1989

A comparative study of univariate and multivariate methodological approaches to educational research

Robert M. Crawford
Iowa State University

Order Number 8920120

A comparative study of univariate and multivariate methodological approaches to educational research

Crawford, Robert M., Ph.D.

Iowa State University, 1989

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

A comparative study of univariate and multivariate methodological approaches to educational research

by

Robert M. Crawford

A Dissertation Submitted to the

Graduate Faculty in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Department: Professional Studies in Education
Major: Education (Research and Evaluation)

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

For the Major Department

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa

1989

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I. INTRODUCTION

This research compares and contrasts two different methodological approaches, univariate and multivariate, in the analysis of data. The source of data throughout this study was collected as a part of the longitudinal study of Iowa State University's teacher preparation program. It was hypothesized that a multivariate analysis of the teacher education program would provide a more in-depth and complete understanding of the underlying factors that were measured.

Background

The appropriate statistical analysis used in any research design should be selected with the requirements of the study in mind. When selecting the method, a number of factors should be considered, including (1) What are the research questions or statistical hypothesis? (2) Are the dependent variables related or correlated with each other? (3) Do the variables meet the required statistical assumptions, including the correct underlying distribution, and (4) What are the levels of measurement for the variables, nominal, ordinal, interval, or ratio? Based on these and the design of the research, an appropriate analysis can be identified. The statistical analyses "should not be an end in themselves, but a means to an end. They assume a service function in the research process" (Wiersma, 1986).

Rarely does one see research that relies solely on one response variable. Pedhazur (1982) wrote, "Phenomenon to be studied is multidimensional, one cannot encapsulate it in a single score without thereby distorting it or even entirely stripping it of its meaning." Researchers should never be so naive as to study the implications of a complex experimental treatment or look for group differences on a survey instrument by examining only one dependent variable. "The many faceted nature of educational processes demands that measurements should be made on many variables, and that the procedures of analysis employed should be capable of the simultaneous examination and analysis of the many variables on which data have been collected" (Keeves, 1988). Social science researchers invest a tremendous amount of time researching, planning, writing, piloting, rewriting, and finally administering a survey or an experimental design and collect many responses for each subject. These responses, or dependent variables, represent subjects' reactions or thoughts to the experimenter's problem. It is then up to the researcher to study and extract all the meaningful and significant factors from these response variables. Univariate and multivariate methodology represent two methods of examining these relationships.

Univariate methodology looks at each response variable as a unique and separate variable. This type of methodology includes such statistical tests as the independent and dependent t-tests, simple linear regression, and analysis of variance. Conversely, multivariate methodology looks at a group of dependent variables and attempts to examine the relationship among the dependent variables, as well as the independent-dependent variable relationships.

Multivariate data consist of observations on a number of different variables for a number of different subjects. This type of data can be found in all types of research, including psychological and educational; in fact, it is believed that a vast majority of data is multivariate in nature (Chatfield and Collins, 1980), yet up to the mid-1960s educational researchers had not explored the relationships between the dependent variables.

The researcher using a multivariate approach looks for a dependence or correlation among subjects' scores on all the dependent variables; that is to say, there should be within each subject a correlation between the dependent variables.

Hubble (1984) states three major concerns to be considered when applying a multivariate technique over a univariate technique. (1) Does the construct being measured require the use of multiple indicators? (2) Are the dependent variables to be analyzed considered as a part of a similar set? (3) Does the research use all the material available? Stevens (1986) notes three reasons why multiple criterion measures should be used in research, and thus a multivariate statistical approach to the analysis of data. (1) Any worthwhile treatment will affect subjects in more than one way, thus multiple measures are necessary. (2) By using multiple measures, a more complete and detailed description of the phenomenon can be obtained. (3) A researcher can work with the maximum amount of information from a project, with minimum increase in costs.

Hubble (1984) wrote a quantitative review of research articles for the 1980 edition of the Journal of Educational Psychology. He stated that 31% of the research used a multiple variable construct, and failed to employ a multivariate analysis, but rather used a univariate technique.

Multivariate techniques are concerned with three sets of variables, with the first being the relationships among the set of dependent or criterion variables. The second set of variables include the independent or predictor variables, with the third set examining the relationship between sets one and two.

Multivariate statistics are in general very difficult to calculate by hand, but are easily calculated with the use of computers. Its limited use should not be interpreted to mean that multivariate statistics are only recent developments, as are computers. The introduction of multivariate statistics can be traced back to the late 1800s to Francis Galton with his work on the correlation between two variables. Karl Pearson built on Galton's work to further the work on the bivariate normal distribution. Sir Ronald Fisher, father of the analysis of variance, also did work with discriminant analysis in the 1930s. At the same time, Harold Hotelling developed the concepts behind canonical correlation and principal components. Finally, Samuel Wilks has been credited for the commonly used lambda test statistic used to examine multivariate analysis of variance. It can be seen that multivariate analyses have been available for a number of years, but until the development of the computer, these procedures were limited in use. Yet even with computers and associated statistical packages, educational researchers have still relied upon the older, more established univariate applications (Keeves, 1988).

Just as univariate data analysis has numerous statistical tests, so does multivariate. Multivariate techniques, in general, look for relationships between the sets of dependent and independent variables, then try to simplify data into relatively few parameters. Some multivariate techniques are:

1. Principal Components - This technique attempts to reduce the original variables into a new reduced number of uncorrelated factors or components. The technique is primarily used for data reduction or simplification.
2. Cluster Analysis - This technique attempts to group or cluster individuals based on numerous dependent variables.
3. Discriminant Analysis - Using subjects in known groups and their responses to dependent variables, discriminant analysis classifies new individuals into groups based on the subject's responses.
4. Multivariate Analysis of Variance - This technique is very similar to univariate analysis of variance with the exception that the difference between a vector of means is examined.
5. Canonical Correlation - Linear combinations of the dependent and independent variables are formed by this technique with the hope of identifying mutually independent relationships between the two sets.
6. Multiple Linear Regression - This technique's primary purpose is to predict the single dependent variable's score using multiple independent or predictor variables.

Need for the Study

Multivariate statistical analyses in educational research projects are presently very limited at this institution and others. While numerous books and articles have been written and computer statistical software packages developed regarding the application of multivariate methodology, its adaption and infusion as a statistical technique has been quite slow. Therefore, a study is needed to define, identify, and illustrate multivariate procedures using an educational example. This study must be clear and concise and could be used as a guide to others exploring multivariate methodology.

Statement of the Problem

In this research a series of multivariate techniques will be used to explore the relationship among areas of teacher preparation in a teacher education program at Iowa State University. The independent factors would include the expected teaching level of the pre-service teacher upon entering the teaching profession and the year in which the pre-service teacher graduated. The dependent factors include 33 areas in which the pre-service teachers rated their perceived preparation, various factors measuring the respondents' satisfaction with their student teaching experience, and a measure of the respondents' overall rating of the teacher education program. It is hypothesized that a cluster of dependent factors are influenced by the level of teaching, year of graduation, and/or an interaction of these two factors.

Purpose of the Study

The purpose of this study was to conduct, compare, and contrast a univariate and multivariate analysis of data collected on Iowa State University teacher education graduates from 1984 through 1988. Using the graduates' self-ratings on 33 areas of preparation in their teacher education program, the researcher attempted to find relationships between the sets of variables that had not been previously discovered. It was also hypothesized that there was a relationship between the students' ratings on the 33 areas of preparation and their satisfaction with their student teaching program of study. Another major purpose was to provide a clear and understandable guide to others who are attempting to apply multivariate methodology to their research projects.

Source of Data

Data used in this methodological study were from the ongoing research conducted by the Research Institute for Studies in Education (RISE) for the purpose of evaluating the teacher preparation program at Iowa State University. In particular, data were gathered from a survey administered to teacher education students at the time they graduated.

In general, the surveys have remained constant over the past five years. Items from the survey that provided data for this research included (1) the graduates' student teaching level, (2) the year in which they graduated, (3) a self-assessment of the adequacy in the Iowa State University teacher education program in 33 areas of teacher preparation, (4) four self-measures of the respondents' satisfaction with their student teaching experience, and (5) a self-rating of the overall quality of the teacher preparation program.

Objectives

Six objectives were established to give guidelines throughout the study. These objectives were:

1. To examine the areas of teacher preparation using a univariate analysis of variance and determine the areas of significance.
2. To determine the underlying factors that can be found by surveying the teacher education graduates on their rating of the areas of preparation in their education program.
3. To examine the areas of teacher preparation using a multivariate analysis approach.
4. To determine if there is a relationship between the 33 areas of preparation and the five measures of satisfaction with the student teaching preparation program.
5. To compare differences and conclusions concerning the areas of teacher preparation when data were analyzed using univariate and multivariate analyses techniques.
6. To provide a practical, clear, and concise guide to educational researchers on the analysis of data drawn from a multivariate population.

This study was conducted by the author in cooperation with the Research Institute for the Studies in Education, RISE, in the College of Education at Iowa State University. The surveys used in this research project all had prior approval from the Iowa State University Human Subjects and Rights Committee, and adequate guidelines were followed to maintain the rights of the individuals sampled.

CHAPTER II. REVIEW OF LITERATURE

Introduction

The primary purpose of this study was to examine the conclusions drawn from the analysis of the same data using two different methodological approaches. One methodological approach was to test a null hypothesis that there is no difference in the means from different groups using a univariate analysis of variance. This approach has been very commonly used in educational and psychological research. The second approach, or multivariate approach, was to test the null hypothesis that there is no difference in the vectors of means for each of the groups.

This review of literature consists of three major sections. The first section pertains to the criteria necessary for a multivariate approach. It includes the various multivariate techniques applicable to this research and their assumptions. A general overall approach to multivariate methodology was also covered in this section. A major problem with multiple univariate tests is their effects on the Type I error rates. This topic is covered in the second section. The third section includes a discussion of the teacher preparation variables and their importance to the improvement in the teacher education program at Iowa State University.

Multivariate Analyses

Multivariate analyses are inherently difficult due to the fact the researcher wishes to examine not only the relationship between a set of independent and dependent variables, but also the relationship within each set of variables. Analyses are further complicated by the immense amount of data collected and the need to use matrix algebra to manipulate the data. Recent advances in computer and statistical packages have eliminated the need for hand calculations, yet the understanding of multivariate analyses still lags behind.

Many multivariate techniques have been developed during the past century to aid researchers in better understanding the data. All multivariate techniques have three assumptions that must be satisfied before the appropriate technique can be applied. First, the observations must be independent. Secondly, the variables must follow a multivariate normal distribution. Third, the population covariance-variance matrix for the dependent variables must be equal for all groups. Each of these assumptions has been addressed separately.

The first assumption, assumption of independent observations, is by far the most important assumption (Stevens, 1986). Violation of this assumption produces a significant effect on both the overall level of significance and the power of the test statistic. Violation of this assumption is caused when there is a dependence among the observations, for example, when one subject's response affects the responses of other subjects. Barcikowski (1981) found that for a given sample size, the actual alpha level increased as the dependence between observations increased. For example, for a sample size of 30 and a nominal alpha level of .05, when the correlation between observations was .10, the actual alpha equaled .30. When the correlation increased to .30, the actual alpha level equaled .59. It is easily seen that the assumption of independence must be rigidly maintained when applying a multivariate technique.

Education research often has a problem with dependence of observations. For example, a few troublemakers in a classroom have an effect on the achievement for all students in the class. One way around this problem of dependence has been to use the unit of analysis as the classroom, although this method results in a greatly reduced sample size. Glass and Hopkins (1984) made the following statement concerning independence. "Whenever the treatment is individually administered, observations are independent. But where treatments involve interaction among persons, the observations may influence each other."

The second assumption is that the observations on the dependent variables follow a multivariate normal distribution in each group. All the techniques discussed in this research were based on the assumption that data were generated from a multivariate normal distribution. To be multivariate normal distributed, the vector of random variables must follow the following distribution:

$$f(x) = \frac{1}{(2\pi)^{p/2} \left|\Sigma\right|^{1/2}} \exp [-1/2(x-u)^T \Sigma^{-1}(x-u)]$$

This is usually abbreviated $x = Np(u,\Sigma)$.

Multivariate normally distributed data must follow three criteria: (1) Each variable when treated separately must come from a normal distribution; (2) any linear combination of the variables will also be normally distributed; and (3) all subsets of the set of variables must also have a multivariate normal distribution.

At the present time there are no statistical tests available to test the assumption that a given sample arising from a population has a multivariate normal distribution (Bock, 1980). The best method has been to graphically examine each of the dependent variables separately to see if data followed the curve of a normal distribution. It should be noted that it is possible that each dependent variable follows the normal distribution, yet when considered collectively they do not follow the multivariate normal distribution. A second graphic method has been to plot all pairs of dependent variables and examine that plot. If the resulting scatterplots are elliptical in shape, the researcher could conclude that together the dependent variables are from a multivariate normal distribution. If the scatterplot was linear in shape, the assumption was rejected. A third graphic method has been to use a full normal plot for each of the dependent variables. After examining the graphs, a determination should be made as to the degree at which it follows the normal distribution. If it appeared that data did not follow the normal distribution, a data transformation should be implemented. Monte Carlo studies examining the effect of violating this assumption has led researchers to conclude that deviations from a multivariate normal distribution have only a nominal effect on Type I error. Violation of this assumption has less importance as sample size increases. Therefore, it can be concluded that the assumption is fairly robust in nature.

Various types of transformations can be applied to the dependent variable with the intent to transform the data into a normal distribution (Ostle and Mensing, 1975). The logarithmic transformation is required when the standard deviation is proportional to the mean of the variable. The new transformed variable is calculated by taking the log of the original variable. The square root transformation, calculated by taking the square root of the initial value, is implemented when the variance of the original data is proportional to the mean. The third transformation is called the arcsine. This is applied when data are considered as count data. The fourth transformation called the reciprocal is applied when the standard deviation is proportional to the square of the mean for the dependent variable (Ostle and Mensing, 1975). Figure 1 shows possible data transformations based on the distribution of the original dependent variable.

The third and final assumption is that the population covariance matrices for the p dependent variables are equal. This assumption means that, for example, in a two group case with five variables, each of the five variances are equal between groups and the off diagonals or the ten covariances are also equal. In research with 33 dependent variables and five separate groups, the assumption requires that each of the five variance-covariance matrices, with their 560 members, be equal. It can easily be seen that this assumption is very restrictive; therefore, it is not a case of are the matrices equal, but rather how will the violation affect the error rate.

Various Monte Carlo studies have been used to examine the effect of an unequal covariance matrix on error rate. Holloway and Dunn (1967) found that if equal sample size was maintained within each group, the actual error rate stayed very close to the nominal or pre-set alpha rate for all

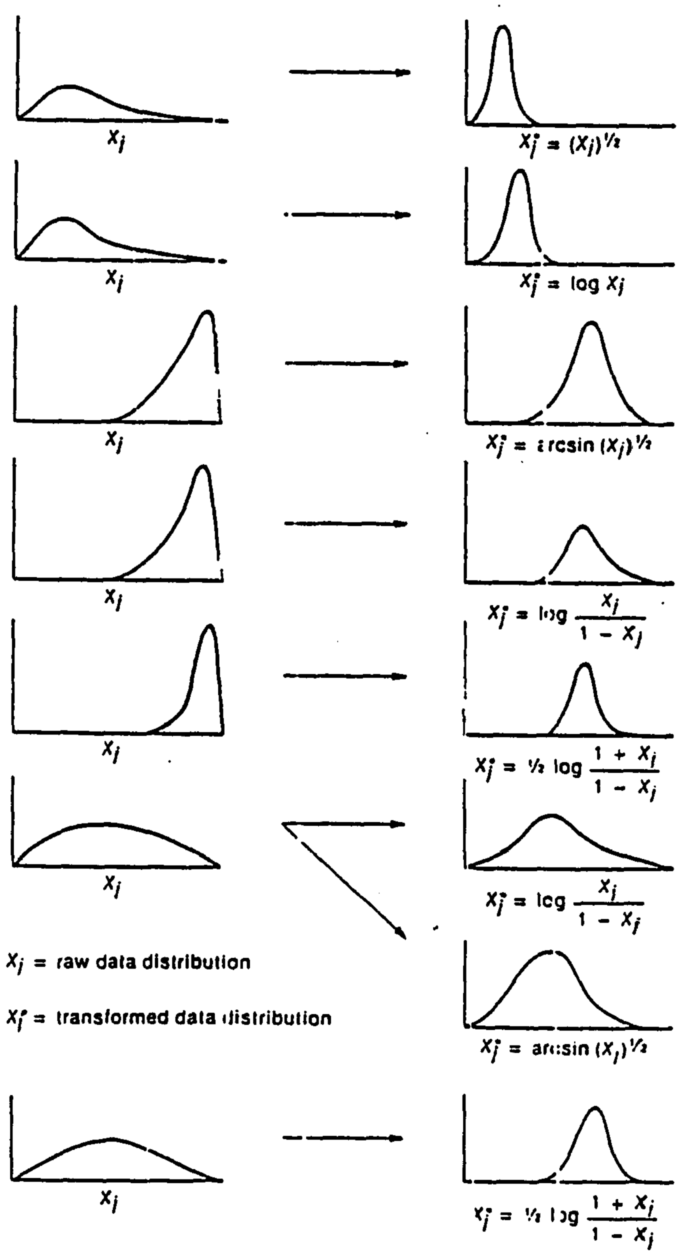


Figure 1. Data transformation

cases, except in extreme cases of heterogeneity of variance. When looking at unequal sample size, and moderate inequality of covariance, if the variability was in the small group, it produced a liberal test; whereas, if the variability was in the large group, the test was conservative. Hakstian et al. (1979) found that with sharply unequal sample size and mild heterogeneity, the Type I error rate was greatly affected. Olson (1974) considered only equal sample size and extreme heterogeneity and concluded that research should "strain to attain equal group size in the k group case."

Attention should also be given to the sample size in each of the groups from which the covariance matrices are determined. Pedhazur (1982) found that a researcher would be well advised to maintain equal sample sizes due to the fact that most statistical tests are more sensitive with equal N. Equal N also minimizes the distortion caused by departures from the assumption that the data come from a multivariate normal distribution.

Unlike the other two multivariate assumptions, the assumption of equal covariance-variance matrices is easily testable. Box (1953) developed the Box statistic that tests whether the covariance matrices are equal. This Box statistic uses the generalized variance, the determinant of the within covariance matrix, to calculate its test statistic. Before using the Box statistic, the researcher should check to insure that data follow a multivariate normal distribution because the Box statistic is very sensitive to non-normality. The Box statistic follows two distributions depending on the size of the sample. Researchers should use the chi-squared distribution with sample sizes less than 20 and six or less dependent variables; otherwise, the F distribution should be used. Using an alpha level of .05, the researcher would desire a calculated alpha greater than .05, thus he or she would conclude that the matrices are equal. If the statistic is found to be significant, the researcher using the generalized variance and sample size for each group determines whether the statistic is liberal or conservative. A step-by-step flow chart designed by Stevens (1986) for accessing multivariate assumptions can be found in Figure 2.

Although multiple dependent variables are commonly measured, it should not be concluded that all dependent variables should be included in the analysis. If a large number of dependent variables are used, often small or negligible differences on most of them may obscure the real differences on a few of the dependent variables. Pruzek (1971) found that there was a reduction in reliability of an instrument when using numerous multiple measures due to increase in errors of measurement. Another drawback to multiple measures was that interpretation of the results often was compounded with increased number of measures; therefore, data reduction methods, such as principal components or factor analysis, should be commonly carried out to reduce the measurements into a few definable constructs, from which a multivariate statistical analysis can be performed.

