and drop-outs needed more than two and one-half years.
2. Scores on the Graduate Record Examination and the Miller Analogies Test were generally lower for graduates than for drop-outs.
3. The undergraduate and master's grade-point averages were usually higher for graduates than for drop-outs.
4. Age at the time of application was approximately thirty for graduates and thirty-six for drop-outs.
5. Generally, a larger percentage of graduates were married than were drop-outs.

Table 5.1.--Summary of means for graduates and drop-outs.

Predictors*	Graduates	Drop-Outs
NYMS	1.66667	2.76190
GREQ	479.33333	524.14286
ATAD	30.85185	36.23810
OGPA	3.00759	2.82619
MTAP	1.07407	1.14286
OMGP	3.57722	3.53667
MATS	55.68519	56.00000
NDEP	1.70370	2.66667
NPUB	1.00000	.52381
YRWE	6.38889	9.33333
GPAL	3.16815	3.07714
LEMP	1.37037	1.57143
MMGP	3.73222	3.67810
GREV	419.96296	454.04762

*Codes for predictors can be found on p. 72.

6. The average number of dependents listed on the application was at least one for graduates and more than two for drop-outs.
7. An average of one publication was listed on the application for graduates, fewer for drop-outs.

8. Generally, graduates had a little more than six years of professional education work experience and drop-outs had more than nine years.
9. A larger proportion of graduates than drop-outs were employed by a post-secondary education system before admittance to the program.

It was finally decided that the nine most effective predictors would provide a basis for developing a selection model. However, it must be remembered that these variables only accounted for 37.25 percent of variance in the criterion variable. This implies that 62.75 percent of variance could be found in other predictor variables.

Recommendations

The statistical method used in selecting the most effective predictors appears to be fundamentally sound. The original list of predictors represents information that was obtainable from student files. However, the list of nine variables provided for improvement of the selection process; additional improvement might occur by using nonobjective variables in the selection process. The following variables are recommended in an attempt to improve the selection process further:

1. Rating for the letter of recommendation
2. Applicant's level of aspiration
3. Rating of the applicant's writing skills

4. Applicant's participation in professional education organizations

If selection decisions are made based on this set of nine predictor variables, it must be remembered that a validation procedure was not included in this study. Therefore, it is recommended that future researchers address themselves to validation procedures.

It is also suggested that future researchers consider studying the success of students on the job in the major field after graduating from or dropping out of the doctoral program as an attempt to improve the selection process.

Finally, the absence of data on students who applied for the doctoral program but were not admitted suggests that some of these people should be included in the sample of subjects for future studies.

APPENDICES

APPENDIX A

PERSONAL INTERVIEW DATA

APPENDIX A

PERSONAL INTERVIEW DATA

Guide for Telephone Call

1. Hello, I am Charlie Harris. May I speak to Dr. Dow please?

2. Dr. Dow, I am Charlie Harris, a doctoral student at Michigan State University. My advisor contacted you recently concerning a selection study that I am planning within Big Ten universities.

3. If possible, I would like to arrange for an interview with you in order to discuss the selection process for industrial education doctoral students at your university. It will take approximately one hour to complete the interview, and the desired dates for the interview are:
   A. July 1 through 30
   B. October 1 through 29
   C. December 1 through 20

4. I will forward a letter tomorrow giving more details pertaining to the concerns that are relevant for my study.

5. I am looking forward to the session.

THANKS!

Typical Letter

3918 Hunters Ridge Drive #2
Lansing, Michigan 48910
July 5, 1974

University of Mars
Division of Industrial Education
Mid Western, University 81111

Dear Dr. Dow:

I am an industrial education doctoral student at Michigan State University in East Lansing, Michigan.

This letter is in reference to my telephone call on July 5, 1974, and my appointment on July 10, 1974, to discuss an industrial education selection study for doctoral students.