Error Rates

A very popular design in educational research has been to assign subjects to X number of treatments, then following the manipulation of the

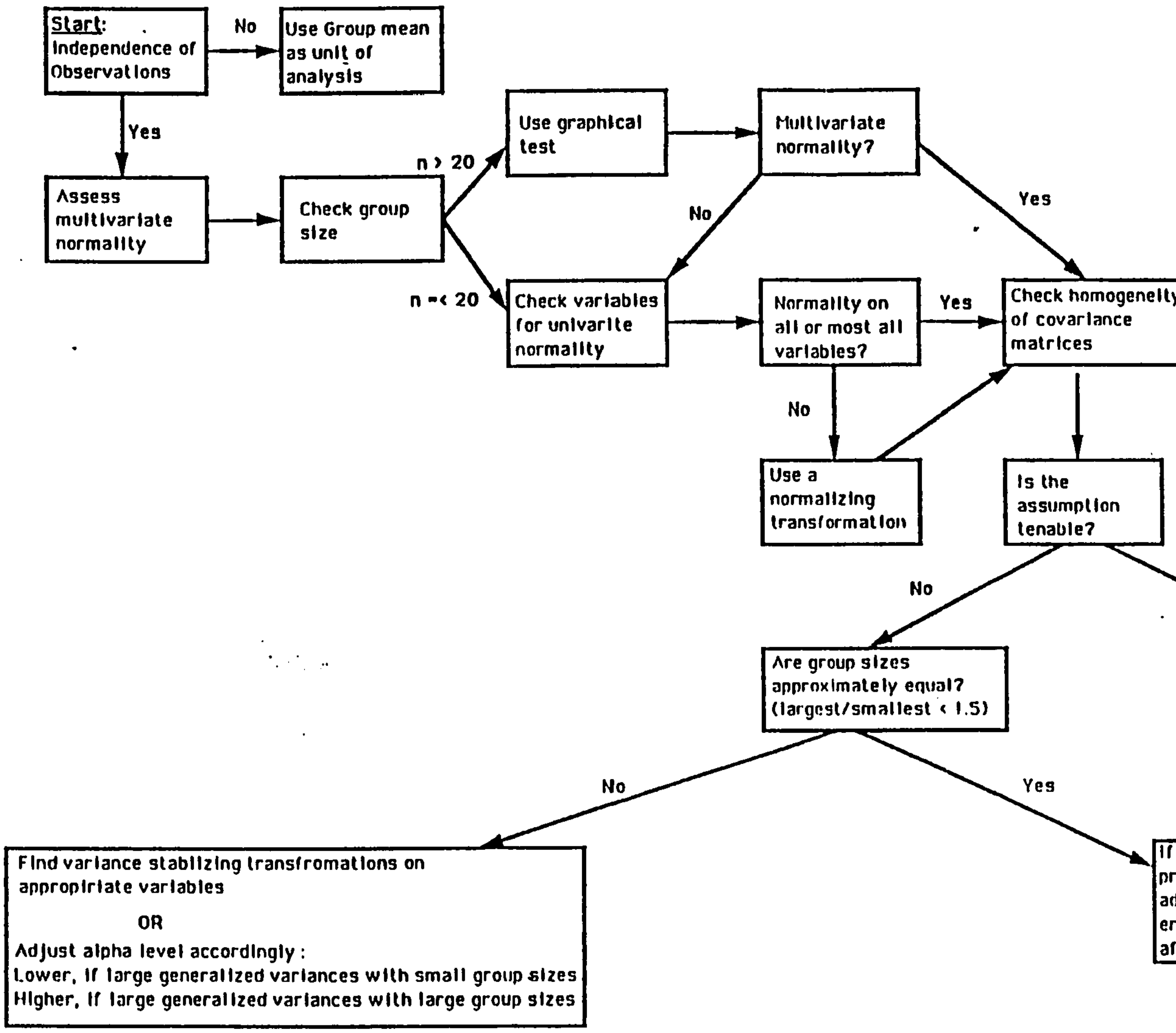
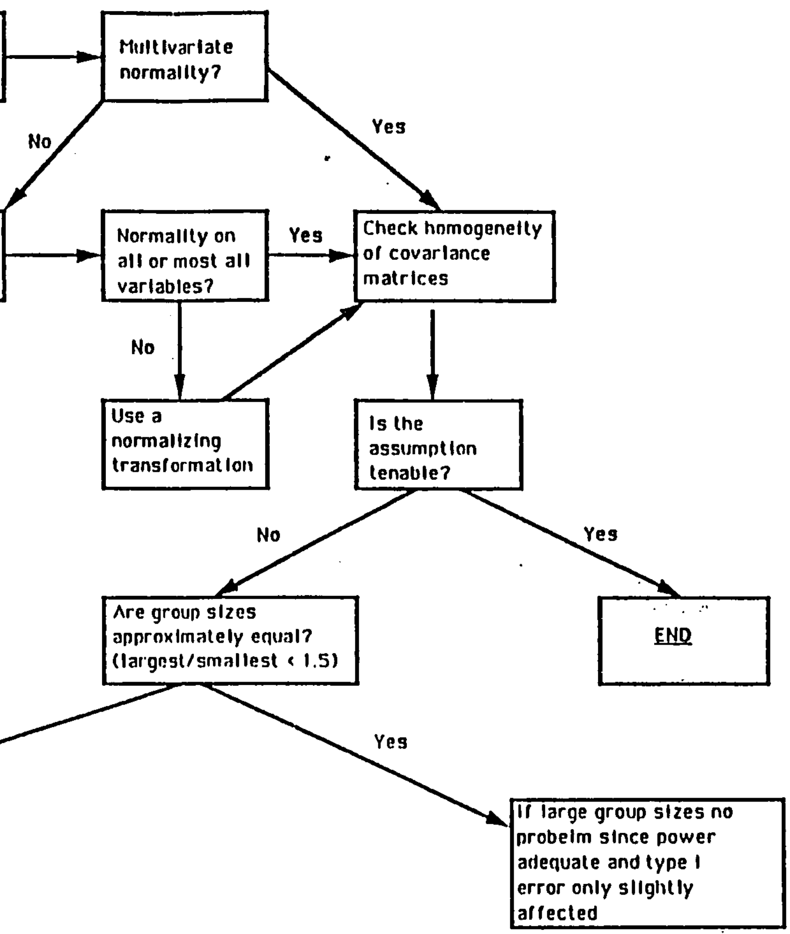


Figure 2. Flow chart for assessing assumptions in MANOVA (from Stevens, App Statistics for the Social Sciences, 1986)



ptions in MANOVA (from Stevens, Applied Multivariate
nces, 1986)

treatment, measurements were taken on several criteria or p dependent variables. Using this approach there have been three common methods used to analyze the data.

One approach has been to consider the problem as a univariate analysis of variance. In this approach the researcher had the null hypothesis that H_o: $U_{1p} = U_{2p}$ where p equaled the number of dependent variables and there was one treatment and one control group. This approach has been very common in educational and psychological research literature (Hummel and Sligo, 1971). The approach has also been generalized to include X number of treatments, depending on the design of the experiment.

A second approach has been to consider the data using a multivariate analysis (Cramer and Bock, 1966). Here, an overall multivariate statistic would test the effect of the treatments on the p dependent variables simultaneously. The null hypothesis was that the vector of dependent variable means from treatment one would equal the vector of dependent variable means from treatment two. If the null hypothesis was rejected, then a univariate analysis of variance on each dependent variable separately would be implemented (Cramer and Bock, 1966).

The third approach would test the same null hypothesis as the second approach but rather apply a simultaneous confidence internal procedure developed by Roy and Bose to determine the significance of the dependent variables. From these three approaches, a decision as to the most appropriate method lies in examining the error rates of each of the methods and the correlations between the dependent variables.

Two major categories of error rates have been defined by Ryan (1959). The first, error rate per comparison, was defined as the probability that a given comparison will be declared significant when in fact the null hypothesis is true for that comparison. This was referred to as the Type I error rate or alpha. The second error rate, experimentwise error rate, was defined as in experiments containing more than one comparison, it is the probability that at least one comparison will be declared significant when in fact the null hypothesis is true.

The experimentwise error rate is directly related to the correlation between the dependent variables. If the dependent variables are not correlated, then the error rate per comparison is alpha and the experimentwise error is $1 - (1\text{-alpha})^p$. Alpha is unaffected by the correlations for the dependent variables (Ryan, 1959). Hummel and Sligo (1971), after studying the three described standard approaches, concluded that experimentwise error rates increased as the number of dependent variables increased and decreased as the proportion of variance, or correlation, in common increased when using the first approach, that of univariate analysis of multivariate data. Using method one, the comparison rate is equal to alpha.

Using method two, it was found that the comparison error rate dropped below the set alpha of .05 to a range of .005 to .022. The experimentwise error rate also varied from .017 to .050. It should be noted that the experimentwise error rate was maintained at a level lower than the preset nominal rate of .05.

The complete multivariate approach allowed for both the comparison and experimentwise error rate to be below the nominal level of .05. It was noted that the error rates did become more stringent as the number of dependent variables were added.

In summary, Hummel and Sligo found that approach three, the completely multivariate approach, followed by simultaneous F test, always maintained the alpha and experimentwise error rate at or below .05. It should also be noted that this approach was very restrictive when the number of dependent variables increased. This method would be very useful when the researcher would be very concerned about making Type I error.

Hubble (1984) addressed the problem of Type I error well when he stated, "Type I errors are rampant when multiple variables are assessed with techniques designed for the analysis of single variables. The further one moves towards increasing Type I error with many univariate analyses, the more vulnerable one becomes with respect to making false inferences about seeming relationships." Not only are there increases in Type I error, but also in the quantity of Type II errors. By increasing your Type II error rate, relationships that do exist could go by unnoticed.

Hummel and Johnston (1986) used seven methods for analyzing multivariate group differences. The seven methods were:

1. Univariate analyses of variance - Univariate F tests were used separately to test the null hypothesis of each of the dependent variables.

2. Multivariate analysis of variance followed by simultaneous F tests - The T^2 statistic was used to test the overall hypothesis. If the statistic was significant, then simultaneous F tests were performed separately on each of the dependent variables.
3. Combination of univariate and multivariate analyses of variance - The T^2 statistic was used to test the overall hypothesis. If this hypothesis was rejected, then univariate F tests were conducted on each of the dependent variables.
4. Bonferroni - Univariate F tests were used to test the hypothesis for each of the dependent variables at an alpha of (alpha/number of dependent variables).
5. Multiple Bonferroni - Univariate tests were used to first test the hypothesis for each of the dependent variables at alpha = $1 - (1-\text{alpha})^{1/p}$. If hypotheses were rejected for one or more variables, then the tests were carried out for the remaining variables at a reduced alpha. This was repeated until there were no rejections or until the final variable was rejected.
6. Method 6 - The T^2 statistic was used to test the overall hypothesis. If this statistic was significant, then the hypothesis for the variable with the maximum F statistic was rejected and the variable was removed. The T^2 statistic was computed for the remaining variables. If it was significant, then the hypothesis for the next highest F statistic was rejected and the variable was removed. This was repeated until the T^2 for the

remaining variables were no longer significant or until no variables remained.

7. Method 7 - The same process was followed as Method 6, conducting repeated T^2 tests, except that for a univariate hypothesis to be rejected, the highest remaining F statistic must have also been significant.

These seven methods were compared on (1) experimentwise error rate, (2) power, (3) number of Type I errors in experiments with at least one error, and (4) experiments with at least one false univariate hypothesis. The method that maintained the alpha level at its original set value was Method 7.

A research contemplating the use of a multivariate technique would benefit from the analysis by controlling the Type I and Type II error rate, but limiting error should not be the only reason for a multivariate approach. It was recommended by Hubble (1984) that the use of multivariate techniques should be conditional by the fact that it is appropriate for the design and based on the correct theoretical model.

Canonical Correlation Analysis

In multivariate analysis the researcher has multiple predictor or independent variables that can be either continuous or categorical variables and a set of dependent variables. From these two sets of variables, three possible correlation matrices can be determined. One matrix is the correlation among the dependent variables. The second group of correlations can be determined among the independent variables. The third set correlates the independent variables (Xs) and the dependent variables (Ys). This interrelationship between the two sets of variables is called a canonical correlation method. The purpose of canonical correlations, developed by Hotelling (1935), is to maximize the correlation between linear functions of the two vectors of variables.

From a canonical correlation analysis, a researcher could determine a set of canonical correlation coefficients, one for each pair of functions. Besides the correlation coefficient, the researcher was interested in the factors, or variables, that make up the canonical variate. The analysis would produce correlations up to the number of variables in the smaller vector set. Each correlation and its variates are statistically independent.

Canonical correlation is the most general of all multivariate statistical analyses. From this step, other methods such as multivariate analysis of variance and discriminant analysis could be applied. Multiple regression can also be considered a type of canonical correlation where a vector of independent variables predict a single dependent variable. Canonical correlation attempts to find a linear combination of dependent variables that are most dependent on a linear combination of independent variables. Stevens (1986) described canonical correlation as a means of breaking down the association of two sets of variables. Canonical correlation has often been compared to principal components analysis in that each is a data reduction technique, each produces sets of uncorrelated linear combination of variables, and the first few combinations account for much of the variance as possible. The difference lies in the fact that principal components deal with either the independent or dependent variable set separately, where canonical correlation works with the dependent and independent variable sets collectively.

In general, the canonical correlation procedure first produces two linear combinations of variables which maximize the Pearson correlation between the two new constructed variables combinations. The model for canonical correlation is:

$$u_i = a_{i1}x_1 + a_{i2}x_2 + \dots a_{ij}x_j \qquad v_i = b_{i1}y_1 + b_{i2}y_2 + \dots b_{ij}y_j$$

where the correlation, Ru_iv_i, is maximized. The a's and b's would be numerical weights that would be used to produce two new variables, u and v. The resulting maximized correlation, R_1, is called the first canonical correlation. The procedure is then repeated to produce a second pair of linear combinations that again maximizes the correlation, but is not correlated with the first combination of variables. This process is repeated until the number of canonical correlations equals the number of variables in the smaller of the two initial sets of variables.

Once all the possible canonical correlations are calculated, the researcher must determine the significance of each of the canonical correlation coefficients and then interpret the canonical variates for each of the significant correlations.

To determine significant canonical correlations, the researcher must calculate Bartlett's V (Bartlett, 1941) statistics where:

$$V = -((N-1.5)-(p+q)/2) \sum_{i=1}^{m} \ln\,(1-R_i^2).$$

V is approximately distributed as a chi-square statistic with (p)(q) degrees of freedom, for the first canonical correlation. The null hypothesis was that there is no relationship among the sets of variables. If the test is significant, then the first canonical correlation is removed and the residual is tested. The second statistic is calculated in the same method, except that the degrees of freedom are (p-1)(q-1). This process is repeated for all canonical correlations or until a canonical correlation that is insignificant is found.

There are two basic methods that have been developed to interpret the canonical variates found in significant canonical correlations. The first is to use the standardized coefficient. Standard coefficients are calculated by multiplying the raw coefficient for each variable by the standard deviation of the variable. The second method was to use the canonical variate-variable correlation. This was the correlation between each canonical variate function and each of the original variables. The question that comes to mind was which method is best, considering the fact that each method could give different results.

Meredith (1964) and Porebski (1966) recommended in favor of using the canonical variate-variable correlation because (1) they were more stable in small and medium sized samples, and (2) the correlation gave a direct indication of the variables that were most closely related to the underlying constructs.

Barcikowski and Stevens (1975) and Huberty (1975) used Monte Carlo studies to conclude that unless the sample size was large relative to the number of variables, both the standardized coefficient and the correlation were very unstable. Results are considered to be unstable when results obtained from one sample would not be similar to another sample's results from the same population. From Barcikowski and Stevens' studies, the number of subjects per variable necessary to achieve reliability must be from 42:1 to 68:1. This has been interpreted by most to be extremely conservative, and in general a 20:1 ratio has been sufficient for stable results.

Cooley and Lohnes (1985) summarize canonical correlation analysis as a model for representing a relationship between two sets of measures as n correlations between n factors of the first set and n factors of the second set, with all other correlations among the factors held to zero. They believe that the number of significant correlations should be determined by the researcher, usually based on theory.

MANOVA Analysis

The three basic assumptions common to multiple analysis of variance are the same as those noted for all multivariate (MANOVA) procedures. They are:

1. The observations on the dependent variables must follow a multivariate normal distribution for each subpopulation.
2. The population covariance matrices for the dependent variables must be equal.
3. The observations are independent.

Numerous studies have been conducted to study the results of violating one or all of the MANOVA assumptions. The following is a summary of these studies. First, when reviewing the criteria necessary to meet the fact that the dependent variables must come from a multivariate normal distribution, it should be noted that it is not sufficient that each dependent variable come from a normal distribution, but rather that together any linear combination of dependent variables must be normally distributed and secondly, all subsets of the dependent variables must have a multivariate normal distribution.

Once the assumptions are tested and transformations are applied, the researcher would be ready to test the null hypothesis. Various techniques have been developed to test the null hypothesis that the vector of means of the population are different among the various levels of the independent variables.

Hotelling T^2 test statistic was developed by Harry Hotelling during the 1930s to examine the difference between multiple dependent variables and two independent samples. This test statistic is very similar to the univariate independent t-test. The formula is:

$$T^2 = \frac{n_1 n_2}{n_1 + n_2} (\bar{y}_1 - \bar{y}_2)' \, S^{-1} \, (\bar{y}_1 - \bar{y}_2)$$

where y_1 is the vector of means for the first group, y_2 is the vector for the second group, n_1 and n_2 are the respective sample sizes, and S^{-1} is the inverse of the pooled within-group covariance matrix. The calculated T^2 statistic is compared to the F statistic with degrees of freedom of the number of dependent variables for the numerator and the total sample size subtract two.

For designs with more than one independent variable or designs with one independent variable and more than two groups, a more complex method and statistics were developed. This design could be compared to the univariate factorial design or a one-way analysis of variance. Test statistics used to test the null hypothesis of equal mean vectors all center around two matrices, the hypothesis (H) and error (E) sums of squares and cross products. The hypothesis matrix (H) included the weighted, by sample size, squared differences of each of the group means from the overall mean for each of the dependent variables. This could be compared to the between sum of squares for the univariate F test. The error sums of square matrix (E) was the indicator of the amount of variability there was in each of the dependent variables. The diagonal of this matrix was the variance of each of the variables and the off diagonals were the sum of cross products of the variables.

Based on these two matrices, a single number, the determinant, must be calculated to represent the overall generalized variance. This determinant was the product of the eigenvalues for the product of the hypothesis error matrices, HE^{-1}. Various test statistics were developed to test the null hypothesis; they are:

1. Pillai's Trace $$V = \sum_{i=1}^{s} \frac{1}{1+\gamma_i}$$

2. Wilks' Lambda $$W = \prod_{i=1}^{s} \frac{1}{1+\gamma_i}$$

3. Hotelling's Trace $$T = \sum_{i=1}^{s} \gamma_i$$

4. Roy's Largest Root $R = \frac{1}{1+\gamma_{max}}$

In these tests, γ_{max} is the largest eigenvalue, γ_i is the ith eigenvalue, and s is the number of nonzero eigenvalues of the HE-1 matrix. Each of these four statistics are equal with the one dependent model design, with the difference in each lying in their power and robustness for designs with more than one dependent variable. The Pillai's trace statistic has been found to be the most robust, the ability to be unaffected by departures from the assumptions, of the four statistics. When reviewing power, the order of high to lowest power is Pillai's, Wilks', Hotelling's, and Roy's.

Numerous studies (Pillai and Jayachandian, 1967; Olson, 1974) have investigated the test statistics used in multivariate analysis of variance as to the one that is most appropriate, yet the studies have proven inconclusive. Researchers all conclude that all four statistics are equal to the F statistic when working with one dependent variable. The difference arises when the number of variables increases. Roy's statistic has been generally accepted as the best statistic when the dependent variables can be grouped together to form one dimension (Bock, 1980). When looking at multiple dimensional responses, the three remaining statistics have proven to be equivalent, although Olson believes that lambda should not be used in research where the covariance matrices are believed to be unequal.

Similar to ANOVA, MANOVA must have methods for determining where the differences exist; a post hoc procedure. A significant MANOVA test statistic implies that there is a linear combination of variables that can be used to explain the differences among the groups.

One post hoc solution is the Roy-Bose confidence interval test. This procedure is very similar to the Scheffé test with pairs of means being examined. Although easy to calculate, the Roy confidence intervals are very conservative (Hummel and Sligo, 1971) and will often fail to detect actual differences. It is a particular problem with designs with moderate or small sample sizes.

A second method was to examine each dependent variable as a univariate ANOVA, knowing that the experimental error rate was maintained by the MANOVA. Of the various post hoc procedures, this has the greatest power (Stevens, 1986), but with a large number of dependent variables, the error increases sizably. The third method, very similar to the second, was to again test each in a univariate fashion, except that the alpha rate equaled (alpha/number of dependent variables), the Bonferroni inequality. This method has proven to be very effective for experiments with a small number of dependent variables, seven or less. It has been recommended (Timm, 1975) that either of these two methods are appropriate providing there is a small number of dependent variables. If the researcher has a large number of variables, it would be recommended to divide the variables into similar clusters based on theory or past research.

A final post hoc method was to use discriminant analysis to identify the linear combination of variables that best separates the groups (Harris, 1976). To apply discriminant analysis, the researcher should be aware that very large sample sizes are required, a 20:1 ratio (Barcikowski and Stevens, 1975), and the linear combination of variables that are identified may not be meaningful.

Discriminant analysis is very similar to multiple regression, except that the linear combinations of variables attempt to predict or describe the groups. By examining a series of uncorrelated linear combinations of dependent variables, a researcher can conclude which of the variables are working together within a specific group. Once produced, the discriminant function is tested, one at a time, starting with the largest root, by a Wilks' lambda. Once the significant functions are identified, the researcher interprets them by examining the standardized coefficients or the correlation between the discriminant function and the initial variable. The discriminant function-variable correlation has been proven to be the best due to their greater stability and that the correlation gives a direct measure of the strength of the variable (Meredith, 1964; Porebski, 1966; Stevens, 1986).

Principal Components Analysis

Principal components analysis was developed as a means of reducing a large number of variables into a few underlying constructs or components. In short, principal components analysis is a data reduction scheme, and not a statistical test unto itself.

Researchers have several methods of grouping variables into constructs. One is to use grouping based on a complete review of the literature. A second method would be grouping variables based on a known hypothesis. The third is an empirical method, of which there are two:

principal components and factor analysis. Both empirical methods are similar; therefore, in the remainder of this paper the author has addressed the problem of factor analysis.

Using a single group, factor analysis takes the total variance of the sample and calculates the linear combination of variables that maximizes the variance. This produces the first factor. The procedure is then repeated for the second factor maximizing the remaining variance, with the condition that the two factors are not correlated. The procedure continues to calculate factors up to the number of variables in the set.

Similar to canonical correlation, factor analysis must be calculated with a large sample size. When using a small size sample, the researcher would be well advised to test the null hypothesis that the population correlation matrix is not correlated. If the researcher fails to reject the null hypothesis, there is no reason to do factor analysis since the variables are not correlated. This test is done by using the Bartlett's sphericity test (Cooley and Lohnes, 1985).

Once all the factors are calculated, the researcher must determine the significance of each of the factors. Four methods are commonly used:

1. Retain factors whose eigenvalues are 1.0 or greater (Kaiser, 1960; Cattell and Jaspers, 1967; Browne, 1968).
2. Using a scree plot keep only the factors on the steep part of the axis (Cattell, 1966).
3. Use a statistic test produced by Lawley (1971). This is strongly discouraged since with large sample size too many factors are retained.

4. Retain factors that account for a specific amount of the variance.

Finally after the reduced number of factors are identified, the researcher must interpret the factors. Rotating the factors greatly aids in the job of interpretation. One rotation method, Quartimax, rotates variables so that each variable will load in only one factor. The problem with this approach is that almost all of the variables load into the same factor; therefore, it is difficult to interpret.

The Varimax rotation (developed by Kaiser, 1960) rotates factors so that variables are high on only some variables and low on the remainder. The major drawback to all rotation methods is that the newly rotated factors no longer have the property of maximum variance.

Teacher Preparation

Preparation is the stage where an individual develops the skills, knowledge, and attitude needed to enter his/her profession (Isaacson, 1978). In a teacher's preparation, a major stage is enrollment and completion of a teacher education program at his/her given institution. For a teacher, it has been proven that his/her perception of their preparation has a lasting effect upon their lives (Ashton et al., 1983; Schalock, 1983).

Research has proven that there is a positive relationship between a teacher's satisfaction with their job and a self-rating of their professional skills (Chapman, 1983; Kyriacou and Sutcliffe, 1979). Teacher satisfaction has been and will continue to be a major issue in education for years to come. Satisfaction has become a major issue when it can be noted that 35% of all public school teachers were dissatisfied with their jobs and 41% of those polled would not become a teacher if they could start over again (National Education Association, 1980). Therefore, to help maintain teacher satisfaction, the issue of teacher preparation must be addressed.

Murphy (1982) found that dissatisfied teachers and those planning to leave the teaching profession were influenced by inadequate preparation for the job. The teacher education program also has been reported to have a significant effect on retaining teacher education graduates in the teaching profession (Chapman, 1983). Regarding Iowa State University teacher education graduates specificity, Sweeney (1987) found that preparation program factors contributed significantly to the teacher education graduate's one-year and five-year career path.

Therefore, by carefully examining areas of a teacher education preparation program, it would be possible to identify areas of concern and then these needs could be addressed through curriculum revision. An improvement in the preparation program could help improve teacher job satisfaction and teacher retention.

CHAPTER III. METHOD OF PROCEDURES

This chapter's purpose was to describe the source of data used in the research, the instruments used to collect the data, and the data collection procedures. A step-by-step discussion of the various multivariate procedures applicable to this research was also covered.

Data Source and Collection Procedures

Data used in this research have been collected as part of the ongoing longitudinal research conducted by the Research Institute for Studies in Education (RISE) of the teacher preparation program at Iowa State University. This longitudinal study includes data from teacher education students and graduates from the Iowa State University teacher education program at a set interval of times in their lives. These intervals are as follows: (1) in their first general education class, Secondary Education 204; (2) graduation from the teacher education program; (c) one year following graduation; and (d) five years following graduation. Various demographic data concerning each participant were obtained from their permanent record at their time of graduation.

The source of data for this research came from the survey administered to students of the teacher education program at the time of their graduation. This survey instrument, started in spring quarter 1980, was utilized at the end of each fall and spring semester. A copy of the most recent survey, spring 1988, can be found in Appendix A.

In conducting the survey, RISE closely followed the procedures for conducting mail surveys recommended by Dillman (1978). At each collection point, those to be surveyed were mailed a copy of the survey with a cover letter explaining the purpose of the survey. Two weeks later, a reminder postcard was mailed to those who had not responded to the earlier mailing. After two more weeks, another copy of the survey and a second letter requesting their participation were mailed to those who did not respond to either of the first two mailings. All surveys in the project have received approval from the Iowa State University Committee on the Use of Human Subjects in Research.

Instrument

The "Teacher Education Program Graduate Survey" was developed by RISE personnel. The collection procedure for the graduate survey for the past three years was personally conducted by the author of this research. The survey has been revised numerous times since its first mailing, over eight years ago, but throughout, many items and response stems included in the questionnaire have remained the same. Revisions in the survey have reflected the changes in curriculum in the teacher education program at Iowa State University.

The following are the variables of interest that were selected from the graduate survey: (1) the subject's teaching level at which the student was to be certified; (2) the subject's year of graduation; (3) the subject's rating of their perception to 33 areas of preparation in their education program of study; (4) four measures of their satisfaction with their student teaching experience; and (5) an overall rating as to quality of the Iowa State University teacher education preparation program.

Population and Sample

The population for this study included all graduates of the Iowa State University teacher education program from fall 1983 through spring 1988. It was divided into five subsamples, one sample for each graduation year.

Sample One (1983-1984 academic year graduates) - The teacher education graduates included in this sample were the graduates from fall semester 1983 and spring semester 1984. The total number of graduates were 343 with 110 completing the fall graduate survey and 233 completing the spring survey.

Sample Two (1984-1985 academic year graduates) - The teacher education graduates included in this sample were the graduates from fall semester 1984 and spring semester 1985. The total number of graduates was 292 with 97 completing the fall graduate survey and 195 completing the spring survey.

Sample Three (1985-1986 academic year graduates) - The teacher education graduates included in this sample were the graduates from fall semester 1985 and spring semester 1986. The total number of graduates were 318 with 107 completing the fall graduate survey and 211 completing the spring survey.

Sample Four (1986-1987 academic year graduates) - The teacher education graduates included in this sample were the graduates from fall semester 1986 and spring semester 1987. The total number of graduates were 344 with 124 completing the fall graduate survey and 220 completing the spring survey.

Sample Five (1987-1988 academic year graduates) - The teacher education graduates included in this sample were the graduates from fall semester 1987 and spring semester 1988. The total number of graduates were 355 with 130 completing the fall graduate survey and 225 completing the spring survey.

Variables

The major thrust of this research was to examine the difference in the results between a univariate and a multivariate analysis of the data. To be considered for a multivariate procedure, there must be more than one dependent variable. In this research the dependent variables used were the subjects' ratings of their adequacy of the professional educational preparation program in 33 areas, four measures of satisfaction with their student teaching experience, and an overall rating of the quality of the teacher education program.

The response categories in these 33 preparation areas were "very adequate" (5), "adequate" (4), "neutral" (3), "inadequate" (2), and "very inadequate" (1). The respondents were also permitted to indicate "not applicable" if the area in question was not appropriate to them. Later the "not applicable" data were declared as a missing value in data analysis.

The four measures of satisfaction with their student teaching experience were measured on a five-point scale of (5) representing "Very Satisfied," (4) "Satisfied," (3) "Neutral," (2) "Dissatisfied," and (1) "Very Dissatisfied." The overall rating as to the quality of the teacher preparation program at Iowa State University was measured on a one-to-ten scale with one representing "Very Poor" and ten representing "Very High."

There were two independent variables used in this research. The first variable was the year in which the subject graduated. This was coded as follows: (4) 1983/1984, (5) 1984/1985, (6) 1985/1986, (7) 1986/1987, and (8) 1987/1988. The second independent variable was the subject's teaching certification level. Teaching level was defined as the level at which the graduates received their teaching certificate, which was at the time of graduation. This information was obtained from the question in the survey when the subject was asked to respond to the question, "At what level did you student teach?" The possible responses were "preschool/kindergarten" (1), "elementary" (2), "secondary" (3), and "K-12" (4). From these raw data, one categorical variable was created combining those respondents indicating preschool/kindergarten and elementary into a category called "Elementary," and those responding secondary or K-12 were categorized as "Secondary."

Empirical Hypotheses

To aid in the process of better understanding multivariate analysis of data, eight statistical hypotheses were developed based on the six objectives defined in Chapter I. This purpose of this research was not to answer the hypotheses, rather to use these hypotheses to present the case for the use of multivariate analyses when appropriate.

1. There is no significant difference in the means on each of the 33 areas of preparation when comparing those who student taught at

the elementary level and those who student taught at the secondary level.

2. There is no significant difference in the means on each of the 33 areas of preparation when comparing the group formed by each of the five graduation years.
3. There is no interaction between the level at which the subject student taught or the year in which the subject graduated as measured by the 33 areas of adequacy of preparation.
4. There are no underlying factors that can express the 33 areas of preparation in a more parsimonious manner.
5. There is no significant difference in the vector of means on the 33 areas of preparation when comparing those who student taught at the elementary level and those who taught at the secondary level.
6. There is no significant difference in the vector of means on the 33 areas of preparation when comparing the groups formed by each of the five graduation years.
7. There is no interaction between the subject's student teaching level and the year of graduation when measured by the vector of means on the 33 areas of preparation.
8. There is no relationship between the 33 areas of preparation and the four measures of satisfaction and overall quality of the teacher preparation program.

One of the most important purposes of this research was to provide a practical, clear, and concise guide to educational researchers on the analyses of data drawn from a multivariate population. The next section of this paper was written to provide that guide. Computer procedures to provide the necessary information could be obtained through many statistical packages, including SPSSX and SAS.

The first step of all multivariate analyses would be to validate each dependent and independent variable separately looking for outliers and missing values. A better understanding of each of the variables was obtained by reviewing the means, standard deviations, ranges, and other descriptive statistics. After reviewing each variable separately, the researcher should examine the relationship that might exist among the dependent variables.

Multivariate Assumptions

For a multivariate analysis to be appropriate, the dependent variables must follow a multivariate normal distribution. One criterion is that each variable must be normally distributed. A plot that has been designed to examine the normality assumption is called a full normal probability plot. A full normal plot provides the observed values versus its paired expected normal value for sample data drawn from a normal distribution of the given sample size. This plot should be a straight line, thus indicating the observed scores are from a normal distribution. A second plot, the detrended normal plot, plots the difference of the observed score and the expected normal value. Normal data should have a cluster of random points surrounding zero. Unexpected results from the plot should cause the researcher to consider a data transformation as discussed in Chapter II.

It is also important to examine the correlation between the dependent variables before the application of multivariate techniques. Using SPSSX, the correlation matrix is determined for the dependent variables. The researcher, after reviewing the matrix, looked for small values for the off-diagonals, thus indicating an independence between the variables. The Bartlett's test of sphericity tests the null hypothesis that the correlation matrix is an identity matrix, one's on the diagonal and zero's on the off diagonals. A small statistic, close to zero, indicated to the researcher that the dependent variables were dependent or correlated with each other, a trait necessary for application of multivariate techniques.

The final multivariate assumption is that the variance-covariance matrices for each of the groups are equal. The test of homogeneity of variance was examined by the Box M statistic, compared to either the F or chi-squared distribution, depending on the sample size. Step one is to examine the variance-covariance matrices for each of the groups. This matrix explains the variability within each specific group. These individual group matrices were combined to form the pooled variance-covariance matrix. Each individual dependent variable was tested for homogeneity of variance among groups by either the Cochran's C or Bartlett Box F statistic. Both are considered to be univariate tests for analyzing homogeneity of variance. The Box M statistic looked at the variance-covariance matrix on all dependent variables collectively. The null hypothesis is that the matrices are equal for all groups; therefore, the researcher desired the resulting test statistic to be insignificant. It should be noted that the Box M statistic is very sensitive to departures from normality; therefore, the Box M should be applied only after studying the underlying distribution and applying a transformation to the data if required.

Additional graphs could be plotted using the MANOVA command in SPSSX. These procedures produce graphs showing the cell means versus cell variances and cell means versus cell standard deviations for each of the dependent variables. Using these two graphs, the researcher could detect heteroscedasticity, nonhomogeneous variances, and if there was a difference, an appropriate transformation could be implemented. Three such transformations were discussed in Chapter II.

There are no statistical tests for examining the assumption of independent observations. The researcher must design into the research controls for eliminating a dependence among subjects either by changing the unit of analysis or in the administration of the treatment, if possible. After examining each of the three multivariate assumptions, the researcher would continue his/her analyses by applying the appropriate statistical tests.

MANOVA With Two Groups

The Hotelling T^2 statistic was used to determine if there was a significant difference in the vector of means between those teaching at the elementary level and those at the secondary level. This statistic follows the F distribution with the number of dependent variables equal to the degrees of freedom in the numerator and N-2 for the degrees of freedom in the denominator. A large test statistic, resulting in a very small significance level, would enable the researcher to reject the null hypothesis. If the resulting statistic is significant, then the researcher would need to examine where the differences lie.

Numerous methods, discussed in Chapter II, could be used to identify differences, including separate univariate analysis of variance, application of the Bonferroni equality, step down F tests, and discriminant analysis.

MANOVA With More Than Two Groups

To analyze differences among the five graduation years, the researcher used a multivariate analysis of variance with the associated Pillai's Trace, Hotelling's Trace, Wilks' lambda, and Roy's largest root statistics. Each statistic was calculated and differences noted. Discriminant analysis was used to follow up a significant test statistic.

Factorial MANOVA Design

The most concise statistical design was to consider the two independent variables and the 33 dependent variables collectively as a multivariate factorial design. In this design the independent variable of teaching level was represented by two possible conditions, elementary and secondary. The second independent variable had five levels, one for each graduation year. With these variables, the researcher had a two-way factorial design or a two-by-five (2x5) factorial design. The researcher then looked for significance in the two main effects and the one interaction term.

Again the researcher would first be concerned with the assumption of equal covariance-variance matrices. The Box M statistic again would be used to examine the assumption. After accepting this assumption, the researcher would proceed to examine the design using the Pillai's Trace, Wilks' lambda, Hotelling's Trace, and Roy's largest root. As noted in Chapter II, Wilks' lambda would be the most appropriate statistical test if the assumption of equal variance-covariance matrices was violated. A separate analysis on the three effects is produced by SPSSX and interpretation can then be noted.

Similar to the procedure used in the Hotelling T^2 test, if the test statistic is found to be significant, then a discriminant analysis would be carried out. Discriminant analysis attempts to find the linear combination of variables that best separates the various levels of the independent variables.

Having analyzed the 33 dependent variables collectively as a group, the procedure was repeated using the significant factors identified through factor analysis.

Discriminant Analysis

Discriminant analysis is a technique that attempts to distinguish among groups of an independent variable by finding a linear combination of predictor variables that maximizes the between-group sum of squares. This technique is very similar to multivariate analysis of variance and multiple linear regression. The major difference is the single dependent variable is a categorical not a continuous variable. Huberty (1975) points out four uses of discriminant analysis:

1. To separate and determine the inter-group significant differences of group centroids.
2. To study group separation with respect to various dimensions and then discriminate among groups.
3. To obtain estimates of interpopulation distances between centroids and estimates of the relationships between the response variables and the group variable.
4. To set up rules to classify individuals into groups.

The researcher used discriminant analysis to indirectly identify variables that showed a significant difference among the groups of the independent variable. This is not the common application of discriminant analysis, but it is an appropriate method to follow up a significant multivariate analysis of variance test.

Following selection of the predictor variables, the researcher would use the stepwise procedure of discriminant analysis in SPSSX to identify variables for the discriminant function. Inclusion of a variable is determined by the change in the Wilks' lambda statistics when compared to the F distribution:

$$F = \left(\frac{(n-g-p)}{g-1}\right)\left(\frac{1-\gamma_{p+1}/\ p}{\gamma_{p+1}/\gamma_p}\right)$$

where n = total number of cases

g = number of groups

γ_p = Wilks' lambda before adding a variable

γ_{p+1} = Wilks' lambda after adding a variable.

The results of discriminant analysis is a list of variables entered into the equation and various coefficients, including both raw and standardized coefficients. The standardized coefficients are direct measures of the importance of the variable of the discriminant function.

The use of standardized coefficients has recently come under fire when the predictor variables are highly correlated. Highly correlated predictor variables "share" the discriminant weights, and are therefore inaccurate. The solution has been to analyze discriminate functions by the correlation between the discriminating variable and the discriminating function. These correlation coefficients also represent the direct effect of the variable on the function and account for shared variance between variables.

Another measure of a discriminant function's strength is the group centroids. The centroid represents the center point for all individuals in a group. The further apart the centroids, the better the groups are discriminated. The best centroids would have values in opposite direction of each other.

The final measure of a discriminant function's strength is the classification analysis. Classification analysis uses the discriminant function to classify individuals into groups, then compares the calculated group to the actual group membership. The higher the overall classification index, the better the strength of the function.

Factor Analysis

Factor analysis uses the correlation of the dependent variables, in this case the 33 areas of preparation, to statistically determine the significant factors. Various methods or extractions can be used to determine the factors. The author used the principal axis factoring (principal factor method) as the extraction procedure. In this procedure the commonalities of the dependent variables are placed on the diagonal.

Following the extraction, the resulting factors were rotated using the Varimax rotation to help examine the resulting factors. The following seven guidelines, outlined by Kang (1987), were used in considering the significant factors and the items that loaded on a particular factor. Factors and items that did not meet these guidelines were not selected.

Guidelines used for the selection of a factor are:

1. Eigenvalue of each factor should be one (1) or greater.
2. Percentage of variance explained in each factor should be about 4% or greater for initial statistics.
3. Cronbach's alpha, as an estimate of reliability of items forming each factor, should be .60 or greater.
4. The factors extracted within each area should be independent or with very low correlation.

Guidelines for the selection of items for a factor are:

1. Factors should be formed by including items with factor loading of .40 or greater.
2. Composite of items forming each factor should be similar in content as far as possible.

3. Previous studies of factor analysis relating to this research should be considered (e.g., Sweeney, 1987; Kang, 1987).

Canonical Correlation

Canonical correlation, in the statistical package SPSSX, is a part of both the multivariate analysis of variance procedure MANOVA and the discriminant analysis procedure. In both procedures, the canonical correlation is used to determine which dependent variables separate the groups of independent variables optimally. To determine if there is a relationship between two sets of variables, each measured on a continuous scale, in this case a one to five scale, the more traditional method of canonical correlation, developed by Hotelling (1935), was sought.

The author of this research used the five previous years of data that sampled Iowa State University teacher education graduates on various measures of their satisfaction and preparation with the teacher education program. This chapter presented the various multivariate techniques necessary to analyze that data. Although the multivariate methodology uses considerable mathematics, with the aid of statistical packages for computers, that problem was overcome. Results of the various analyses are presented in the next chapter.

CHAPTER IV. FINDINGS

The purpose of this chapter is to present the results from the analysis of data using both univariate and multivariate methodologies. The first section of this chapter presents the basic descriptive statistics for all the dependent and independent variables. The second section provides the univariate analyses, including independent t-tests, one-way analysis of variance tests, and a series of two-by-five factorial analysis of variance techniques. Part three includes the results of two factor analyses; the first being the 33 areas of preparation and the second analyzing the four continuous measures of satisfaction with their student teaching experience and general satisfaction with the teacher preparation program. The final section, and the most comprehensive, presents the results of the multivariate methodological approach. Included in this section are the tests for the three multivariate assumptions and the various multivariate techniques, including multivariate analysis of variance (MANOVA), discriminant analysis, and canonical correlation.

Throughout all four sections, the eight hypotheses, discussed in Chapter III, are presented and answered. An overall discussion as to the interpretation of the data as they relate to the Iowa State University teacher education program has been presented at the end of this chapter.

Descriptive Statistics

There were a total number of 1053 teacher education graduates that were included in this research project; 571 were certified at the elementary level and 482 were certified at the secondary level. The frequencies of the five graduation years by the two appropriate teaching certification levels are found in Table 1. It should be noted that those indicating they were to be certified in preschool/kindergarten and elementary were combined to form the category of "Elementary," and those that were to be certified seven through twelfth grade and kindergarten through twelfth grade were recoded into the category of "Secondary."

Although the five graduation years were not equal in size, the sample size to number of variables ratio, 32:1, was sufficient to assume normality due to the central limit theorem. The chi-square statistic, used to determine if there were any statistically significant differences among the cell counts, was found to be insignificant.

Whenever a researcher uses multiple dependent measures, regardless of the method of analysis, it is important to examine the relationships among

Table 1. Frequencies of graduates by graduation year and teaching certification level[a]

Graduation year	Level: Elementary (No. students)	Level: Secondary (No. students)
1983/1984	117	112
1984/1985	94	101
1985/1986	119	90
1986/1987	108	92
1987/1988	133	87
Total	571	482
	54.2%	45.8%

[a]Chi-square = 7.81; p = .10.

all the measures. The correlation matrix for all the dependent variablescan be found in Table 2. A list of the variable names and a short description of each of the dependent variables can be found in Appendix A. To simplify the table used in this research, the author used the variable names whenever possible.

Univariate Analysis of the Data

Hypothesis 1

There is no significant difference in the means on each of the 33 areas of preparation when comparing those who student taught at the elementary level and those who taught at the secondary level.

This univariate analysis used 33 independent t-tests and the associated t statistics. The results for these t-tests are summarized in Table 3. One step commonly skipped in univariate t-tests and analysis of variance techniques is to examine the variances between the groups or levels. It is assumed that the variances are equal for both groups in the t-test. The F statistic was used to test the null hypothesis that the variances of each group are equal. If the F value was found to be significant, then the separate variance estimate procedure was used to determine the t statistic; otherwise, the pooled variance estimate was used. The t value labeled with a # in Table 3, indicating the separate variance estimate, was used to determine the value.