I would like to discuss the following items during my visit:

1. Selection criteria and procedures for industrial education doctoral students at your university (Ph.D. and Ed.D)
2. Factors that have been identified pertaining to the selection of students:
    A. Grade-point averages
    B. Graduate Record Examination scores
    C. Miller Analogies Test scores
    D. Other test scores
    E. Marital status
    F. Age of applicant
    G. Years of professional education work experience
    H. Number of different jobs at the time of application
3. Additional factors that you consider important in the selection process
4. The procedure that I could use to collect data on the following people from your department:
    A. Most recent ten doctoral graduates
    B. Most recent five drop-outs from the department (means of identifying drop-outs)

Dr. Dow July 5, 1974

5. Change in industrial education doctoral program at your school within the past eight years:
   A. Selection process
   B. Course content
   C. Objective
   D. Student population
6. The number of years a student has to complete the doctoral program in your department
7. The average number of years it takes a student to complete your doctoral program
8. The number of people who applied for the doctoral program in your department this year:
   A. Estimate of the number accepted
   B. Estimate of the number rejected
9. Accessibility of data from the student's record:
   A. Admissions office
   B. Industrial education (the student's file)
10. Any other confounding variables that you have encountered with the selection process in industrial education

This information would be extremely helpful to me while completing my proposal and conducting a study of this nature.

I am looking forward to my visit on July 10, 1974, and thanks for the opportunity.

Respectfully yours,

Charlie Harris

APPENDIX B

QUESTIONNAIRE FOR DATA COLLECTION

APPENDIX B

QUESTIONNAIRE FOR DATA COLLECTION

Please fill in the data that you have available and return the questionnaire as soon as possible.

1. When was the student admitted to the doctoral program? 19____
2. What was the overall undergraduate grade-point average? _____
3. What was the undergraduate grade-point average for the last two years of study? (Last ninety quarter or last sixty semester hours) _____
   A. Check "✓" whether quarter ___ or semester ___ hours.
   B. Check "✓" the highest possible point attainable under the grading system: 12__11__10__9__8__7__6__5__4__ 3__2__1__ Other (list)_____
4. What was the overall master's grade-point average?_____
5. What was the master's grade-point average of courses taken in industrial education?
   A. Check "✓" whether quarter ___ or semester ___ hours.
   B. Check "✓" the highest possible point attainable under the grading system: 12__11__10__9__8__7__6__5__4__ 3__2__1__ Other (list)_____
6. What was the number of years of relevant professional education work experience listed on the application for the doctoral program? (Ten or nine calendar months equal one year) _____
7. What was the last employment prior to admittance to the doctoral program? (Check "✓" one)
   A.__Employed by a post-secondary education system.
   B.__Employed by an elementary or secondary education system.
   C.__Employed by business and industry, the military, or other organizations.
8. What was the Graduate Record Examination Aptitude Raw Score? (Answer below):
   A. Verbal Score_____
   B. Quantitative Score_____
9. What was the Miller Analogies Test Raw Score?_____
10. What was the student's age at the time of application to the doctoral program?_____

11. How many years did it take the student to complete the master's study? (Ten or nine calendar months equal one year) _____

12. How many dependents were listed on the application for the doctoral program? _____

13. Was the student married at the time of application to the doctoral program? (Check "✓" one) Yes___ No___

14. How many publications were listed on the application for the doctoral program? _____

15. Did the student begin or return to a full-time job prior to getting the dissertation proposal approved? (Check "✓" one) Yes___ No___

16. What type of job accepted immediately after leaving the university? (Check "✓" one)
    A.__Returned to old job (job before admitted to the program).
    B.__Accepted a new job.

17. What was the student's legal residence at the time of application to the doctoral program? (Check "✓" one)
    A.__In-state classification
    B.__Out-of-state classification

18. What year did the student graduate or terminate (drop out) from the doctoral program? 19___

NOTE: Please feel free to estimate the answer for any question; however, please place a plus (+) sign by the estimated answer.

THANKS!

APPENDIX C

DATA FROM COMPUTER OUTPUT SHEET

APPENDIX C

DATA FROM COMPUTER OUTPUT SHEET

Table C1.--Standard deviations for predictor variables.