Table 2. Correlation among all dependent variables

	TB1	TB2	TB3	TB4	TB5	TB6	TB7	TB8	TB9	TB10	TB11	TB12
TB1	1.00											
TB2	0.22	1.00										
TB3	0.34	0.23	1.00									
TB4	0.15	0.11	0.44	1.00								
TB5	0.32	0.17	0.41	0.33	1.00							
TB6	0.25	0.20	0.33	0.36	0.40	1.00						
TB7	0.27	0.13	0.40	0.40	0.34	0.54	1.00					
TB8	0.16	0.11	0.28	0.24	0.23	0.36	0.36	1.00				
TB9	0.19	0.13	0.24	0.24	0.25	0.25	0.29	0.57	1.00			
TB10	0.24	0.08	0.30	0.27	0.31	0.27	0.32	0.49	0.69	1.00		
TB11	0.27	0.15	0.34	0.29	0.34	0.32	0.37	0.53	0.57	0.71	1.00	
TB12	0.35	0.16	0.27	0.24	0.46	0.27	0.27	0.23	0.32	0.34	0.37	1.00
TB13	0.21	0.15	0.15	0.21	0.34	0.27	0.23	0.26	0.37	0.38	0.42	0.56
TB14	0.32	0.18	0.27	0.19	0.40	0.24	0.27	0.20	0.23	0.25	0.28	0.34
TB15	0.19	0.23	0.22	0.29	0.27	0.36	0.29	0.29	0.08	0.28	0.29	0.28
TB16	0.24	0.17	0.23	0.19	0.26	0.24	0.29	0.22	0.21	0.27	0.31	0.26
TB17	0.30	0.18	0.28	0.31	0.40	0.34	0.32	0.29	0.29	0.33	0.39	0.49
TB18	0.36	0.17	0.46	0.30	0.38	0.33	0.42	0.33	0.32	0.36	0.38	0.35
TB19	0.27	0.25	0.27	0.21	0.33	0.31	0.31	0.22	0.22	0.27	0.25	0.24
TB20	0.39	0.15	0.38	0.23	0.37	0.36	0.42	0.28	0.25	0.29	0.29	0.38
TB21	0.33	0.17	0.36	0.31	0.37	0.30	0.35	0.34	0.35	0.41	0.40	0.35
TB22	0.40	0.21	0.40	0.27	0.45	0.35	0.36	0.24	0.22	0.26	0.32	0.39
TB23	0.35	0.24	0.43	0.22	0.40	0.30	0.32	0.24	0.22	0.27	0.33	0.32
TB24	0.23	0.20	0.28	0.31	0.29	0.51	0.38	0.32	0.26	0.27	0.30	0.23
TB25	0.21	0.16	0.34	0.38	0.28	0.46	0.39	0.35	0.27	0.31	0.35	0.26
TB26	0.24	0.18	0.37	0.37	0.31	0.53	0.45	0.35	0.26	0.27	0.32	0.31
TB27	0.30	0.21	0.39	0.31	0.36	0.44	0.44	0.34	0.29	0.34	0.37	0.31
TB28	0.24	0.12	0.22	0.14	0.25	0.20	0.26	0.22	0.25	0.27	0.29	0.27
TB29	0.28	0.23	0.31	0.19	0.30	0.30	0.28	0.24	0.20	0.21	0.25	0.27
TB30	0.44	0.18	0.34	0.25	0.38	0.36	0.34	0.27	0.30	0.30	0.31	0.47
TB31	0.14	0.18	0.20	0.26	0.26	0.32	0.27	0.27	0.29	0.27	0.28	0.25
TB32	0.17	0.16	0.16	0.08	0.14	0.15	0.18	0.18	0.24	0.22	0.24	0.16
TB33	0.25	0.17	0.32	0.27	0.32	0.33	0.31	0.17	0.17	0.24	0.27	0.30
TA1	0.07	0.04	0.06	0.10	0.04	0.03	0.02	0.02	0.00	0.01	0.00	0.03
TA2	0.15	0.13	0.13	0.09	0.12	0.05	0.06	0.06	0.10	0.09	0.09	0.10
TA3	0.20	0.04	0.20	0.15	0.17	0.13	0.15	0.13	0.15	0.16	0.15	0.19
TA4	0.19	0.05	0.23	0.11	0.16	0.14	0.12	0.11	0.13	0.18	0.18	0.10
QTPP	0.42	0.22	0.45	0.37	0.45	0.33	0.39	0.27	0.28	0.32	0.36	0.34

Table 2. Continued

	TB13	TB14	TB15	TB16	TB17	TB18	TB19	TB20	TB21	TB22	TB23	TB24	TB25
TB1													
TB2													
TB3													
TB4													
TB5													
TB6													
TB7													
TB8													
TB9													
TB10													
TB11													
TB12													
TB13	1.00												
TB14	0.28	1.00											
TB15	0.33	0.28	1.00										
TB16	0.34	0.24	0.37	1.00									
TB17	0.42	0.32	0.39	0.41	1.00								
TB18	0.30	0.31	0.31	0.35	0.49	1.00							
TB19	0.26	0.34	0.28	0.27	0.32	0.41	1.00						
TB20	0.26	0.29	0.27	0.27	0.35	0.46	0.42	1.00					
TB21	0.33	0.32	0.26	0.28	0.37	0.50	0.36	0.54	1.00				
TB22	0.30	0.36	0.28	0.29	0.42	0.48	0.46	0.49	0.56	1.00			
TB23	0.29	0.34	0.26	0.32	0.33	0.47	0.38	0.42	0.45	0.56	1.00		
TB24	0.29	0.24	0.43	0.29	0.35	0.35	0.29	0.34	0.34	0.40	0.41	1.00	
TB25	0.27	0.18	0.34	0.29	0.38	0.37	0.29	0.29	0.33	0.36	0.33	0.50	1.00
TB26	0.28	0.28	0.40	0.30	0.37	0.41	0.28	0.36	0.37	0.40	0.36	0.58	0.67
TB27	0.33	0.32	0.30	0.34	0.36	0.47	0.36	0.42	0.44	0.45	0.47	0.45	0.48
TB28	0.29	0.24	0.30	0.35	0.33	0.36	0.24	0.32	0.33	0.32	0.34	0.29	0.26
TB29	0.19	0.27	0.29	0.26	0.32	0.43	0.44	0.34	0.34	0.40	0.42	0.38	0.35
TB30	0.38	0.36	0.31	0.27	0.36	0.40	0.34	0.37	0.39	0.43	0.42	0.37	0.32
TB31	0.32	0.16	0.60	0.31	0.29	0.24	0.23	0.25	0.26	0.24	0.22	0.42	0.33
TB32	0.22	0.15	0.21	0.31	0.22	0.27	0.21	0.23	0.22	0.22	0.27	0.24	0.18
TB33	0.27	0.24	0.32	0.31	0.33	0.37	0.31	0.33	0.30	0.35	0.34	0.29	0.28
TA1	0.00	0.06	0.02	0.06	0.04	0.02	0.06	0.04	0.06	0.05	0.02	0.06	0.06
TA2	0.04	0.26	0.07	0.08	0.09	0.14	0.13	0.09	0.12	0.10	0.13	0.06	0.08
TA3	0.12	0.22	0.10	0.13	0.16	0.15	0.08	0.14	0.15	0.20	0.16	0.14	0.12
TA4	0.07	0.18	0.07	0.08	0.14	0.23	0.12	0.19	0.22	0.16	0.16	0.09	0.11
QTPP	0.28	0.37	0.27	0.32	0.36	0.42	0.31	0.38	0.38	0.46	0.41	0.33	0.32

Table 2. Continued

	TB26	TB27	TB28	TB29	TB30	TB31	TB32	TB33	TA1	TA2	TA3	TA4	QTPP
TB1													
TB2													
TB3													
TB4													
TB5													
TB6													
TB7													
TB8													
TB9													
TB10													
TB11													
TB12													
TB13													
TB14													
TB15													
TB16													
TB17													
TB18													
TB19													
TB20													
TB21													
TB22													
TB23													
TB24													
TB25													
TB26	1.00												
TB27	0.54	1.00											
TB28	0.33	0.39	1.00										
TB29	0.36	0.40	0.40	1.00									
TB30	0.35	0.44	0.29	0.42	1.00								
TB31	0.37	0.30	0.30	0.27	0.37	1.00							
TB32	0.19	0.24	0.54	0.26	0.24	0.29	1.00						
TB33	0.33	0.35	0.34	0.33	0.34	0.34	0.34	1.00					
TA1	0.04	0.04	0.06	0.01	0.08	0.07	0.11	0.08	1.00				
TA2	0.12	0.13	0.09	0.06	0.13	0.07	0.07	0.07	0.08	1.00			
TA3	0.16	0.14	0.07	0.12	0.20	0.08	0.01	0.15	0.06	0.21	1.00		
TA4	0.13	0.16	0.16	0.12	0.13	0.08	0.12	0.14	0.07	0.36	0.21	1.00	
QTPP	0.38	0.41	0.29	0.35	0.35	0.25	0.27	0.36	0.07	0.20	0.24	0.27	1.00

Table 3. Univariate t-tests by student teaching level

Variable	Sample size	Mean	S.D.	t value	Prob.
Planning instruction					
Elementary	566	4.01	0.92	6.22#	.00**
Secondary	479	3.60	1.16		
Overall	1045	3.82	1.06		
Using media					
Elementary	561	3.82	0.92	-0.40	0.69
Secondary	479	3.84	0.95		
Overall	1040	3.83	0.93		
Maintaining student interest					
Elementary	563	3.63	0.91	5.29	.00**
Secondary	478	3.32	0.95		
Overall	1039	3.49	0.95		
Classroom management techniques					
Elementary	561	2.99	1.14	-0.46	0.65
Secondary	480	3.02	1.06		
Overall	1041	3.00	1.11		
Teaching the basic skills					
Elementary	563	3.72	0.89	1.27	0.21
Secondary	463	3.64	0.97		
Overall	1026	3.68	0.93		
Working with other professionals					
Elementary	556	3.16	1.06	-0.07	0.95
Secondary	472	3.16	1.04		
Overall	1028	3.16	1.05		
Developing student-student relationships					
Elementary	556	3.33	1.00	3.81	.00**
Secondary	465	3.08	1.05		
Overall	1021	3.22	1.03		
Referring students for special assistance					
Elementary	561	3.36	1.01	3.66	.00**
Secondary	462	3.13	0.99		
Overall	1023	3.25	1.01		

#Indicates the separate variance estimate used to determine value.

**Significant at the .01 level.

Table 3. Continued

Variable	Sample size	Mean	S.D.	t value	Prob.
Skills for mainstreaming students					
Elementary	552	3.54	1.01	3.92#	.00**
Secondary	465	3.27	1.13		
Overall	1017	3.42	1.07		
Methods of working with children with learning problems					
Elementary	561	3.42	1.00	5.45#	.00**
Secondary	464	3.06	1.10		
Overall	1025	3.26	1.07		
Assessing learning problems					
Elementary	558	3.41	0.97	6.67	.00**
Secondary	462	2.99	1.02		
Overall	1020	3.22	1.02		
Developing tests					
Elementary	541	3.26	1.03	-2.93#	.00**
Secondary	475	3.46	1.15		
Overall	1016	3.35	1.09		
Using standardized tests					
Elementary	556	3.46	0.98	-0.49	0.62
Secondary	458	3.49	1.03		
Overall	1014	3.48	1.01		
Content area preparation in specialization					
Elementary	545	4.06	0.95	-1.02	0.31
Secondary	480	4.12	1.01		
Overall	1025	4.09	0.98		
Ethics and legal obligations					
Elementary	565	3.43	1.01	-2.59	.01**
Secondary	481	3.59	1.02		
Overall	1046	3.51	1.02		
Learning psychology					
Elementary	561	3.90	0.85	3.49	.00**
Secondary	478	3.71	0.87		
Overall	1039	3.81	0.86		
Evaluating student work					
Elementary	564	3.69	0.87	1.68#	0.09
Secondary	482	3.60	0.99		
Overall	1046	3.65	0.93		

Table 3. Continued

Variable	Sample size	Mean	S.D.	t value	Prob.
Relating activities to students					
Elementary	567	4.02	0.77	6.42#	.00**
Secondary	481	3.68	0.94		
Overall	1048	3.87	0.87		
Locating and using materials					
Elementary	560	3.85	0.91	-0.09	0.93
Secondary	481	3.86	0.99		
Overall	1041	3.86	0.95		
Evaluating your own instruction					
Elementary	565	3.87	0.82	4.72#	.00**
Secondary	482	3.61	0.94		
Overall	1047	3.76	0.89		
Individualizing instruction					
Elementary	566	3.87	0.86	4.05#	.00**
Secondary	480	3.64	0.96		
Overall	1046	3.79	0.91		
Selecting and organizing materials					
Elementary	564	3.88	0.83	2.88#	.00**
Secondary	480	3.71	0.96		
Overall	1044	3.79	0.89		
Using a variety of instructional techniques					
Elementary	566	4.12	0.81	2.59#	.01**
Secondary	482	3.98	0.93		
Overall	1048	4.06	0.87		
Understanding teacher roles					
Elementary	565	3.46	0.99	-0.91	0.36
Secondary	478	3.51	0.99		
Overall	1043	3.48	0.99		
Working with parents					
Elementary	566	3.2	1.08	0.56	0.58
Secondary	473	3.16	1.01		
Overall	1039	3.18	1.05		
Working with other teachers					
Elementary	563	3.40	0.99	-0.10	0.92
Secondary	479	3.41	0.93		
Overall	1042	3.41	0.96		

Table 3. Continued

Variable	Sample size	Mean	S.D.	t value	Prob.
Assess/implement innovations					
Elementary	552	3.39	0.85	0.45	0.66
Secondary	473	3.36	0.90		
Overall	1025	3.37	0.87		
Appreciating individual differences					
Elementary	563	4.11	0.85	4.21	.00**
Secondary	479	3.87	0.93		
Overall	1042	4.00	0.89		
Using community resources					
Elementary	565	3.79	0.84	3.88#	.00**
Secondary	469	3.56	1.01		
Overall	1034	3.68	0.93		
Techniques of curriculum construction					
Elementary	558	3.41	0.99	-1.50#	0.13
Secondary	474	3.51	1.12		
Overall	1032	3.45	1.05		
Influence of laws related to schools					
Elementary	560	3.28	0.97	-4.04	.00**
Secondary	479	3.52	0.99		
Overall	1039	3.39	0.98		
Techniques of infusing multicultural education					
Elementary	565	4.03	0.90	3.90#	.00**
Secondary	478	3.79	1.08		
Overall	1043	3.92	0.99		
Learning to write effectively					
Elementary	565	3.76	0.91	0.44	0.66
Secondary	479	3.73	0.94		
Overall	1044	3.74	0.92		

There were a total of 19 variables that had highly significant t values, with 16 having the elementary level having the higher mean rating. Therefore, the researcher would reject the null hypothesis and accept the alternative hypothesis that there is a significant difference between the two teaching levels for 19 of the 33 areas.

Thirteen of the 33 t-tests rejected the null hypothesis of equal variances between the two groups, therefore requiring the t statistic to be calculated using the separate variance procedure. The t statistic is generally regarded as a very robust statistic; therefore, deviations from equal variances do not affect the statistic significantly (Bernstein, 1988). A robust test statistic is one which will work well for a wide variety of population types. Precisely, a robust test will function adequately when the assumptions required for its application are violated.

Hypothesis 2

There is no significant difference in the mean on each of the 33 areas of preparation when comparing the groups formed by each of the five graduation years.

Table 4 presents the means, standard deviations, and sample size for each of the five years, plus the overall mean, standard deviation, and sample size. Also presented is the F statistic determined by a one-way analysis of variance. Throughout the course of this research, the alpha level for determining significance was .05. If the F statistic had a probability less than .05, it was labeled with one asterisk (*). If the

Table 4. Univariate one-way ANOVA's by graduation year

Variable	Sample size	Mean	S.D.	F	Prob.	Sig. group
Planning instruction						
1983/84	228	4.04	0.94	3.52	.01**	84-88
1984/85	191	3.81	1.04			
1985/86	208	3.74	1.13			
1986/87	199	3.75	1.12			
1987/88	219	3.73	1.03			
Overall	1045	3.82	1.06			
Using media						
1983/84	227	3.90	0.93	1.05	0.38	
1984/85	191	3.74	0.97			
1985/86	204	3.87	0.88			
1986/87	198	3.85	0.89			
1987/88	220	3.78	0.99			
Overall	1040	3.83	0.93			
Maintaining student interest						
1983/84	225	3.66	0.91	3.54	.01**	84-88
1984/85	192	3.55	0.97			
1985/86	208	3.40	0.91			
1986/87	197	3.45	0.94			
1987/88	219	3.37	0.97			
Overall	1041	3.49	0.94			
Classroom management techniques						
1983/84	226	3.02	1.10	0.57	0.68	
1984/85	193	3.07	1.11			
1985/86	209	3.00	1.10			
1986/87	195	3.03	1.14			
1987/88	218	2.91	1.08			
Overall	1041	3.00	1.11			
Teaching the basic skills						
1983/84	224	3.71	0.92	0.32	0.86	
1984/85	186	3.69	0.91			
1985/86	202	3.72	0.87			
1986/87	197	3.62	0.97			
1987/88	217	3.67	0.98			
Overall	1026	3.68	0.93			

**Significant at the .01 level.

Table 4. Continued

Variable	Sample size	Mean	S.D.	F	Prob.	Sig. group
Working with other professionals						
1983/84	222	3.28	0.94	2.70	.03*	84-87
1984/85	189	3.27	1.08			
1985/86	207	3.16	1.10			
1986/87	194	3.02	1.08			
1987/88	216	3.06	1.02			
Overall	1028	3.16	1.05			
Developing student-student relationships						
1983/84	223	3.28	0.98	0.69	0.60	
1984/85	188	3.28	1.06			
1985/86	205	3.21	1.06			
1986/87	193	3.17	1.10			
1987/88	212	3.15	0.97			
Overall	1021	3.22	1.03			
Referring students for special assistance						
1983/84	224	3.34	1.02	3.27	.01**	86-88
1984/85	187	3.34	1.00			
1985/86	204	3.35	0.98			
1986/87	195	3.18	1.02			
1987/88	213	3.07	0.99			
Overall	1023	3.25	1.01			
Skills for mainstreaming students						
1983/84	223	3.41	1.12	1.42	0.23	
1984/85	185	3.46	1.12			
1985/86	203	3.44	1.03			
1986/87	195	3.50	1.04			
1987/88	211	3.27	1.04			
Overall	1017	3.41	1.07			
Methods of working with children with learning problems						
1983/84	223	3.24	1.06	0.30	0.88	
1984/85	188	3.28	1.10			
1985/86	204	3.31	1.04			
1986/87	198	3.21	1.10			
1987/88	212	3.25	1.04			
Overall	1025	3.26	1.07			

*Significant at the .05 level.

Table 4. Continued

Variable	Sample size	Mean	S.D.	F	Prob.	Sig. group
Assessing learning problems						
1983/84	225	3.25	0.94	1.09	0.36	
1984/85	188	3.21	1.04			
1985/86	200	3.34	1.02			
1986/87	194	3.15	1.08			
1987/88	213	3.16	1.01			
Overall	1020	3.22	1.02			
Developing tests						
1983/84	221	3.50	1.02	6.08	.00**	84-88
1984/85	187	3.43	1.09			86-88
1985/86	203	3.48	1.10			85-88
1986/87	195	3.28	1.11			
1987/88	210	3.06	1.10			
Overall	1016	3.35	1.09			
Using standardized tests						
1983/84	219	3.48	0.97	0.97	0.42	
1984/85	188	3.53	1.00			
1985/86	205	3.55	1.03			
1986/87	191	3.46	1.00			
1987/88	211	3.37	1.02			
Overall	1014	3.47	1.00			
Content area preparation in specialization						
1983/84	220	4.10	0.97	1.19	0.31	
1984/85	192	4.17	0.92			
1985/86	209	4.13	0.92			
1986/87	190	4.08	1.01			
1987/88	214	3.97	1.06			
Overall	1025	4.09	0.98			
Ethics and legal obligations						
1983/84	228	3.54	0.98	1.36	0.25	
1984/85	192	3.40	1.08			
1985/86	209	3.62	0.97			
1986/87	199	3.51	1.05			
1987/88	218	3.46	1.01			
Overall	1046	3.51	1.02			

Table 4. Continued

Variable	Sample size	Mean	S.D.	F	Prob.	Sig. group
Learning psychology						
1983/84	227	3.81	0.86	0.51	0.73	
1984/85	190	3.81	0.88			
1985/86	208	3.85	0.90			
1986/87	197	3.75	0.85			
1987/88	217	3.85	0.84			
Overall	1039	3.81	0.86			
Evaluating student work						
1983/84	228	3.67	0.92	0.58	0.68	
1984/85	193	3.68	0.90			
1985/86	208	3.69	0.92			
1986/87	198	3.65	0.97			
1987/88	219	3.57	0.92			
Overall	1046	3.65	0.93			
Relating activities to students						
1983/84	228	4.00	0.77	2.39	.05*	84-88
1984/85	194	3.89	0.91			
1985/86	208	3.86	0.87			
1986/87	199	3.83	0.89			
1987/88	219	3.74	0.87			
Overall	1048	3.87	0.86			
Locating and using materials						
1983/84	227	3.93	0.89	1.06	0.37	
1984/85	192	3.83	0.98			
1985/86	209	3.92	0.90			
1986/87	196	3.82	1.04			
1987/88	217	3.78	0.92			
Overall	1041	3.86	0.94			
Evaluating your own instruction						
1983/84	228	3.74	0.85	0.87	0.48	
1984/85	193	3.80	0.87			
1985/86	209	3.81	0.86			
1986/87	199	3.76	0.86			
1987/88	218	3.67	0.99			
Overall	1047	3.75	0.89			

Table 4. Continued

Variable	Sample size	Mean	S.D.	F	Prob.	Sig. group
Individualizing instruction						
1983/84	228	3.88	0.85	1.78	0.13	
1984/85	194	3.81	0.97			
1985/86	209	3.72	0.91			
1986/87	196	3.74	0.87			
1987/88	219	3.67	0.95			
Overall	1046	3.77	0.91			
Selecting and organizing materials						
1983/84	226	3.85	0.84	1.37	0.24	
1984/85	193	3.88	0.84			
1985/86	209	3.80	0.96			
1986/87	198	3.74	0.90			
1987/88	218	3.70	0.92			
Overall	1044	3.79	0.89			
Using a variety of instructional techniques						
1983/84	228	4.19	0.80	1.75	0.14	
1984/85	194	4.03	0.85			
1985/86	209	4.03	0.87			
1986/87	199	3.99	0.92			
1987/88	218	4.03	0.90			
Overall	1048	4.06	0.87			
Understanding teacher roles						
1983/84	228	3.53	1.00	1.31	0.27	
1984/85	191	3.58	0.94			
1985/86	208	3.49	0.99			
1986/87	197	3.43	0.96			
1987/88	219	3.38	1.02			
Overall	1043	3.48	0.99			
Working with parents						
1983/84	224	3.33	0.97	4.17	.00**	84-88
1984/85	191	3.29	1.03			
1985/86	208	3.24	1.10			
1986/87	197	3.11	1.07			
1987/88	219	2.97	1.04			
Overall	1039	3.18	1.05			

Table 4. Continued

Variable	Sample size	Mean	S.D.	F	Prob.	Sig. group
Working with other teachers						
1983/84	227	3.52	0.95	3.81	.00**	84-88
1984/85	193	3.43	0.93			86-88
1985/86	207	3.51	0.94			
1986/87	197	3.35	0.96			
1987/88	218	3.22	1.00			
Overall	1042	3.41	0.96			
Assess/implement innovations						
1983/84	223	3.45	0.81	4.06	.00**	85-88
1984/85	189	3.53	0.84			
1985/86	205	3.37	0.88			
1986/87	192	3.32	0.91			
1987/88	216	3.21	0.89			
Overall	1025	3.37	0.87			
Appreciating individual differences						
1983/84	227	3.93	0.89	0.48	0.77	
1984/85	193	4.01	0.86			
1985/86	208	4.00	0.94			
1986/87	196	4.02	0.88			
1987/88	218	4.04	0.91			
Overall	1042	4.00	0.89			
Using community resources						
1983/84	227	3.73	0.93	0.49	0.74	
1984/85	189	3.62	1.00			
1985/86	205	3.72	0.90			
1986/87	197	3.65	0.91			
1987/88	216	3.68	0.92			
Overall	1034	3.68	0.93			
Techniques of curriculum construction						
1983/84	225	3.65	0.98	3.81	.00**	84-88
1984/85	188	3.53	1.05			
1985/86	207	3.43	1.09			
1986/87	196	3.34	1.08			
1987/88	216	3.31	1.02			
Overall	1032	3.45	1.05			

Table 4. Continued

Variable	Sample size	Mean	S.D.	F	Prob.	Sig. group
Influence of laws related to schools						
1983/84	226	3.34	0.96	1.60	0.17	
1984/85	190	3.43	1.02			
1985/86	207	3.53	0.94			
1986/87	199	3.31	1.03			
1987/88	217	3.36	0.97			
Overall	1039	3.39	0.98			
Techniques of infusing multicultural education						
1983/84	227	3.79	1.05	2.19#	0.07	
1984/85	191	3.92	0.99			
1985/86	207	3.95	1.02			
1986/87	199	3.89	1.05			
1987/88	219	4.06	0.82			
Overall	1043	3.92	0.99			
Learning to write effectively						
1983/84	228	3.64	0.87	1.79	0.13	
1984/85	191	3.70	0.92			
1985/86	209	3.80	0.98			
1986/87	199	3.73	0.97			
1987/88	217	3.85	0.86			
Overall	1044	3.74	0.92			

#Indicates null hypothesis of equal variances across groups was rejected.

F statistic's probability was less than .01, it was labeled with two asterisks (**), signifying a highly significant difference. A significant F statistic was followed by a Scheffé post hoc test to determine where the significant differences in means lay.

Similar to the t-tests, it was important to examine the variances for the dependent variables in each of the five graduation years. Heterogeneity of variance could imply that the independent variable, the year of graduation, had an effect on the dispersion of the scores in any one or more years. Two statistics, Cochran C and Bartlett Box F, were used to evaluate the null hypothesis that the variances are equal among the five levels. The F statistic followed by a # indicates that the null hypothesis of equal variances across groups was rejected for that given dependent variable.

When the researcher reviewed the 33 one-way ANOVA's, it was found that there were ten areas in which the means were significantly different among the five graduation years. Of those ten areas, eight were highly significant, a probability of less than .01. Therefore, the researcher would reject the null hypothesis of equal means across the five graduation years and accept the alternative hypothesis that at least two means in ten of the 33 areas of preparation are not equal.

When reviewing the Scheffé post hoc test, it could be noted that in general the significant difference was noted between the first year of the study, 1983/84, and the final year of the study, 1987/88. In all ten areas, the early years of the study had significantly higher means than the final years. This can be concluded to mean the perceived adequacy of preparation in those areas tended to decrease with time. Of the 33 one-way analysis of variance tests, one variable, techniques of infusing multicultural education, had heterogeneity of variance. It is important to note that the Bartlett Box F statistic was significant, while the Cochran C statistic was not. Like the t statistic, the F statistic is considered to be very robust, so minor departures from the null hypothesis of equal variances have little effect on the statistic (Bernstein, 1988).

Hypothesis 3

There is no relationship between the level at which the subject student taught and the year in which the subject graduated as measured by the 33 areas of adequacy of preparation.

The most compact and statistically correct analysis of the data using the univariate methodology was to consider the 33 areas of preparation variables in a factorial design. In this type of design, the independent variables were considered jointly, which in this case was to form a two-by-five factorial design. Here the researcher examined the F statistics for each of the independent variables or main effects. The design also allows the researcher to explore the possible interaction effect of the independent variables on the dependent variable. The factorial design is regarded as the best statistical design because the variance can be partitioned into four major components, one for each independent variable, one for the interaction term, and the remaining variance becoming the error variance. A less complete design increases the amount of variance in the error term, thus decreasing the size of the F statistic. Table 5 provides a summary of the results of the two-by-five analysis of variance for the 33 areas of preparation variables.

The same 19 areas of preparation in which there was a significant difference between the two teaching levels using the independent t-tests were identified to be significant using the factorial design. Reviewing the main effect for the graduation years found that the same ten areas identified in the one-way analysis of variance were again significant. In addition to those ten areas, another area, Understanding teachers' role in relation to administrators, supervisors, and counselors, was found to be significant. This difference could be attributed to the reduced error term due to the partitioning of the total sum of squares into the two main effects, interaction term, and then the error term.

Two areas, Using media, and Using a variety of instructional techniques, were identified as having a significant interaction effect. When the dependent variable means for each cells were plotted in a graph, it was noted that in both preparation areas the secondary group had means greater than the elementary level starting in 1983/84 and continued into 1984/85. In 1985/86 the relative position of the two groups switched. Elementary graduates in 1985/86 through 1987/88 continued to have higher means for the preparation area of using media. In 1986/87, the secondary group mean was again higher than the elementary group mean. Finally in the 1987/88 academic year, the mean for elementary was again higher than the secondary groups for the instructional techniques preparation area.

Table 5. Univariate level by graduation year factorial design

Variable	Year	Sample size	Mean	F value	F prob.
TB1					
Elementary	1983/84	116	4.26	43.59[a]	0.00**
	1984/85	91	3.99	4.39[b]	0.00**
	1985/86	119	4.01	0.76[c]	0.55
	1986/87	107	3.91		
	1987/88	133	3.87		
Secondary	1983/84	112	3.82		
	1984/85	100	3.64		
	1985/86	89	3.37		
	1986/87	92	3.58		
	1987/88	86	3.51		
TB2					
Elementary	1983/84	115	3.87	0.17	0.68
	1984/85	92	3.43	1.08	0.37
	1985/86	115	3.96	6.14	0.00**
	1986/87	106	3.95		
	1987/88	133	3.82		
Secondary	1983/84	112	3.93		
	1984/85	99	4.02		
	1985/86	89	3.76		
	1986/87	92	3.74		
	1987/88	87	3.72		
TB3					
Elementary	1983/84	115	3.90	31.53	0.00**
	1984/85	92	3.67	4.44	0.00**
	1985/86	119	3.55	1.00	0.41
	1986/87	105	3.51		
	1987/88	132	3.52		
Secondary	1983/84	110	3.42		
	1984/85	100	3.43		
	1985/86	89	3.20		
	1986/87	92	3.37		
	1987/88	87	3.14		

[a]Teaching level main effect F statistic.
[b]Graduation year main effect F statistic.
[c]Interaction effect F statistic.
**Significant at the .01 level.

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB4					
Elementary	1983/84	114	3.02	0.11	0.74
	1984/85	93	3.11	0.55	0.70
	1985/86	119	2.92	1.37	0.24
	1986/87	104	2.92		
	1987/88	131	3.00		
Secondary	1983/84	112	3.04		
	1984/85	100	3.03		
	1985/86	90	3.10		
	1986/87	91	3.14		
	1987/88	87	2.78		
TB5					
Elementary	1983/84	115	3.86	1.64	0.20
	1984/85	92	3.68	0.33	0.86
	1985/86	118	3.72	1.22	0.30
	1986/87	107	3.65		
	1987/88	131	3.66		
Secondary	1983/84	109	3.55		
	1984/85	94	3.70		
	1985/86	84	3.71		
	1986/87	90	3.59		
	1987/88	86	3.69		
TB6					
Elementary	1983/84	112	3.26	0.02	0.88
	1984/85	91	3.23	2.70	0.03*
	1985/86	118	3.24	0.55	0.70
	1986/87	105	2.99		
	1987/88	130	3.08		
Secondary	1983/84	110	3.31		
	1984/85	98	3.31		
	1985/86	89	3.06		
	1986/87	89	3.06		
	1987/88	86	3.02		

*Significant at the .05 level.

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB7					
Elementary	1983/84	115	3.36	15.63	0.00**
	1984/85	91	3.54	0.96	0.43
	1985/86	116	3.41	1.87	0.11
	1986/87	105	3.20		
	1987/88	129	3.19		
Secondary	1983/84	108	3.19		
	1984/85	97	3.03		
	1985/86	89	2.97		
	1986/87	88	3.13		
	1987/88	83	3.08		
TB8					
Elementary	1983/84	114	3.53	15.34	0.00**
	1984/85	92	3.48	3.77	0.01**
	1985/86	118	3.45	0.76	0.55
	1986/87	107	3.21		
	1987/88	130	3.17		
Secondary	1983/84	110	3.15		
	1984/85	95	3.20		
	1985/86	86	3.21		
	1986/87	88	3.16		
	1987/88	83	2.90		
TB9					
Elementary	1983/84	112	3.63	17.08	0.00**
	1984/85	89	3.56	1.78	0.13
	1985/86	117	3.54	0.40	0.81
	1986/87	105	3.61		
	1987/88	129	3.38		
Secondary	1983/84	111	3.20		
	1984/85	96	3.38		
	1985/86	86	3.30		
	1986/87	90	3.38		
	1987/88	82	3.10		

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB10					
Elementary	1983/84	113	3.50	30.35	0.00**
	1984/85	91	3.46	0.37	0.83
	1985/86	118	3.45	0.51	0.73
	1986/87	107	3.32		
	1987/88	132	3.39		
Secondary	1983/84	110	2.97		
	1984/85	97	3.11		
	1985/86	86	3.13		
	1986/87	91	3.08		
	1987/88	80	3.01		
TB11					
Elementary	1983/84	115	3.52	44.80	0.00**
	1984/85	90	3.47	1.23	0.30
	1985/86	117	3.49	0.57	0.69
	1986/87	104	3.31		
	1987/88	132	3.29		
Secondary	1983/84	110	2.96		
	1984/85	98	2.97		
	1985/86	83	3.12		
	1986/87	90	2.97		
	1987/88	81	2.96		
TB12					
Elementary	1983/84	109	3.55	7.17	0.01**
	1984/85	89	3.39	5.70	0.00**
	1985/86	114	3.36	1.77	0.13
	1986/87	103	3.16		
	1987/88	126	2.90		
Secondary	1983/84	112	3.46		
	1984/85	98	3.47		
	1985/86	89	3.64		
	1986/87	92	3.41		
	1987/88	84	3.31		

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB13					
Elementary	1983/84	112	3.43	0.15	0.70
	1984/85	93	3.47	0.94	0.44
	1985/86	117	3.55	0.44	0.78
	1986/87	103	3.51		
	1987/88	131	3.37		
Secondary	1983/84	107	3.53		
	1984/85	95	3.58		
	1985/86	88	3.56		
	1986/87	88	3.39		
	1987/88	80	3.39		
TB14					
Elementary	1983/84	108	4.15	0.78	0.38
	1984/85	91	4.04	1.13	0.34
	1985/86	119	4.11	0.76	0.55
	1986/87	100	4.05		
	1987/88	127	3.95		
Secondary	1983/84	112	4.04		
	1984/85	101	4.28		
	1985/86	90	4.17		
	1986/87	90	4.11		
	1987/88	87	4.00		
TB15					
Elementary	1983/84	116	3.39	7.12	0.01**
	1984/85	92	3.23	1.47	0.21
	1985/86	119	3.66	1.52	0.20
	1986/87	107	3.41		
	1987/88	131	3.42		
Secondary	1983/84	112	3.69		
	1984/85	100	3.56		
	1985/86	90	3.57		
	1986/87	92	3.62		
	1987/88	87	3.52		

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB16					
Elementary	1983/84	115	3.92	11.81	0.00**
	1984/85	91	3.86	0.43	0.79
	1985/86	118	3.99	0.99	0.41
	1986/87	106	3.86		
	1987/88	131	3.86		
Secondary	1983/84	112	3.70		
	1984/85	99	3.76		
	1985/86	90	3.67		
	1986/87	91	3.62		
	1987/88	86	3.84		
TB17					
Elementary	1983/84	116	3.74	3.22	0.07
	1984/85	92	3.70	0.67	0.61
	1985/86	118	3.74	0.16	0.96
	1986/87	106	3.69		
	1987/88	132	3.63		
Secondary	1983/84	112	3.60		
	1984/85	101	3.67		
	1985/86	90	3.62		
	1986/87	92	3.61		
	1987/88	87	3.48		
TB18					
Elementary	1983/84	116	4.13	45.92	0.00**
	1984/85	93	4.08	3.26	0.01**
	1985/86	119	4.08	0.79	0.53
	1986/87	107	3.94		
	1987/88	132	3.92		
Secondary	1983/84	112	3.86		
	1984/85	101	3.71		
	1985/86	89	3.58		
	1986/87	92	3.71		
	1987/88	87	3.49		

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB19					
Elementary	1983/84	115	3.84	0.00	0.97
	1984/85	92	3.77	1.06	0.37
	1985/86	119	3.97	1.15	0.33
	1986/87	104	3.83		
	1987/88	130	3.84		
Secondary	1983/84	112	4.02		
	1984/85	100	3.88		
	1985/86	90	3.86		
	1986/87	92	3.80		
	1987/88	87	3.69		
TB20					
Elementary	1983/84	116	3.80	23.85	0.00**
	1984/85	92	3.99	1.16	0.33
	1985/86	119	3.97	0.75	0.56
	1986/87	107	3.89		
	1987/88	131	3.76		
Secondary	1983/84	112	3.69		
	1984/85	101	3.62		
	1985/86	90	3.60		
	1986/87	92	3.62		
	1987/88	87	3.52		
TB21					
Elementary	1983/84	116	4.02	18.52	0.00**
	1984/85	93	3.95	2.26	0.06
	1985/86	119	3.85	0.41	0.80
	1986/87	106	3.78		
	1987/88	132	3.78		
Secondary	1983/84	112	3.74		
	1984/85	101	3.68		
	1985/86	90	3.56		
	1986/87	90	3.69		
	1987/88	87	3.51		

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB22					
Elementary	1983/84	115	3.83	9.69	0.00*
	1984/85	92	3.93	1.68	0.15
	1985/86	119	3.95	1.42	0.23
	1986/87	106	3.83		
	1987/88	132	3.80		
Secondary	1983/84	111	3.86		
	1984/85	101	3.82		
	1985/86	90	3.60		
	1986/87	92	3.64		
	1987/88	86	3.55		
TB23					
Elementary	1983/84	116	4.14	7.41	0.01**
	1984/85	93	4.09	1.90	0.11
	1985/86	119	4.18	2.50	0.04*
	1986/87	107	4.03		
	1987/88	131	4.15		
Secondary	1983/84	112	4.24		
	1984/85	101	3.98		
	1985/86	90	3.83		
	1986/87	92	3.95		
	1987/88	87	3.84		
TB24					
Elementary	1983/84	116	3.46	0.54	0.46
	1984/85	91	3.44	1.24	0.29
	1985/86	119	3.61	3.07	0.02*
	1986/87	107	3.33		
	1987/88	132	3.44		
Secondary	1983/84	112	3.62		
	1984/85	100	3.70		
	1985/86	89	3.34		
	1986/87	90	3.57		
	1987/88	87	3.29		

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB25					
Elementary	1983/84	115	3.37	0.70	0.40
	1984/85	93	3.30	4.28	.00**
	1985/86	119	3.28	1.59	0.18
	1986/87	107	3.00		
	1987/88	132	3.08		
Secondary	1983/84	109	3.28		
	1984/85	98	3.28		
	1985/86	89	3.18		
	1986/87	90	3.23		
	1987/88	87	2.80		
TB26					
Elementary	1983/84	115	3.49	0.01	0.92
	1984/85	92	3.41	3.81	0.00**
	1985/86	118	3.55	0.88	0.48
	1986/87	107	3.29		
	1987/88	131	3.28		
Secondary	1983/84	112	3.56		
	1984/85	101	3.45		
	1985/86	89	3.45		
	1986/87	90	3.42		
	1987/88	87	3.11		
TB27					
Elementary	1983/84	113	3.46	0.62	0.43
	1984/85	90	3.51	4.16	0.00**
	1985/86	115	3.46	1.14	0.33
	1986/87	104	3.27		
	1987/88	130	3.26		
Secondary	1983/84	110	3.44		
	1984/85	99	3.56		
	1985/86	90	3.24		
	1986/87	88	3.39		
	1987/88	86	3.14		

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB28					
Elementary	1983/84	115	4.12	17.18	0.00**
	1984/85	93	4.15	0.34	0.85
	1985/86	118	4.07	0.71	0.58
	1986/87	106	4.08		
	1987/88	131	4.12		
Secondary	1983/84	112	3.74		
	1984/85	100	3.88		
	1985/86	90	3.92		
	1986/87	90	3.94		
	1987/88	87	3.92		
TB29					
Elementary	1983/84	116	3.84	15.32	0.00**
	1984/85	93	3.65	0.47	0.77
	1985/86	119	3.81	0.68	0.61
	1986/87	106	3.78		
	1987/88	131	3.82		
Secondary	1983/84	111	3.61		
	1984/85	96	3.59		
	1985/86	86	3.59		
	1986/87	91	3.51		
	1987/88	85	3.47		
TB30					
Elementary	1983/84	114	3.54	1.67	0.20
	1984/85	92	3.52	3.64	0.01**
	1985/86	118	3.46	0.85	0.49
	1986/87	105	3.23		
	1987/88	129	3.30		
Secondary	1983/84	111	3.76		
	1984/85	96	3.53		
	1985/86	89	3.38		
	1986/87	91	3.46		
	1987/88	87	3.33		

Table 5. Continued

Variable	Year	Sample size	Mean	F value	F prob.
TB31					
Elementary	1983/84	114	3.11	16.78	0.00**
	1984/85	92	3.28	1.72	0.14
	1985/86	117	3.50	2.07	0.08
	1986/87	107	3.12		
	1987/88	130	3.35		
Secondary	1983/84	112	3.57		
	1984/85	98	3.56		
	1985/86	90	3.57		
	1986/87	92	3.52		
	1987/88	87	3.38		
TB32					
Elementary	1983/84	115	3.92	14.29	0.00**
	1984/85	92	4.08	1.85	0.12
	1985/86	119	4.08	0.71	0.58
	1986/87	107	4.02		
	1987/88	132	4.08		
Secondary	1983/84	112	3.66		
	1984/85	99	3.77		
	1985/86	88	3.78		
	1986/87	92	3.74		
	1987/88	87	4.05		
TB33					
Elementary	1983/84	116	3.66	0.05	0.82
	1984/85	92	3.64	1.76	0.14
	1985/86	119	3.84	1.33	0.26
	1986/87	107	3.65		
	1987/88	131	3.93		
Secondary	1983/84	112	3.63		
	1984/85	99	3.75		
	1985/86	90	3.74		
	1986/87	92	3.83		
	1987/88	86	3.73		

Factor Analysis

Hypothesis 4

There is no underlying factors that can express the 33 areas of preparation in a more parsimonious manner.

Table 2 provides evidence that there was a correlation among many of the dependent variables. In cases similar to this, it has been commonly accepted that the researcher should use a factor analysis to determine the reduced number of factors. The results of the principal axis factoring factor analysis can be found in Table 6 for the 33 areas of preparation as the variables. After examining the results and considering the guidelines outlined in Chapter III, five factors were identified. Variables TB2, TB14, TB16, TB27, TB31, and TB33 were not included in any of the factors since they all had item loading less than .40.

These five factors were: (1) Planning and delivering instruction and maintaining student interests; (2) interpersonal relationships; (3) assessing and dealing with learning problems; (4) understanding individual differences; and (5) monitoring, testing, and evaluating student achievement. These five factors are in very close agreement with factors identified by Sweeney (1987) and Kang (1987). These researchers, using the same variables with slightly different sample groups, discovered that the variables loaded into the same factors as did this research. Reliability coefficients calculated by using Cronbach's alpha are found in Table 7.

Table 6. Factor matrix of the adequacy of teacher preparation

Item no.	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
TB22	.69				
TB23	.61				
TB20	.61				
TB21	.56				
TB18	.56				
TB1	.52				
TB19	.50				
TB3	.50				
TB5	.47				
TB30	.46				
TB29	.46				
TB26		.71			
TB25		.66			
TB6		.61			
TB24		.57			
TB7		.47			
TB4		.46			
TB15		.43			
TB10			.80		
TB9			.77		
TB11			.69		
TB8			.56		
TB32				.62	
TB28				.59	
TB12					.64
TB13					.57
TB17					.43
% Variance	33.1%	4.5%	3.6%	3.1%	2.3%
Eigenvalue	10.93	1.50	1.19	1.01	0.76

Table 7. Item selected for factors and reliability coefficients

Factor	Item	Alpha
Factor 1.	Planning and delivering instruction and maintaining student interests	.88
TB22	Selecting and organizing material	
TB23	Using a variety of instructional techniques	
TB20	Evaluating your own instruction	
TB21	Individualizing instruction	
TB18	Relating activities to interests and abilities of students	
TB1	Planning units of instruction and individual lessons	
TB19	Locating and using materials	
TB3	Maintaining students' interest	
TB5	Teaching the basic skills	
TB30	Techniques of curriculum construction	
TB29	Using community resources	
Factor 2.	Interpersonal relationships	.84
TB26	Working with other teachers	
TB25	Working with parents	
TB6	Consultation skills in interacting with other professionals	
TB24	Understanding teachers' roles in relation to administrators, supervisors, and counselors	
TB7	Developing student-student relationships	
TB4	Classroom management	
TB15	Ethics and legal obligations	
Factor 3.	Assessing and dealing with learning problems	.86
TB10	Methods of working with children with learning problems	
TB9	Skills for mainstreaming handicapped students	
TB11	Assessing learning problems	
TB8	Referring students for special assistance	
Factor 4.	Understanding individual differences	.76
TB32	Techniques for infusing multicultural education	
TB28	Appreciating and understanding individual and intergroup differences in values and lifestyles	
Factor 5.	Monitoring, testing, and evaluating student achievement	.74
TB12	Developing tests	
TB13	Interpreting and using standardized tests	
TB17	Evaluating and reporting student work and achievement	

The results of the principal axis factoring factor analysis can be found in Table 8 using the four measures of satisfaction with their student teaching experience and the overall rating as to the quality of the teacher preparation program as the variables. After examining the results and considering the guidelines outlined in Chapter III, one factor was identified. Variable TA1, Choice of geographical location of student teaching, was not included in the factor since it had item loading less than 40.

Table 8. Factor matrix on the general satisfaction variables

Item no.	Factor 1
TA4	.60
TA2	.53
QTPP	.46
TA3	.41
% Variance	21.1%
Eigenvalue	1.05

The loadings on all five satisfaction variables are generally low. That fact, coupled with an overall reliability index of .41 and the percentage variance of 21.1%, led the researcher to conclude that these five variables do not combine to form a factor.

Multivariate Analysis

Assumptions

Whenever a researcher is considering the use of a multivariate procedure, it would be wise to first test the three basic assumptions. This first assumption is that the observations, or subjects, are measured independently. There is no statistical test to analyze this assumption; rather it is up to the researcher to place restrictions on the design of the research to insure that the observations are independent. Anytime treatments, in this case the students' education classes, are administered to subjects in groups, there is a chance that the observations are dependent. One possible solution would be to use a large unit of analysis, such as a classroom mean. This was impractical in this research since the treatment took place over the course of the years the students were at Iowa State University. Given no other choice, the researcher assumed that the observations were independent.

The second multivariate assumption is that the dependent variables come from a multivariate normal distribution. Although it is impossible to graphically represent the distribution of all dependent variables, research has shown that by examining each variable's distribution separately, conclusions can be made regarding their joint distribution.