Predictors[a]	Group-1	Group-2	Total
NYMS	.89020	1.41084	1.16217
GREQ	66.98099	72.21100	70.94249
ATAD	6.13806	7.13376	6.83125
OCPA	.40460	.26849	.37875
MTAP	.26435	.35857	.29286
OMGP	.25994	.30542	.27193
MATS	9.62666	6.73795	8.86928
NDEP	1.12652	1.74165	1.38499
NPUB	1.95226	1.36452	1.81088
YRWE	4.77579	4.90238	4.96009
GPAL	.39247	.32861	.37576
LEMP	.55952	.59761	.57359
MMGP	.28808	.25719	.27913
GREV	50.95354	77.59799	61.02688

[a]Codes for predictors can be identified on page 72.

Table C2.--Standardized discriminant function coefficients.

Predictors[a]	Function Coefficients
NYMS	-.60827
GREQ	-.40722
ATAD	-.69082
OGPA	.22746
MTAP	-.45350
OMGP	-.54301
MATS	-.32631
NDEP	-.46544
NPUB	.30440
YRWE	.37086
GPAL	.22285
LEMP	-.19574
MMGP	.20444
GREV	.12971

[a]Codes for predictors can be identified on page 72.

Table C3.--Unstandardized discriminant function coefficients.

Predictors[a]	Unstandardized Coefficients
NYMS	- .523397
GREQ	- .574013E-02
ATAD	- .101127
OGPA	.600559
MTAP	-1.54852
OMGP	-1.99691
MATS	- .367915E-01
NDEP	- .336062
NPUB	.168098
YRWE	.747679E-01
GPAL	.593053
LEMP	- .101127
MMGP	.732423
GREV	.212543E-02

[a]Codes for predictors can be identified on page 72.

Table C4.--Summary of entry criteria and F-to-remove.

Predictors[a]	Entry Criteria	F-to-Remove
NYMS	22.47788	5.61457
GREQ	33.29598	2.67982
ATAD	37.18753	5.71948
OGPA	40.17172	.55363
MTAP	43.26518	3.51180
OMGP	48.34701	2.69806
MATS	52.34745	2.10943
NDEP	56.19416	2.76199
NPUB	60.18635	2.04796
YRWE	62.58881	1.37527
GPAL	64.00377	.54292
LEMP	65.37889	.74429
MMGP	66.91270	.39828
GREV	66.50984	.25371

[a]Codes for predictors can be identified on page 72.

Table C5.--Summary of variables in the function.

Predictors[a]	Wilks Lambda	Sig.	RAOS V	Change in RAOS V	Sig.
NYMS	.81853	.000	16.18407	16.18407	.000
GREQ	.75279	.000	23.97310	7.78903	.005
ATAD	.73165	.000	26.77502	2.80192	.094
OGPA	.71622	.000	28.92344	2.14862	.143
MTAP	.70091	.000	31.15093	2.22729	.136
OMGP	.67712	.000	34.80984	3.65892	.056
MATS	.65950	.000	37.69017	2.88032	.090
NDEP	.64340	.000	40.45980	2.76963	.096
NPUB	.62750	.000	43.33417	2.87438	.090
YRWE	.61831	.000	45.06394	1.72977	.188
GPAL	.61302	.001	46.08271	1.01877	.313
LEMP	.60796	.001	47.07280	.99009	.320
MMGP	.60242	.001	48.17714	1.10434	.293
GREV	.59989	.002	48.68953	.51239	.474

[a]Codes for predictors can be identified on page 72.

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

Anderson, Jonathan; Durston, Berry; and Poole, Millicent. Thesis and Assignment Writing. London: John Wiley and Sons Austraiasia PTY. Ltd., 1970.

Astin, Alexander W. Predicting Academic Performance in College. London: Collier-MacMillan Limited, 1970.

Campbell, Giles W., and Ballou, Stephen V. Form and Style; Theses, Reports, Term Papers. Atlanta: Houghton Mifflin Company, 1974.

Carmichael, Oliver C. Graduate Education: A Critique and a Program. New York: Harper and Brothers, 1961.

Catell, R. B., and others. The Prediction of Achievement and Creativity. New York: The Bobbs-Merrill Company, Inc., 1968.

Chaiho, Kim. Statistical Analysis for Induction and Decision. Hinsdale: The Dryden Press, Inc., 1973.

Chao, Lincoln L. Statistics: Methods and Analyses. New York: McGraw-Hill Book Company, 1969.