Using the graphing functions of SPSSX, the researcher produced a normal plot and a detrended normal plot for each of the 38 variables. Graphs demonstrating the distribution of the subject's graduating grade point average was also plotted in hopes of finding variables that failed to show a normal distribution. Both the normal and detrended normal distribution for the preparation variable, Working with other professionals, are shown in Figure 3. The normal plot shows the scores falling on a straight line from which it can be concluded that the variable follows a normal distribution. In a detrended normal plot, there should be a band of points surrounding the zero mark. Again the distribution demonstrates that the variable follows a normal distribution. Similar results were found for each of the 38 dependent variables. Therefore, the researcher concluded that each of the variables came from a normal distribution, and therefore they probably also follow a multivariate normal distribution.

Two other variables were also graphed. Figure 4 graphed the variable representing the measure of the overall rating of the teacher education program. This variable, QTPP, also demonstrated the normal distribution, and the cluster of points surrounding the zero mark in the detrended normal plot. A second graph ploted the graduating grade point average of each of the graduates and can be found in Figure 5 in Appendix C. Although this variable was not used in the analysis, its plot was included to demonstrate a variable that does not follow the normal distribution. Each tail of the normal plot bows out, and the detrended normal plot shows a pattern other than the cluster surrounding zero that was expected.

The major focus of multivariate analysis of data is that the dependent variables are correlated, and if they are not, there is no point of using the technique. The Bartlett's test of sphericity was used to test the

NORMAL PLOTS

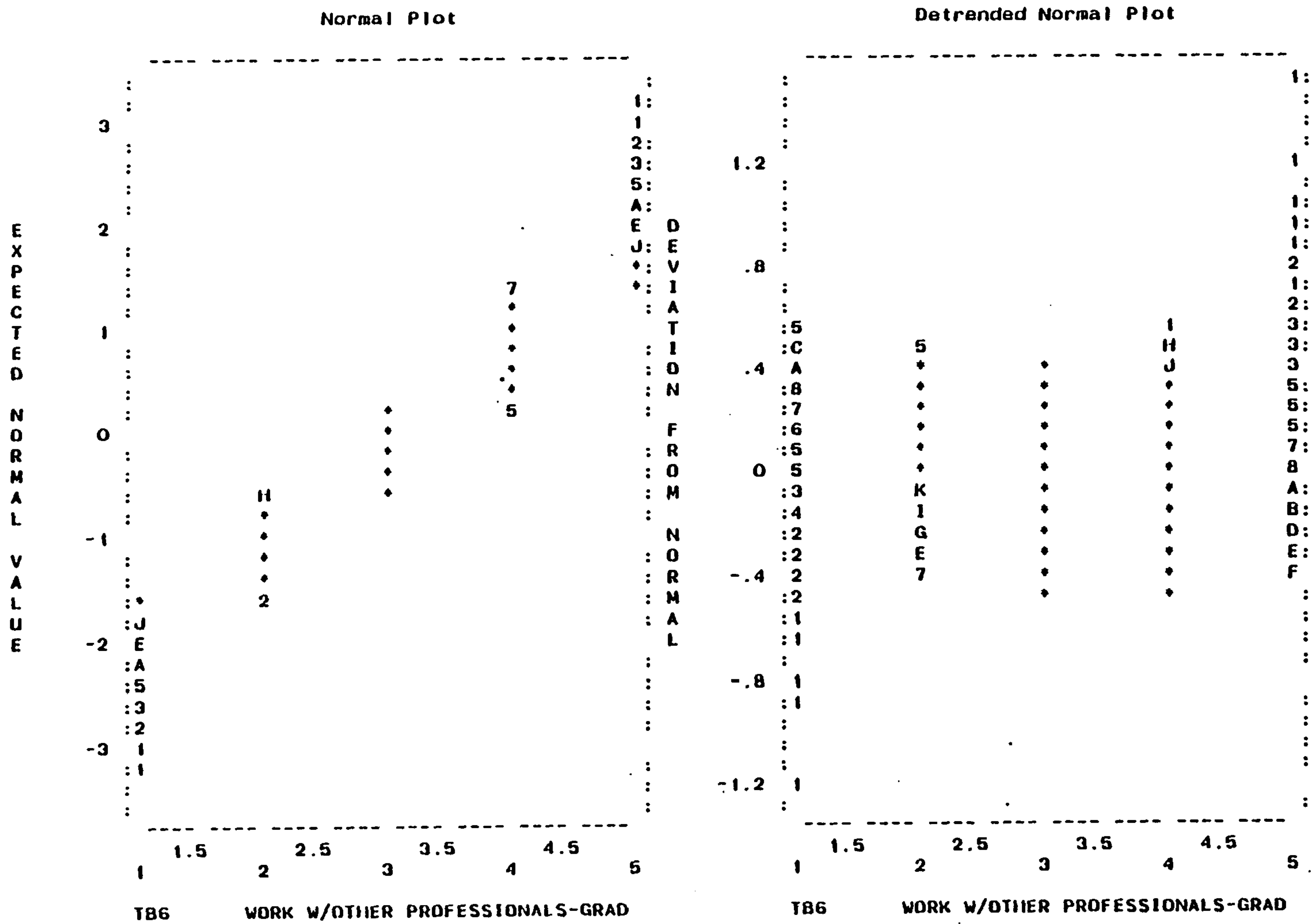


Figure 3. Normal plot of preparation variable

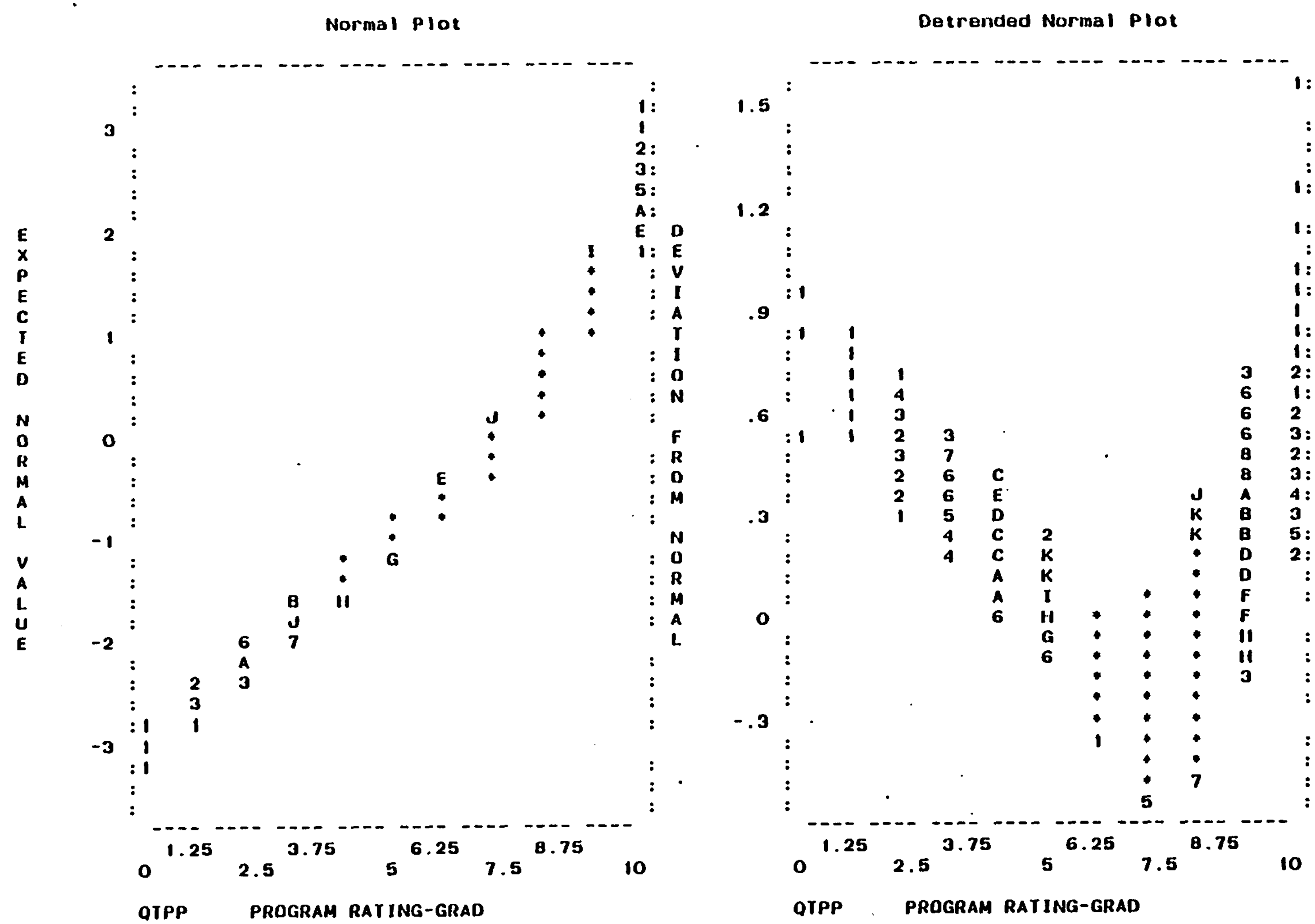


Figure 4. Normal plot of overall satisfaction

Table 9. Bartlett's test of sphericity

Design	Determinant	Prob.
Full factorial with level and graduation year on preparation variables	11984.87	.00**
Preparation variables on graduation year	12072.79	.00**
Preparation variables on student teaching level	12094.57	.00**

**Significant at the .01 level.

null hypothesis that the population correlation was an identity matrix. This means that the correlations between variables were zero. This hypothesis was tested by calculating the determinant of the within-cells correlation matrix for each of the multivariate designs used in this research. Table 9 shows the determinant for each of the designs. The null hypothesis was rejected for each of the designs; therefore, a multivariate analysis would be appropriate.

The final multivariate assumption to be tested was that the covariance-variance matrices were equal. The number of matrices vary with the design of the analysis. For example, in the full factorial design with the two independent variables of student teaching level and graduation year, there were ten matrices. Initially it was useful to examine the homogeneity of variance test for each of the dependent variables separately, using either Cochran's C or the Bartlett Box F statistics. However, since multivariate techniques were being applied, a multivariate homogeneity of variance test, Box M statistic, was applied. The Box M statistic used the determinant for each of the variance-covariance matrix for each of the cells and the pooled covariance-variance matrix. Table 10 reports the Box M statistic and the associated F statistic and probability for each of the designs. After assessing all the multivariate assumptions, then the researcher can examine the various multivariate techniques in the analysis of the data.

The researcher concluded from Table 10 that the covariance-variance matrices were not equal for any of the three designs used in this research. As noted in Chapter II, rejection of this null hypothesis can be very restrictive. Reviewing Steven's flowchart found in Chapter II, it was found that the ratio of largest to smallest sample sizes helps assume the assumption of equal covariance-variance matrices in spite of the significant of the Box M statistic. Stevens (1986) and Bernstein (1988)

Table 10. Box M homogeneity of variance tests

Design	Determinant	F value	F prob.
Full factorial with level and graduation year on preparation variables	7351.85	1.21	.00**
Preparation variables on graduation year	2975.21	1.21	.00**
Preparation variables on student teaching level	906.71	1.55	.00**

**Significant at the .01 level.

noted that in very large sample size research, similar to this, it was almost impossible not to have a significant Box M statistic. The researcher attempted to stabilize the variances by various transformations, including the square root, log, and reciprocal, yet all still had a significant Box M statistic. The researcher therefore concluded the covariance-variance matrices' inequality was due to trivial differences ascended by the large sample.

Hypothesis 5

> There is no significant difference in the vector of mean ratings on the 33 areas of adequacy of preparation when comparing those who student taught at the elementary level and those who taught at the secondary level.

This design tests all 33 dependent variables collectively and one independent variable with two levels. A Hotelling T^2 value of .42 was calculated with an associated F value of 9.77 and a probability of .000. This test statistic was highly significant; therefore, it can be concluded that there was a difference in the two mean vectors. The next step was to determine which dependent variables caused the difference.

One method to identify the differences is to examine the univariate F-tests for each of the 33 dependent variables. This step is very similar to the discussion surrounding Hypothesis 1 except the degrees of freedom are reduced. For a subject to be included in this F-test, valid responses have to be present in all 33 dependent variables; if not, the subject was eliminated, causing a reduction in sample size from 1053 to 810. Table 11 summarizes the results of the univariate F-tests.

A second method of examining which variables caused the significant T^2 statistic was to use discriminant analysis to identify a cluster of dependent variables that maximize the differences between the two levels, elementary and secondary. The discriminant analysis procedure used included all 33 measures of preparation. Anytime a researcher contemplates using discriminant analysis, it is important to first review the intercorrelations between the predictor variables. It may be observed in Table 2 that the correlation coefficient between variables was in general very low; therefore, all variables could be included in the original analysis.

Various techniques were available to judge the entry level of the variables. A step-wise discriminant analysis procedure was used in which the 33 variables were allowed to enter one at a time, with an F statistic to enter of greater than or equal to 1.0 and an F to remove of less than 1.0. For this research, the Wilks' lambda was used to determine the point at which the entry of an additional variable would not significantly change the F approximation. Following the conclusion of the analysis, 26 variables remained. These variables then were used to determine the discriminant functions. These 26 variables, the step at which each entered the analysis, the Wilks' lambda value and the significance of each, and the standardized discriminant function coefficient, which indicates the extent to which each variable contributed to the discriminating efficiency of the function, are presented in Table 12.

Table 11. Univariate F-tests on the preparation variables with 810 degrees of freedom

Variable and level	Mean	S.D.	F	Prob.
Planning instruction				
Elementary	4.07	.88	41.56	.00**
Secondary	3.60	1.16		
Overall	3.87	1.04		
Using media				
Elementary	3.83	.90	.26	.61
Secondary	3.87	.91		
Overall	3.85	.90		
Maintaining student interest				
Elementary	3.65	.91	22.05	.00**
Secondary	3.34	.95		
Overall	3.51	.94		
Classroom management techniques				
Elementary	2.99	1.13	.48	.49
Secondary	3.05	1.05		
Overall	3.02	1.09		
Teaching the basic skills				
Elementary	3.75	.86	1.65	.20
Secondary	3.67	.97		
Overall	3.71	.91		
Working with other professionals				
Elementary	3.13	1.04	.29	.59
Secondary	3.17	1.02		
Overall	3.15	1.03		
Developing student-student relationships				
Elementary	3.34	.98	15.25	.00**
Secondary	3.06	1.04		
Overall	3.22	1.01		
Referring students for special assistance				
Elementary	3.36	1.01	7.62	.01**
Secondary	3.18	.96		
Overall	3.28	.99		

**Significant at the .01 level.

Table 11. Continued

Variable and level	Mean	S.D.	F	Prob.
Skills for mainstreaming students				
Elementary	3.54	1.00	9.98	.00**
Secondary	3.31	1.09		
Overall	3.43	1.05		
Methods of working with children with learning problems				
Elementary	3.44	1.00	25.52	.00**
Secondary	3.08	1.07		
Overall	3.28	1.05		
Assessing learning problems				
Elementary	3.43	.98	36.71	.00**
Secondary	3.01	1.02		
Overall	3.24	1.02		
Developing tests				
Elementary	3.33	1.01	4.35	.04*
Secondary	3.49	1.15		
Overall	3.41	1.08		
Using standardized tests				
Elementary	3.51	.95	.02	.89
Secondary	3.50	1.00		
Overall	3.50	.98		
Content area preparation in specialization				
Elementary	4.05	.95	1.73	.19
Secondary	4.15	1.01		
Overall	4.09	.98		
Ethics and legal obligations				
Elementary	3.40	1.02	8.00	.01**
Secondary	3.60	1.00		
Overall	3.49	1.02		
Learning psychology				
Elementary	3.91	.88	9.01	.00**
Secondary	3.72	.85		
Overall	3.83	.87		

*Significant at the .05 level.

Table 11. Continued

Variable and level	Mean	S.D.	F	Prob.
Evaluate student work				
Elementary	3.73	.85	2.87	.09
Secondary	3.62	.99		
Overall	3.68	.92		
Relating activities to students				
Elementary	4.02	.77	32.94	.00**
Secondary	3.68	.92		
Overall	3.87	.85		
Locating and using materials				
Elementary	3.87	.90	.05	.81
Secondary	3.88	.95		
Overall	3.87	.92		
Evaluating your own instruction				
Elementary	3.89	.83	17.90	.00**
Secondary	3.63	.93		
Overall	3.77	.89		
Individualizing instruction				
Elementary	3.89	.83	10.89	.00**
Secondary	3.68	.94		
Overall	3.78	.90		
Selecting and organizing materials				
Elementary	3.88	.83	7.55	.01**
Secondary	3.71	.97		
Overall	3.80	.90		
Using a variety of instructional techniques				
Elementary	4.11	.80	2.46	.12
Secondary	4.01	.92		
Overall	4.06	.85		
Understanding teacher roles				
Elementary	3.45	.98	.85	.36
Secondary	3.51	.97		
Overall	3.48	.97		
Working with parents				
Elementary	3.18	1.07	.05	.83
Secondary	3.17	.96		
Overall	3.18	1.01		

Table 11. Continued

Variable and level	Mean	S.D.	F	Prob.
Working with other teachers				
Elementary	3.41	1.00	.04	.84
Secondary	3.43	.91		
Overall	3.42	.96		
Assess/implement innovations				
Elementary	3.40	.86	.20	.66
Secondary	3.37	.88		
Overall	3.38	.87		
Appreciating individual differences				
Elementary	4.14	.81	19.76	.00**
Secondary	3.87	.89		
Overall	4.01	.86		
Using community resources				
Elementary	3.79	.85	13.39	.01**
Secondary	3.55	1.00		
Overall	3.68	.93		
Techniques of curriculum construction				
Elementary	3.44	.97	1.09	.30
Secondary	3.52	1.09		
Overall	3.48	1.03		
Influence of laws related to schools				
Elementary	3.25	.97	18.11	.00**
Secondary	3.54	.97		
Overall	3.38	.98		
Techniques of infusing multicultural education				
Elementary	4.07	.84	21.30	.00**
Secondary	3.76	1.08		
Overall	3.93	.97		
Learning to write effectively				
Elementary	3.75	.92	.01	.94
Secondary	3.74	.92		
Overall	3.75	.92		

Group differences are further explained by the item-to-function correlation also found in Table 12. The item-to-function correlation describes how the variable within the groups is related to each of the functions. The larger the item-to-function correlation, the greater that variable contributes to the group differences.

Two methods were used to judge the ability for the function to discriminate between the two teaching certification levels. The first method calculated the group centroids, presented in Table 13. The ideal results would have coefficients of opposite directions, as demonstrated by the group centroids in Table 13.

Using the discriminant functions to classify each of the cases, a classification analysis is presented in Table 14. This analysis tests the accuracy of the functions by comparing the derived level with the actual student teaching level.

The author would conclude based on Tables 12, 13, and 14 that the discriminant function does a very good job of discriminating between teaching levels. Prior probability of predicting the elementary teaching level was approximately .50. Using the function, an overall declassification probability increased to .75. This fact, coupled with the separated group centroids, indicated that the equation functions very adequately.

Table 12. Discriminant analysis by student teaching level (Summary table of variables remaining at conclusion of analysis)

Variable	Step	Wilks' lambda	Sign.	Standardized function coefficient	Item-to-function correlation
TB1	1	0.95	.00	0.47	0.35
TB31	2	0.92	.00	-0.38	-0.23
TB11	3	0.88	.00	0.36	0.33
TB12	4	0.84	.00	-0.57	-0.11
TB18	5	0.82	.00	0.33	0.31
TB32	6	0.81	.00	0.23	0.25
TB14	7	0.79	.00	-0.25	-0.07
TB30	8	0.78	.00	-0.26	-0.06
TB29	9	0.77	.00	0.34	0.20
TB19	10	0.76	.00	-0.30	-0.01
TB20	11	0.76	.00	0.24	0.23
TB27	12	0.75	.00	-0.23	0.02
TB7	13	0.74	.00	0.25	0.21
TB6	14	0.74	.00	-0.14	-0.03
TB13	15	0.73	.00	0.21	0.01
TB3	16	0.73	.00	0.20	0.26
TB23	17	0.73	.00	-0.20	0.09
TB4	18	0.72	.00	-0.13	-0.04
TB5	19	0.72	.00	0.12	0.07
TB33	20	0.72	.00	-0.15	0.00
TB16	21	0.72	.00	0.14	0.16
TB15	22	0.71	.00	-0.14	-0.15
TB28	23	0.71	.00	0.13	0.24
TB10	24	0.71	.00	0.14	0.27
TB24	25	0.71	.00	-0.13	-0.05
TB22	26	0.71	.00	0.11	0.15

Table 13. Discriminant analysis by student teaching level (Canonical discriminant function evaluated at group means)

Group	Group centroid
Elementary	0.58
Secondary	-0.71

Table 14. Discriminant analysis by student teaching level (Results of classification analysis)[a]

Group	Actual number of cases	Predicted group membership	
		Elementary	Secondary
Elementary	456	343 (75.2%)	113 (24.8%)
Secondary	376	97 (25.8%)	279 (74.2%)

[a]Percentage of all cases classified correctly = 74.76%.

Hypothesis 6

There is no significant difference in the vector of mean ratings on the 33 areas of preparation when comparing the groups formed by each of the five graduation years.

The design behind this hypothesis is similar to the univariate one-way analysis of variance, where there are more than two groups on one independent variable. The exception is that the researcher studies the difference among the vectors of means for the dependent variables. Using the MANOVA command in SPSSX, the researcher generated the three test statistics listed in Table 15.

Table 15. MANOVA test statistics for difference between graduation years

Test name	Value	F statistic	Prob. of F
Pillai's	.21	1.30	.013**
Hotelling's	.23	1.33	.009**
Wilks'	.80	1.31	.011**

**Significant at the .01 level.

All three test statistics indicate there is a difference among the vector of means for each graduation year. To determine the difference, two post hoc tests were performed. The first post hoc test was 33 univariate analyses of variance. Again, this test is very similar to the results found for Hypothesis 2, except that the degrees of freedom are again reduced. Table 16 summarizes these results. The total sample size was 810 with 183 from 1983/84, 142 in 1984/85, 170 in 1985/86, 149 in 1986/87, and 166 from graduation year 1987/88.

With the reduced sample size, there were a total of eight areas identified as areas where at least two means were not equal among the five graduation years. Seven of the eight areas were previously identified using the univariate analysis of variance procedure. One new area, techniques for infusing multicultural education, was discovered to be significant where previously it was not. It is important to remember that in multiple univariate tests, there is an increased chance of Type I error, rejecting the null hypothesis when in fact it is true, due to the actual increase in the experimental-wise error rate.

A second method, discriminant analysis, was also used to identify the variables that contributed to the significance shown by the three multivariate test statistics. Of the 33 dependent variables, 13 variables, presented in Table 17, entered into the four significant discriminant functions. Standardized function coefficients are presented in Table 17. The asterisks (*) indicate the significant variables for each function. Please note that none of the variables overlap into more than one function. The item-to-function correlations, a stable method of

Table 16. Univariate one-way analysis of variance on preparation variables

Variable and year	Mean	S.D.	F	Prob.
Planning instruction				
1983/84	4.05	0.92	2.36	0.05*
1984/85	3.84	1.03		
1985/86	3.80	1.11		
1986/87	3.74	1.12		
1987/88	3.81	1.00		
Overall	3.86	1.04		
Using media				
1983/84	3.88	0.91	0.51	0.73
1984/85	3.75	0.94		
1985/86	3.88	0.89		
1986/87	3.86	0.85		
1987/88	3.85	0.93		
Overall	3.85	0.90		
Maintaining student interest				
1983/84	3.67	0.90	1.90	0.11
1984/85	3.51	0.99		
1985/86	3.45	0.89		
1986/87	3.46	0.93		
1987/88	3.43	0.98		
Overall	3.51	0.94		
Classroom management techniques				
1983/84	3.02	1.08	0.42	0.79
1984/85	3.08	1.11		
1985/86	3.06	1.08		
1986/87	3.00	1.15		
1987/88	2.93	1.06		
Overall	3.01	1.09		
Teaching the basic skills				
1983/84	3.70	0.93	0.43	0.79
1984/85	3.68	0.89		
1985/86	3.76	0.8		
1986/87	3.66	0.97		
1987/88	3.77	0.97		
Overall	3.72	0.91		

*Significant at the .05 level.

Table 16. Continued

Variable and year	Mean	S.D.	F	Prob.
Working with other professionals				
1983/84	3.26	0.93	3.58	0.01**
1984/85	3.27	1.02		
1985/86	3.25	1.06		
1986/87	2.97	1.06		
1987/88	2.99	1.04		
Overall	3.15	1.03		
Developing student-student relationships				
1983/84	3.28	0.97	0.84	0.50
1984/85	3.27	1.02		
1985/86	3.24	1.07		
1986/87	3.10	1.04		
1987/88	3.18	0.97		
Overall	3.22	1.01		
Referring students for special assistance				
1983/84	3.37	1.01	2.98	0.02*
1984/85	3.39	0.94		
1985/86	3.35	0.98		
1986/87	3.22	1.00		
1987/88	3.07	0.99		
Overall	3.28	0.99		
Skills for mainstreaming students				
1983/84	3.46	1.08	1.32	0.26
1984/85	3.53	1.07		
1985/86	3.48	1.01		
1986/87	3.44	1.04		
1987/88	3.28	1.03		
Overall	3.43	1.05		
Methods of working with children with learning problems				
1983/84	3.30	1.02	0.96	0.43
1984/85	3.37	1.08		
1985/86	3.34	1.04		
1986/87	3.17	1.07		
1987/88	3.22	1.05		
Overall	3.28	1.05		

**Significant at the .01 level.

Table 16. Continued

Variable and year	Mean	S.D.	F	Prob.
Assessing learning problems				
1983/84	3.26	0.94	1.76	0.13
1984/85	3.25	1.07		
1985/86	3.39	1.00		
1986/87	3.13	1.10		
1987/88	3.14	1.00		
Overall	3.24	1.02		
Developing tests				
1983/84	3.55	1.01	4.38	0.00**
1984/85	3.49	1.08		
1985/86	3.52	1.10		
1986/87	3.30	1.08		
1987/88	3.14	1.08		
Overall	3.40	1.08		
Using standardized tests				
1983/84	3.49	0.98	1.27	0.28
1984/85	3.55	0.91		
1985/86	3.60	0.96		
1986/87	3.50	1.01		
1987/88	3.37	1.00		
Overall	3.50	0.98		
Content area preparation in specialization				
1983/84	4.06	1.00	0.79	0.53
1984/85	4.09	0.98		
1985/86	4.21	0.86		
1986/87	4.06	1.04		
1987/88	4.05	1.01		
Overall	4.10	0.98		
Ethics and legal obligations				
1983/84	3.51	0.99	1.70	0.15
1984/85	3.32	1.10		
1985/86	3.62	0.96		
1986/87	3.48	1.04		
1987/88	3.48	1.01		
Overall	3.49	1.02		

Table 16. Continued

Variable and year	Mean	S.D.	F	Prob.
Learning psychology				
1983/84	3.80	0.88	0.59	0.67
1984/85	3.79	0.90		
1985/86	3.89	0.85		
1986/87	3.77	0.87		
1987/88	3.87	0.87		
Overall	3.82	0.87		
Evaluating student work				
1983/84	3.70	0.94	0.87	0.48
1984/85	3.70	0.88		
1985/86	3.76	0.88		
1986/87	3.59	1.02		
1987/88	3.62	0.88		
Overall	3.68	0.92		
Relating activities to students				
1983/84	3.95	0.78	1.22	0.30
1984/85	3.91	0.85		
1985/86	3.89	0.88		
1986/87	3.80	0.91		
1987/88	3.78	0.86		
Overall	3.87	0.85		
Locating and using materials				
1983/84	3.94	0.85	0.59	0.67
1984/85	3.87	0.95		
1985/86	3.91	0.90		
1986/87	3.80	1.05		
1987/88	3.84	0.89		
Overall	3.87	0.93		
Evaluating your own instruction				
1983/84	3.78	0.84	0.55	0.70
1984/85	3.8	0.89		
1985/86	3.82	0.85		
1986/87	3.76	0.88		
1987/88	3.69	0.98		
Overall	3.77	0.89		

Table 16. Continued

Variable and year	Mean	S.D.	F	Prob.
Individualizing instruction				
1983/84	3.88	0.83	1.16	0.32
1984/85	3.85	0.94		
1985/86	3.75	0.91		
1986/87	3.76	0.87		
1987/88	3.71	0.94		
Overall	3.79	0.90		
Selecting and organizing materials				
1983/84	3.83	0.86	1.13	0.34
1984/85	3.89	0.86		
1985/86	3.85	0.95		
1986/87	3.71	0.91		
1987/88	3.74	0.90		
Overall	3.80	0.90		
Using a variety of instructional techniques				
1983/84	4.12	0.83	0.63	0.64
1984/85	4.07	0.84		
1985/86	4.05	0.88		
1986/87	3.98	0.89		
1987/88	4.08	0.84		
Overall	4.06	0.85		
Understanding teacher roles				
1983/84	3.51	0.99	1.21	0.30
1984/85	3.56	0.93		
1985/86	3.55	0.98		
1986/87	3.39	0.95		
1987/88	3.39	1.01		
Overall	3.48	0.97		
Working with parents				
1983/84	3.28	0.95	2.61	0.04*
1984/85	3.27	1.01		
1985/86	3.25	1.06		
1986/87	3.04	1.07		
1987/88	3.02	0.99		
Overall	3.18	1.02		

Table 16. Continued

Variable and year	Mean	S.D.	F	Prob.
Working with other teachers				
1983/84	3.51	0.93	2.29	0.06
1984/85	3.42	0.96		
1985/86	3.52	0.96		
1986/87	3.37	0.97		
1987/88	3.25	0.99		
Overall	3.42	0.96		
Assess/implement innovations				
1983/84	3.45	0.8	2.95	0.02*
1984/85	3.52	0.88		
1985/86	3.43	0.86		
1986/87	3.32	0.90		
1987/88	3.22	0.88		
Overall	3.39	0.87		
Appreciating individual differences				
1983/84	3.95	0.86	0.49	0.74
1984/85	4.05	0.80		
1985/86	4.01	0.94		
1986/87	4.03	0.82		
1987/88	4.06	0.86		
Overall	4.02	0.86		
Using community resources				
1983/84	3.69	0.89	0.97	0.42
1984/85	3.58	0.98		
1985/86	3.75	0.88		
1986/87	3.61	0.91		
1987/88	3.74	0.96		
Overall	3.68	0.92		
Techniques of curriculum construction				
1983/84	3.64	0.98	2.79	0.03*
1984/85	3.54	1.00		
1985/86	3.50	1.06		
1986/87	3.30	1.06		
1987/88	3.38	1.01		
Overall	3.47	1.03		

Table 16. Continued

Variable and year	Mean	S.D.	F	Prob.
Influence of laws related to schools				
1983/84	3.33	0.94	1.03	0.39
1984/85	3.42	1.03		
1985/86	3.51	0.93		
1986/87	3.33	1.00		
1987/88	3.34	1.01		
Overall	3.38	0.98		
Techniques of infusing multicultural education				
1983/84	3.77	1.05	2.35	0.05*
1984/85	3.95	0.88		
1985/86	3.96	1.02		
1986/87	3.89	1.02		
1987/88	4.08	0.80		
Overall	3.93	0.97		
Learning to write effectively				
1983/84	3.63	0.86	1.32	0.26
1984/85	3.71	0.94		
1985/86	3.81	0.94		
1986/87	3.75	0.98		
1987/88	3.83	0.88		
Overall	3.74	0.92		

Table 17. Discriminant analysis by graduation year (Summary table of variables remaining at conclusion of analysis)

Variable	Step	Wilks' lambda	Sign.	Standardized function coefficients 1	2	3	4
TB12	1	0.98	0	0.60*	0.27	0.25	-0.34
TB32	2	0.96	0	-0.29	0.29	-0.39	0.35
TB8	3	0.95	0	0.35	0.16	-0.14	-0.38
TB5	4	0.94	0	-0.55*	0.06	-0.11	0.15
TB1	5	0.93	0	0.10	-0.58*	-0.10	0.13
TB15	6	0.92	0	-0.24	-0.31	0.63*	-0.37
TB6	7	0.9	0	0.36	0.22	0.12	0.67*
TB33	8	0.89	0	-0.46*	0.26	-0.02	-0.18
TB3	9	0.89	0	0.22	-0.60*	-0.25	-0.23
TB27	10	0.88	0	0.33	0.49*	-0.29	-0.31
TB29	11	0.87	0	-0.27	-0.23	0.42*	0.17
TB30	12	0.87	0	0.24	-0.21	-0.14	0.60*
TB11	13	0.86	0	-0.15	0.21	0.59*	0.35

*Significant at the .05 level.

examining the strength of the variables, are presented in Table 20. Variables labeled with asterisks indicate the variables with the strongest correlation with the function. All variables, with the exception of planning instruction, correlate strongly with only one function.

To examine the strength of the four functions, the researcher examined the group centroid, presented in Table 18, and the classification analysis, found in Table 19. The average prior probability for predicting the correct graduation year, based on no information, was .20. Using the discriminant functions, there was only a marginal increase in the probability up to .28. Similarly, the group centroids tended to cluster together, therefore pointing to an inability for the functions to

Table 18. Discriminant analysis by graduation year (Canonical discriminant function evaluated at group means)

Group	Group centroid: Function 1	Function 2	Function 3	Function 4
1983/84	0.37	-0.22	0.03	0.02
1984/85	0.29	0.21	-0.18	0.05
1985/86	-0.02	0.15	0.22	0.03
1986/87	-0.15	0.00	-0.04	-0.22
1987/88	-0.50	-0.09	-0.06	0.10

Table 19. Discriminant analysis by graduation year (Results of classification analysis)[a]

Group	Actual number of cases	Predicted group / Membership group: 83/84	84/85	85/86	86/87	87/88
1983/84	202	66 32.70%	45 22.30%	27 13.40%	24 11.90%	40 19.80%
1984/85	158	41 25.90%	40 25.30%	31 19.60%	23 14.60%	23 14.60%
1985/86	180	43 23.90%	26 14.40%	39 21.70%	32 17.80%	40 22.20%
1986/87	170	38 22.40%	31 18.20%	22 12.90%	26 15.30%	53 31.20%
1987/88	187	25 13.40%	34 18.20%	27 14.40%	20 10.70%	81 43.30%

[a]Percentage of cases correctly classified was 28.09%.

discriminate well. There can be noted a large separation between the centroids from function one between the early two years of the study and the last year of the study. Similar differences were noted by the Scheffé post hoc test following the univariate analysis of variance tests. The researcher concluded that of the four functions, only the first function was practically significant.

Table 20. Discriminant analysis by graduation year (Item-to-function correlations)

Variable	Function 1	2	3	4
TB12	.42*	.15	.41*	.07
TB32	-.27	.28	-.14	.40*
TB8	.35*	.22	.21	-.01
TB5	-.07	.01	.18	.31
TB1	.23	-.44*	.03	.36*
TB15	-.06	-.09	.68*	-.05
TB6	.35	.17	.27	.54*
TB33	-.22	.22	.15	.13
TB3	.24	-.37*	-.01	.06
TB27	.35*	.28	.04	.13
TB11	.14	.22	.52*	.28
TB29	-.08	-.13	.39*	.33
TB30	.31	-.13	.15	.55*

*Significant at the .05 level.

Hypothesis 7

There is no interaction between the subject's student teaching level and the year of graduation when measured by the vector of means on the 33 areas of adequacy of preparation.

This design was similar to the univariate two-by-five factorial design except that the analysis used the vector of means of the dependent variables to detect significant differences. The three multivariate test statistics and their associated F statistics and probability for the interaction and the two main effects are presented in Table 21. All three statistics reviewing the interaction effect indicate there was a significant interaction between the graduation year and student teaching level in the vector of means among the ten cells. One way of detecting which dependent variables caused the difference was to employ a univariate two-by-five factorial design. The results of these 33 univariate interaction tests are presented in Table 22.

Table 21. MANOVA test statistics for difference among graduation years and student teaching level

Test name	Value	F statistic	Prob. of F
Interaction effect			
Pillai's	.20	1.25	.03*
Hotelling's	.22	1.25	.03*
Wilks'	.81	1.25	.03*
Graduation year main effect			
Pillai's	.21	1.30	.01**
Hotelling's	.23	1.32	.01**
Wilks'	.80	1.31	.01**
Student teaching level main effect			
Pillai's	.29	9.72	.00**
Hotelling's	.42	9.72	.00**
Wilks'	.71	9.72	.00**

*Significant at the .05 level.

**Significant at the .01 level.

Table 22. Univariate 2x5 factorial design interaction effect, F-tests, with reduced N

Variable	F value	Prob.
Planning instruction	0.63	0.64
Using media	4.57	.00**
Maintaining student interest	0.41	0.80
Classroom management techniques	1.31	0.27
Teaching the basic skills	1.76	0.14
Working with other professionals	0.18	0.95
Developing student-student relationships	1.31	0.27
Referring students for special assistance	0.37	0.83
Skills for mainstreaming students	0.67	0.61
Methods of working with children with learning problems	0.34	0.85
Assessing learning problems	0.78	0.54
Developing tests	1.90	0.11
Using standardized tests	0.64	0.63
Content area preparation in specialization	0.75	0.56
Ethics and legal obligations	0.93	0.45
Learning psychology	0.78	0.54
Evaluating student work	0.26	0.90
Relating activities to students	0.42	0.79
Locating and using materials	0.91	0.46
Evaluating your own instruction	0.90	0.46
Individualizing instruction	0.39	0.82
Selecting and organizing materials	1.39	0.24
Using a variety of instructional techniques	1.94	0.10
Understanding teacher roles	2.03	0.09
Working with parents	0.39	0.82
Working with other teachers	0.14	0.97
Assess/implement innovations	0.44	0.78
Appreciating individual differences	0.77	0.55
Using community resources	0.69	0.60
Techniques of curriculum construction	0.21	0.93
Influence of laws related to schools	1.39	0.24
Techniques of infusing multicultural education	0.63	0.64
Learning to write effectively	0.61	0.65

**Significant at the .01 level.

Results from the univariate interaction tests with the reduced sample size indicated one area, using media, as having an interaction between the teaching level and the graduation year. This pattern also existed in the univariate tests discussed under Hypothesis 3. The second area, using a variety of instructional techniques, was not found to be significant at the .05 level when analyzing with the smaller sample size.

A second method, discriminant analysis, was also used to detect the variables that caused the multivariate significant interaction effect. The two independent variables, student teaching level and graduation year, were recoded into a single new variable with ten levels. Presented in Table 23 is the summary of the 26 variables that meet the requirements necessary to be included in the discriminant function.

Nine discriminant functions were possible from the analysis, but the researcher, based on each function's ability to discriminate between the ten levels, selected six as significant. These six functions' standardized coefficients are presented in Table 24, with the associated item-to-function correlations found in Table 25.

As with the two previous discriminant analysis procedures, the ability for a function to discriminate well was determined by comparing the group centroids, Table 26, and the classification analysis, presented in Table 27. Reviewing the centroids, the researcher concluded that the first function discriminates very well between the two student teaching levels. This function also accounted for over 50% of the total variance. The second function addressed the difference between graduation years. The first two years of the study, regardless of the level, had centroids in

Table 23. Discriminant analysis of level-graduation year interaction (Summary table of variables at conclusion of analysis)

Variable	Step	Wilks' lambda	Sign.
TB1	1	.93	0.00
TB12	2	.88	0.00
TB11	3	.83	0.00
TB31	4	.79	0.00
TB32	5	.75	0.00
TB2	6	.73	0.00
TB18	7	.71	0.00
TB14	8	.69	0.00
TB33	9	.67	0.00
TB5	10	.66	0.00
TB23	11	.64	0.00
TB29	12	.63	0.00
TB27	13	.61	0.00
TB3	14	.60	0.00
TB15	15	.59	0.00
TB28	16	.58	0.00
TB20	17	.56	0.00
TB6	18	.55	0.00
TB7	19	.54	0.00
TB30	20	.53	0.00
TB4	21	.52	0.00
TB13	22	.52	0.00
TB19	23	.51	0.00
TB22	24	.50	0.00
TB21	25	.49	0.00
TB10	26	.49	0.00

Table 24. Discriminant analysis by level-graduation year interaction (Standardized function coefficients)

Variable	Significant functions					
	1	2	3	4	5	6
TB1	.50	-.17	.20	.19	-.33	-.10
TB2	-.07	.23	.15	.50	.05	.24
TB3	.24	-.36	-.11	.39	-.23	.22
TB4	-.16	.18	.06	-.41	.06	.26
TB5	.17	.33	-.64	-.06	-.05	-.21
TB6	-.19	-.38	.15	.24	.42	.15
TB7	.28	.05	.05	-.34	-.32	-.47
TB10	.13	.12	.14	.15	.15	.49
TB11	.35	-.14	-.19	-.08	.45	-.52
TB12	-.55	-.73	-.35	.05	.18	-.30
TB13	.21	.28	.29	.07	.22	.14
TB14	-.28	.14	-.22	.05	.19	.17
TB15	-.10	.19	-.05	.53	-.25	-.58
TB18	.31	-.21	.10	-.15	-.02	.25
TB19	-.26	-.20	.07	.17	-.07	-.11
TB20	.20	.28	.20	-.27	.42	-.10
TB21	.03	-.32	-.19	-.02	-.63	.06
TB22	.06	.22	.45	-.08	.57	.16
TB23	-.20	.19	.51	-.01	-.39	-.24
TB27	-.24	-.33	-.01	-.11	.08	.30
TB28	.13	-.04	-.33	.04	-.03	.54
TB29	.32	.30	-.11	.27	.22	.02
TB30	-.26	-.25	.06	-.07	-.18	-.28
TB31	-.43	.02	.26	-.39	.08	.28
TB32	.26	.20	-.01	-.17	.17	-.41
TB33	-.13	.43	-.22	-.13	-.30	.15

Table 25. Discriminant analysis of level-graduation year interaction (Significant item-to-function correlation coefficients)

Variable	Discriminant functions 1	2	3	4	5	6
TB1	.35*	.28	.22	.19	-.09	-.12
TB2	-.03	.12	.21	.58*	.07	.12
TB3	.26	-.29*	.05	.16	-.09	.17
TB4	-.05	-.08	.02	-.27	.04	.15
TB5	.07	-.01	-.31	.04	.15	-.14
TB6	-.04	-.27	.18	.09	.29	-.03
TB7	.21	-.18	.17	-.24	.01	-.21
TB10	.26	-.15	.04	.04	.31*	.13
TB11	.32	-.19	-.04	.02	.43*	-.16
TB12	-.11	-.43*	-.15	.07	.33	-.21
TB13	-.01	-.07	.11	.07	.38*	-.02
TB14	-.08	-.02	-.16	.14	.22	.00
TB15	-.16	.11	.09	.28	.04	-.27
TB18	.30	-.25	.18	-.04	.05	.11
TB19	-.02	-.04	.23	.19	.13	-.04
TB20	.22	-.08	.24	-.13	.23	-.10
TB21	.18	-.25*	.11	-.07	-.08	.08
TB22	.14	-.07	.38*	-.03	.27	.00
TB23	.08	-.01	.40*	.07	-.07	.10
TB27	.01	-.29	.17	-.06	.16	.21
TB28	.24*	.04	-.17	.00	.12	.24
TB29	.19	.08	.03	.22	.15	.03
TB30	-.06	-.28	.16	.00	.02	-.18
TB31	-.25	.08	.23	-.13	.11	.02
TB32	.25	.23	.02	-.10	.19	-.14
TB33	-.01	.20	-.04	-.08	-.05	.08

*Significant at the .05 level.