Culbertson, Jack A., and Heneley, Stephen P. Educational Research: New Perspectives. Danville: The Interstate Printers and Publishers, Inc., 1963.

Dial, O. Eugene. Computer Programming and Statistics for Basic Research. Atlanta: American Book Company, 1968.

Dunnette, Marvin D. Personnel Selection and Placement. Belmont: Brooks/Cole Publishing Company, 1966.

Griggs, Charles M. Graduate Education. New York: The Center for Applied Research in Education, Inc., 1965.

Hays, William L. Statistics for the Social Sciences. Atlanta: Holt, Rinehart and Winston, Inc., 1973.

Heiss, Ann M. Challenges to Graduate Schools. San Francisco: Jossey-Bass, Inc., Publishers, 1970.

Huck, Schuyler W., and others. Reading Statistics and Research. New York: Harper and Row, Publishers, 1974.

Jackson, Robert W. B., and Johnson, Palmer O. Modern Statistical Method: Descriptive and Inductive. Chicago: Rand McNally and Company, 1959.

Jones, Ralph H. Methods and Techniques of Educational Research. Danville: The Interstate Printers and Publishers, Inc., 1973.

Nie, Norman H., and others. Statistical Package for Social Sciences. New York: McGraw-Hill Book Company, 1975.

Roscoe, John T. Fundamental Research Statistics for the Behavioral Sciences. Toronto: Holt, Rinehart and Winston, Inc., 1969.

Schuessler, Karl. Analyzing Social Data: A Statistical Orientation. Atlanta: Houghton Mifflin Company, 1971.

Thatcher, Virginia S., and others. The New Webster Encyclopedic Dictionary of the English Language. Chicago: Consolidated Book Publishers, 1969.

Tuckman, Bruce W. Conducting Educational Research. New York: Harcourt-Brace-Jovanovich, Inc., 1972.

Turabian, Kate L. A Manual for Writers of Term Papers, Theses, and Dissertations. Chicago: The University of Chicago Press, 1973.

Wallen, Norman E. Educational Research: A Guide to the Process. Belmont: Wadsworth Publishing Company, Inc., 1974.

Walters, Everett. Graduate Education Today. Menasha: George Banta Company, 1965.

Monographs

Brown, Nicholas C. Higher Education Incentives and Obstacles. Washington, D.C.: The American Council on Education, 1960.

Cartter, Allan M. An Assessment of Quality in Graduate Education. Washington, D.C.: The American Council on Education, 1966.

Chase, Clinton I., and others. Predicting Success for Master's Degree Students in Education. Bloomington: Bureau of Educational Studies and Testing, Indiana University, 1964.

Guide to the Use of the Graduate Record Examination 1973-74. Princeton: Educational Testing Service, 1973.

Industrial Teacher Education Directory. Cedar Falls: The Wolverton Printing Company, 1975.

McClure, Michael, and Elliot, Jeff. Big Ten Records Book 1972-73. Chicago: Big Ten Service Bureau, 1972.

Tellen, Johnson Judy G. Predictive Model of the Cumulative Academic Achievement of Graduate Students From India. Ann Arbor: University of Michigan, 1971.

Walton, J. C. Graduate Study in Universities and Colleges in the U.S. Bulletin #20. Washington, D.C.: Government Printing Office, 1935.

Articles

Alexakos, Constantine E. "The Graduate Record Examination Aptitude Tests as Screening Devices for Students in the College of Human Resources and Education, West Virginia University." College and University 43 (Spring 1968): 342-47.

Belman, H. S., and Evans, R. N. "Selection of Students for a Trade and Industrial Education Curriculum." Journal of Educational Psychology 42 (Winter 1951): 52-59.

Bogue, E. G. "Application of a Minimum Loss Decision Strategy in the Selection of Cut-Off Points in College and University Admissions." College and University 43 (Winter 1968): 131-42.

Borg, Walter R. "GRE Aptitude Scores as Predictors of GPA for Graduate Students in Education." Educational and Psychological Measurement 23 (Summer 1963): 379-82.

Chaplin, Jack; Gradewell, John; and Todd, Ronald. "Industrial Arts Teacher Education: Myths and Realities." Man/Society/Technology: A Journal of Industrial Arts Education 34 (Winter 1974): 93-94.

Chase, Edith B. "A Study of Undergraduate Records of Graduates From Hunter College Who Later Earned Doctorates." Journal of Experimental Education 29 (Fall 1960): 49-60.

Feder, Daniel D. "Intriguing Problems of Design in Predicting College Success." Educational and Psychological Measurement 25 (Spring 1965): 29-37.

Haskell, Roger W. "The Influence of Instructional Learner Academic Achievement--An Observation." Journal of Industrial Teacher Education 9 (Summer 1972): 50-55.

Hillgarth, J. W. "Graduate Admission--Havoc Into Chaos." College and University 42 (Summer 1967): 489-504.

Kooker, Earl W. "The Relationship Between Performance in a Graduate Course in Statistics and the Miller Analogies Test and the Watson-Glaser Critical Thinking Appraisal." Journal of Psychology 77 (Spring 1971): 165-68.

Madaus, George G., and Walsh, John J. "Departmental Differentials in the Predictive Validity of the Graduate Record Examination Aptitude Test." Educational and Psychological Measurement 25 (Winter 1965): 1105-10.

Mehrabian, Albert. "Undergraduate Ability Factors in Relationship to Graduate Performance." Educational and Psychological Measurement 29 (Summer 1969): 409-14.

Merenda, Peter F., and Reilly, Raymond. "Validity of Selection Criteria in Determining Success of Graduate Students in Psychology." Psychological Report 28 (Winter 1971): 259-66.

Platz, Arthur; Katz, Daniel; and McClintock, Charles. "Undergraduate Grades and the Miller Analogies Test as Predictors of Graduate Success." American Psychologist 14 (Summer 1959): 285-89.

Roscoe, John T., and Houston, Samuel R. "The Predictive Validity of GRE Scores for a Doctoral Program in Education." Educational and Psychological Measurement 29 (Summer 1969): 507-509.

Watley, Donivan J. "Factors That Influence the Selection of Predictor Variables in Multiple Regression." College and University 39 (Fall 1963): 72-76.

Dissertations

Bagley, Clarence H. "An Evaluation of Differential Prediction of Academic Success for Students at Washington State University." Ph.D. dissertation, Michigan State University, 1966.

Bakan, Rita. "The Relationship-Variability to Academic Performance and Self-Concept of Academic Ability." Ph.D. dissertation, Michigan State University, 1968.

Brandt, Richard P. "The Relationship of Selected Preadmission Data to Graduation Measures of Graduate Performance, and Department Profiles of College of Education Master's Students at MSU." Ph.D. dissertation, Michigan State University, 1970.

Burrell, Leon F. "Non-Academic Variables as They Relate to Academic Achievement of Male Black Doctoral Candidates." Ph.D. dissertation, Michigan State University, 1971.

Harris, Robert G. "A Classification Model for Predicting Academic Performance for Master of Business Administration Students at Michigan State University." Ph.D. dissertation, Michigan State University, 1968.

Millar, John James. "The Graduate Admission Process in Two Behavioral Science Departments at Michigan State University." Ph.D. dissertation, Michigan State University, 1973.

Microfilms

Benson, Willard A. "Measurable and Observable Factors in the Selection Retention of Doctoral Candidates With Special Implication for Industrial Education." Ann Arbor, Michigan: Xerox University Microfilms, 1958. #ED 11611.

Jarvis, John. "Student Survival Factors in the Stout Institute: A Statistical Study of High School Records, Entrance Test Scores, College Course Grades and Other Measures With Relation to Survival in the Graduation by a College of Teacher Training Type-Male Student." Ann Arbor, Michigan: Xerox University Microfilms, 1953. #ED 11615.

Johnson, Rufus C. "A Study of Selection and Guidance Procedures for Students in the Program of Industrial Arts Teacher Education at the State Teachers College." Ann Arbor, Michigan: Xerox University Microfilms, 1949. #ED 11616.

Torres, Leonard. "A Study of the Relationship Between Selected Variables and the Achievement of Industrial Arts Students at Long Beach State College." Ann Arbor, Michigan: Xerox University Microfilms, 1963. #ED 11620.