Table 26. Discriminant analysis level-graduation year interaction (Canonical discriminant functions evaluated at group means)

Group	Significant functions					
	1	2	3	4	5	6
83/84 Elementary	.70	-.63	-.30	.28	-.12	.00
84/85 Elementary	.59	-.35	.07	-.61	.09	.04
85/86 Elementary	.39	.08	.22	.07	.19	-.15
86/87 Elementary	.62	.31	.04	.16	.18	.05
87/88 Elementary	.61	.50	.03	-.04	-.22	.18
83/84 Secondary	-.68	-.22	.51	.06	-.17	-.14
84/85 Secondary	-.78	-.12	.13	.18	.19	.39
85/86 Secondary	-.82	.05	-.36	-.11	.38	.01
86/87 Secondary	-.72	.02	-.25	-.20	-.37	.16
87/88 Secondary	-.49	.33	-.28	.08	-.09	-.47
Percent variance explained	52.56%	14.32%	8.94%	6.86%	6.01%	5.36%

Table 27. Discriminant analysis by level-graduation year interaction (Results of classification index)[a]

	Sample size	Predicted group membership				
		Elementary				
		83/84	84/85	85/86	86/87	87/88
83/84 Elementary	91	38 41.8%	14 15.4%	8 8.8%	6 6.6%	6 6.6%
84/85 Elementary	77	11 14.3%	28 36.4%	6 7.8%	8 10.4%	8 10.4%
85/86 Elementary	101	13 12.9%	14 13.9%	23 22.8%	11 10.9%	12 11.9%
86/87 Elementary	82	11 13.4%	9 11.0%	9 11.0%	17 20.7%	15 18.3%
87/88 Elementary	103	8 7.8%	11 10.7%	12 11.7%	12 11.7%	29 28.2%
83/84 Secondary	94	8 8.5%	6 6.4%	4 4.3%	4 4.3%	4 4.3%
84/85 Secondary	73	5 6.8%	5 6.8%	2 2.7%	2 2.7%	2 2.7%
85/86 Secondary	70	6 8.6%	3 4.3%	5 7.1%	3 4.3%	5 7.1%
86/87 Secondary	72	8 11.1%	3 4.2%	2 2.8%	2 2.8%	7 9.7%
87/88 Secondary	67	3 4.5%	7 10.4%	1 1.5%	4 6%	3 4.5%

[a]Percent of grouped cases correctly classified = 30.00%.

Secondary				
83/84	84/85	85/86	86/87	87/88
4 4.4%	4 4.4%	2 2.2%	5 5.5%	4 4.9%
7 9.1%	3 3.9%	2 2.6%	2 2.6%	2 2.6%
6 5.9%	7 6.9%	3 3.0%	4 4.0%	8 7.9%
3 3.7%	1 1.2%	6 7.3%	4 4.9%	7 8.5%
5 4.9%	6 5.8%	6 5.8%	9 8.7%	5 4.9%
28 29.8%	17 18.1%	6 6.4%	8 8.5%	9 9.6%
15 20.5%	19 26.0%	1 13.7%	6 8.2%	7 9.6%
4 5.7%	8 11.4%	26 37.1%	7 10.0%	3 4.3%
6 8.3%	9 12.5%	10 13.9%	18 25.0%	7 9.7%
9 13.4%	5 7.5%	4 6.0%	8 11.9%	23 34.3%

opposite directions of the remaining three years. The remaining four functions each accounted for a much smaller percentage of the total variance addressed by the interaction effect. In each of the four functions, the reader can find coefficients in opposite directions at various levels and graduation years. The interpretation of these functions has been presented later in this chapter.

Hypothesis 8

> There is no relationship between the 33 areas of preparation and the four measures of satisfaction with the student teaching experience and the overall rating as to the quality of the teacher education program.

The canonical correlation procedure attempts to find a relationship between two sets of variables--for this research the preparation variables and the satisfaction variables. Unfortunately, the procedures for canonical correlation in both SAS and SPSSX are very limited in nature and, therefore, the results were much less than ideal. Regardless, a series of three significant functions were calculated between the two sets of variables. The standardized coefficients are presented in Table 28.

Based on the raw canonical correlation coefficients, the researcher calculated the Pearson correlation between the two sets of variables for the three functions. Ideally, the diagonal would have very high values, and the off-diagonals would have values close to zero. These first-order correlation coefficients are presented in Table 29.

Table 28. Canonical correlation analysis (Standardized canonical coefficients)

Variable	Function 1	2	3
Planning instruction	-0.28	0.08	-0.11
Using media	-0.07	-0.28	-0.07
Maintaining student interest	-0.18	0.02	0.21
Classroom management techniques	-0.16	-0.16	-0.06
Teaching the basic skills	-0.18	0.16	-0.32
Working with other professionals	0.05	0.21	0.46
Developing student-student relationships	-0.06	0.18	-0.42
Referring students for special assistance	-0.02	0.08	-0.25
Skills for mainstreaming students	-0.04	-0.11	0.18
Methods of working with children with problems	0.00	0.03	0.21
Assessing learning problems	-0.04	0.10	0.27
Developing tests	0.04	-0.19	-0.04
Using standardized tests	-0.01	0.38	-0.22
Content area preparation in specialization	-0.19	-0.72	0.19
Ethics and legal obligations	0.05	0.25	-0.13
Learning psychology	-0.08	-0.15	-0.18
Evaluating student work	-0.02	0.16	-0.08
Relating activities to students	-0.02	0.05	0.47
Locating and using materials	0.02	-0.13	-0.08
Evaluating your own instruction	0.02	0.13	0.37
Individualizing instruction	-0.02	0.11	0.22
Selecting and organizing materials	-0.18	0.39	-0.19
Using a variety of instructional techniques	-0.02	-0.18	-0.03
Understanding teacher roles	-0.01	-0.14	-0.08
Working with parents	0.11	-0.12	-0.01
Working with other teachers	-0.16	-0.21	-0.33
Assess/implement innovations	0.00	0.13	-0.16
Appreciating individual differences	0.07	-0.15	0.54
Using community resources	-0.07	0.47	-0.16
Techniques of curriculum construction	0.04	-0.40	0.10
Influence of laws related to schools	-0.01	-0.29	0.03
Techniques of infusing multicultural education	-0.11	0.16	-0.08
Learning to write effectively	-0.08	-0.04	-0.22
TA1	-0.05	-0.34	-0.13
TA2	-0.09	-0.93	0.08
TA3	-0.15	-0.16	-0.02
TA4	-0.06	0.32	1.00
QTPP	-0.90	0.31	-0.38

Table 29. Pearson correlations among the three canonical variates

	Satisfaction variables set			Percent variance explained
	Variate 1	Variate 2	Variate 3	
Preparation variables set:				
Variate 1	.69	-.01	-.00	13.99
Variate 2	.00	.29	.00	.18
Variate 3	.00	.00	.25	.16
Percent variance explained	27.49%	18.16%	19.32%	

No computer methods were available to identify a subset of variables from both sets of variables that were significant; therefore, the researcher examined the correlation coefficient, presented in Table 30, to determine the variables with the greatest effect on the correlation variates. Highly correlated variables were labeled for each variate with an asterisk (*).

Each of the canonical correlation variates has one satisfaction variable that correlated very high with a subset of the 33 dependent variables. Function 1 indicates a relationship between the overall satisfaction with the general preparation program and a series of five preparation areas centering around the topic of instructional techniques. The second function points to a possible relationship between the students' satisfaction with their cooperating teacher and the preparation in a specific content area. The final function relates the students' satisfaction with student teaching in general and the area of appreciating individual differences.

As noted in Table 30, the correlation between the two sets of variables, satisfaction and preparation, for the first canonical correlation was .69. This could also be interpreted to mean that together each accounts for approximately 49% of the total variance. The second function was judged to be much weaker due to the lower correlation of .29, with a percentage of shared variance of approximately only 9%.

Table 30. Canonical correlation analysis (Correlations between variables and canonical variables)

Variable	Function 1	Function 2	Function 3
Planning instruction	-0.67	0.04	0.08
Using media	-0.35	-0.22	-0.13
Maintaining student interest	-0.68*	0.04	0.13
Classroom management techniques	-0.54	-0.07	-0.10
Teaching the basic skills	-0.67*	0.05	-0.08
Working with other professionals	-0.48	0.14	0.04
Developing student-student relationships	-0.57	0.20	-0.16
Referring students for special assistance	-0.42	0.13	0.04
Skills for mainstreaming students	-0.42	-0.01	0.27
Methods of working with children with problems	-0.49	0.07	0.35*
Assessing learning problems	-0.55	0.12	0.29
Developing tests	-0.53	-0.00	-0.00
Using standardized tests	-0.42	0.13	-0.05
Content area preparation in specialization	-0.59	-0.44*	0.12
Ethics and legal obligations	-0.39	0.01	-0.12
Learning psychology	-0.48	-0.01	-0.13
Evaluating student work	-0.57	0.13	-0.03
Relating activities to students	-0.64*	0.16	0.30
Locating and using materials	-0.51	-0.03	-0.06
Evaluating your own instruction	-0.58	0.21	0.27
Individualizing instruction	-0.61*	0.14	0.27
Selecting and organizing materials	-0.71	0.24	-0.04
Using a variety of instructional techniques	-0.62*	0.04	0.03
Understanding teacher roles	-0.49	-0.05	-0.10
Working with parents	-0.42	-0.03	-0.11
Working with other teachers	-0.58	-0.08	-0.16
Assess/implement innovations	-0.59	0.07	-0.03
Appreciating individual differences	-0.42	0.06	0.35*
Using community resources	-0.51	0.26	-0.04
Techniques of curriculum construction	-0.57	-0.18	0.05
Influence of laws related to schools	-0.36	-0.16	-0.07
Techniques of infusing multicultural education	-0.40	0.10	0.10
Learning to write effectively	-0.55	0.01	-0.11
TA1	-0.13	-0.38	-0.09
TA2	-0.33	0.82*	0.30
TA3	-0.40	-0.25	-0.08
TA4	-0.36	0.06	0.92*
QTPP	-0.98*	0.14	-0.10

*Significant at the .05 level.

Discussion

Teaching level comparisons

Reviewing the 33 multiple t-tests, the researcher expected approximately 5% of the tests to be significant based on chance alone. Some statisticians might argue, therefore, that of the 19 significant areas, two were significant only due to sampling error. The same conclusions could be drawn on the univariate tests from the MANOVA output and the level main effect from the full factorial design.

To guard against this Type I error rate, a multivariate test followed by discriminant analysis if necessary was applied. The Hotelling statistic, used when comparing two groups, had a value of .42, which computed to an expected probability of .00. This probability implied there was a significant difference between the two teaching certification levels when comparing the vector of means of the preparation areas. By applying the multivariate technique to the research, the researcher guarded against an inflated error rate. Hummel and Sligo (1971) noted that when many dependent variables are used, the multivariate error rate actually became much less than .05.

The significance of the variables across all four designs is summarized in Table 31. There was general agreement as to the variables that were significant. Discriminant analysis provided an equation with 26 variables that made up the function, but ten of those had correlations less than .10, therefore contributed very little to the function.

Across the four analyses comparing the two teaching certification levels, the researcher concluded that there is a significant difference

Table 31. Summary table of preparation areas by level

Variable	Univariate t-tests (n=1030)	Univariate ANOVA (n=810)	Factorial design (n=810)	Discriminant analysis (n=810)	Item to function correlation
TB1	-*	-*	-*	-*	0.35
TB2					
TB3	-*	-*	-*	-*	0.26
TB4				-*	-0.04
TB5				-*	0.07
TB6				-*	-0.03
TB7	-*	-*	-*	-*	0.21
TB8	-*	-*	-*		
TB9	-*	-*	-*		
TB10	-*	-*	-*	-*	0.27
TB11	-*	-*	-*	-*	0.33
TB12	-*	-*	-*	-*	-0.11
TB13				-*	0.01
TB14				-*	-0.07
TB15	-*	-*	-*	-*	-0.15
TB16	-*	-*	-*	-*	0.16
TB17					
TB18	-*	-*	-*	-*	0.31
TB19				-*	-0.01
TB20	-*	-*	-*	-*	0.23
TB21	-*	-*	-*		
TB22	-*	-*	-*	-*	0.15
TB23	-*		-*	-*	0.09
TB24				-*	-0.05
TB25					
TB26					
TB27				-*	0.02
TB28	-*	-*	-*	-*	0.24
TB29	-*	-*	-*	-*	0.20
TB30				-*	-0.06
TB31	-*	-*	-*	-*	-0.23
TB32	-*	-*	-*	-*	0.25
TB33				-*	0.00

*Significant at the .05 level.

between those that were prepared to teach at the elementary level compared to those at the secondary level on the following 16 variables: Planning units of instruction and individual lessons (E); maintaining students' interest (E); developing student-student relationships (E); methods of working with children with learning problems (E); assessing learning problems (E); developing tests (S); ethics and legal obligations (S); learning psychology (E); relating activities to interests and abilities of students (E); evaluating your own instruction (E); selecting and organizing materials (E); using a variety of instructional techniques (E); appreciating and understanding individual and intergroup differences in values and lifestyles (E); using community resources (E); influences of the laws and policies related to schools (S); and techniques for infusing multicultural education (E). The letter following the area of preparation indicates the level, elementary (E) or secondary (S), in which the higher mean was found. In all, in 13 of the 16 significant areas it was found that those prepared to teach at the elementary level had a significantly higher rating than those prepared to teach at the secondary level.

These 16 significant items were scattered throughout the five factors as follows:

Factor 1: Planning and delivering instruction and maintaining students' interest (8 out of 11 variables)

Factor 2: Interpersonal relationships (2 out of 7 variables)

Factor 3: Assessing and dealing with learning problems (2 out of 4 variables)

Factor 4: Understanding individual differences (2 out of 2 variables)

Factor 5: Monitoring, testing, and evaluating (1 out of 3 variables)

Regardless of the method of analyzing the 33 areas of preparation comparing the two teaching certification levels, the same areas were identified to be significant. The advantage of the multivariate approach lies in the overall confidence that the researcher has in the conclusions. The application of the multivariate technique assures the researcher that the Type I error rate was maintained at .05. More importantly, the multivariate technique was the most appropriate for the design of the research since multiple correlated dependent variables were measured.

Pruzek (1971) recommended that when using multivariate analysis of variance, it is often appropriate, when more than ten dependent variables are involved, to first factor analyze the variables. Following the identification and the calculations of the new factor scores, a MANOVA could be performed with the end results in a more parsimonious form. Using the five factor scores as dependent variables, a two-by-five factorial multiple analysis of variance was applied. The three multivariate statistic, Wilks', Hotelling's, and Pillai's, were all highly significant, a probability of less than .01; therefore, discriminant analysis was applied to identify the significant factors.

Two of the five discriminant functions calculated were found to be statistically significant because they had the ability to discriminate among the various groups. The first discriminating function separated the two teaching certification levels. In this first function, two factors, planning and delivering instruction and maintaining students' interests and assessing and dealing with learning problems, had correlation coefficients greater than .43. Many of the variables identified as discriminating well between the two teaching levels in Hypothesis 5 were used to determine these two factors' scores. The results of this MANOVA are presented in Table 33 through 36 in Appendix B.

Graduation year comparisons

There was a great deal of similarity among the results of the procedures used in analyzing differences among the five graduation years. A summary of variables among the five graduation years was provided in Table 32. Those variables labeled with an asterisk (*) were judged to be significant at the .05 level for that particular analysis.

All the significant variables identified using the univariate analysis of variance, with a sample size of approximately 1030, were also identified by the factorial design. The reduced error term, found in the factorial design, failed to locate any new significant variables for the main effect of graduation year at the preset alpha of .05. As expected, the univariate analysis of variance with a sample size of 810 identified less significant variables. It should be noted that one new variable, Techniques for infusing multicultural education into the classroom, was found to be significant where it was not significant previously.

Following the significant MANOVA statistics, discriminant analysis was used to identify variables that discriminated well among the five

Table 32. Summary table of preparation areas by graduation year

Variable	Univariate ANOVA (n=1030)	Univariate ANOVA (n=810)	Factorial design (n=810)	Discriminant analysis (n=810)	Item to function correlation Function 1	2
TB1	-*	-*	-*	-*	.23	-.44
TB2						
TB3	-*		-*	-*	.24	-.37
TB4						
TB5				-*	-.07	.01
TB6	-*	-*	-*	-*	.35	.17
TB7						
TB8	-*	-*	-*	-*	.35	.22
TB9						
TB10						
TB11				-*	.14	.22
TB12	-*	-*	-*	-*	.42	.15
TB13						
TB14						
TB15				-*	-.06	-.09
TB16						
TB17						
TB18	-*		-*			
TB19						
TB20						
TB21						
TB22						
TB23						
TB24						
TB25	-*	-*	-*			
TB26	-*		-*			
TB27	-*	-*	-*	-*	.35	.28
TB28						
TB29				-*	-.08	-.13
TB30	-*	-*	-*	-*	.31	-.13
TB31						
TB32		-*		-*	-.27	.28
TB33				-*	-.22	.22

*Significant at the .05 level.

graduation years. Of the 13 variables that entered into the equation, seven were also identified by at least two of the three previously mentioned designs. These seven variables were: (1) Planning units of instruction and individual lessons; (2) Maintaining students' interest; (3) Consultation skills in interacting with other professionals; (4) Referring students for special assistance; (5) Developing tests; (6) Assessing and implementing innovations; and (7) Techniques for curriculum construction. Discriminant analysis did identify four areas that neither of the other designs found to be significant. They were: (1) Teaching the basic skills; (2) Assessing learning problems; (3) Ethics and legal obligations; and (4) Learning to write effectively.

The item-to-function correlations were also presented for the first two discriminant functions in Table 32. The first function discriminated between the first two years from the last three years. Function 2 separated the first and last years from the middle three years. The final two discriminant functions did not discriminate strongly between any of the five graduation years; thus, no significant variables were considered.

The researcher concluded that discriminant analysis did identify significant variables that would have otherwise gone unnoticed in a typical univariate design. This ability to measure multiple measures in a more complete and detailed manner is a primary advantage of multivariate techniques over univariate techniques (Hubble, 1984). The variables that appeared to differentiate among the years were (1) Planning units of instruction and individual lessons; (2) Maintaining students' interest; (3) Teaching basic skills; (4) Consultation skills in interacting with other professionals; (5) Referring students for special assistance; (6) Developing tests; (7) Assessing and implementing innovations; and (8) Techniques of curriculum construction. These eight variables appeared in four of the five factors. Four of the eight variables were found in the factor, Planning and delivering instruction and maintaining students' interest. The remaining four variables loaded into one factor each, with the last variable not a part of any significant factor. There has been a downtrend in the rating on the areas planning and teaching interesting instruction over the course of the past five years. The reader should refer back to Table 4 to identify the years that were significantly different. In general the difference was between the 1983/84 survey year and the 1987/88 survey year.

Factorial design comparisons

Both the univariate factorial design and the full factorial multivariate design identified a small set of variables in which the graduate's expected teaching level and graduation year jointly had an effect. Two variables, using media and using a variety of instructional techniques, were identified with the univariate factorial design. Both variables were also a part of the 26 variables that entered into the discriminant functions. The variable, using media, had the largest single correlation with a function. The variable, instruction techniques, had the fourth largest correlation. Neither of the variables contributed to the two largest functions, but they were not expected since these two functions discriminated between the two teaching levels, Function 1, and the difference among the five graduation years, Function 2.

The third interaction discriminant function correlated strongly with selecting and organizing material and using a variety of instructional techniques, .40. It also correlated with the related area of selecting and organizing material, .38. By reviewing the group centroids, presented in Table 26, an interaction effect of this function can be noted. At the elementary level, the rating increased over time, whereas in the secondary level the rating decreased with time, therefore an interaction between teaching level and graduation year. The fourth discriminant function correlated highly with only one area, Using media, with an item-to-function correlation of .58. The interaction effect from this function appeared to show a year-to-year fluctuation of the means for the elementary level and a gradual falling of means for the secondary level, with an increase in the final year of the study. Although the interaction effects were more difficult to interpret through discriminant analysis, the procedure did identify exactly the same variables that caused the interaction as did the univariate factorial design. It also identified an additional variable that the univariate procedure had not.

<u>Canonical correlation</u>

The canonical correlation procedure attempted to relate the 33 areas of preparation with the graduate's satisfaction with the teacher education program, measured by five separate items. Canonical correlation did not place a value or try to discriminate among groups; it only looked for possible relationships.

The first positive relationship suggested that graduates with high overall satisfaction with the teacher preparation program rated various measures on their preparation in instructional techniques highly. In other words, graduates who felt they had good instruction in the basics of how to teach gave the overall program high marks. Therefore, stressing the techniques of good instruction to students in the teacher preparation program at Iowa State University will probably result in high satisfaction with the program.

The second positive relationship revolved around the graduates' student teaching cooperating teacher. Graduates who had high satisfaction with their cooperating teachers gave the program high marks.

Results from the canonical correlation point to two areas in the preparation program that correlate highly with the overall satisfaction in the program. An excellent working relationship with the cooperating teacher and good knowledge in instructional technique relate to high overall satisfaction with the teacher preparation program.

CHAPTER V. SUMMARY, RECOMMENDATIONS, AND LIMITATIONS

Summary

The purpose of this research was to examine a meaningful set of data from a longitudinal educational research project using univariate and multivariate methodological approaches. It was hypothesized that the multivariate analysis would provide a more in-depth and complete understanding of the underlying factors that were measured. Due to multivariate analyses limited infusion into current educational research, a second purpose was to provide a practical, clear, and concise guide for other educational researchers to draw upon.

Data used in this research were a part of a longitudinal study to evaluate the teacher preparation program conducted by the Research Institute for Studies in Education at Iowa State University. In particular, the researcher first explored the possible relationship between the teacher education graduates' teaching certificate level, elementary or secondary, and their rating on 33 areas of preparation in their teacher preparation program. A comparison was made between the results of multiple univariate t-tests and the multivariate Hotelling's T^2 followed by discriminant analysis. A second relationship explored the time at which the students graduated, 1984 through 1988, and their ratings in the 33 preparation areas. Results from the univariate one-way analysis of variance were compared to the results of the multivariate analysis of variance, again followed by discriminant analysis. The third univariate to multivariate comparison was made of the two-by-five univariate factorial design to the two-by-five multivariate factorial design.

Finally after exploring the relationships between a set of continuous variables, the preparation areas, and a set of categorical variables, teaching certification level and graduation year, the researcher examined the canonical correlation between the 33 areas of preparation with five continuous measures of the graduates' overall satisfaction with the teacher education program at Iowa State University.

Currently, research centers around the various univariate approaches examining single response variables (Hubble, 1984). Multivariate approaches examine a group of dependent variables and attempts to explain the relationship among those dependent variables, as well as the independent-dependent variable relationships. Researchers that examine measurements on many variables should employ analytical procedures that are capable of simultaneous examination of the many variables collected (Keeves, 1988). This type of procedure limits the Type I error, rejecting the null hypothesis when in fact it is true, to the present alpha. Multiple univariate procedures cause the alpha rate to become greatly inflated. A multivariate methodology would be appropriate when (1) the treatment affects the subjects in more than one way, (2) a complete and detailed description of a phenomenon is required, and (3) the researcher requires the maximum amount of information with only a minimum increase in costs (Stevens, 1986).

When considering the application of multivariate techniques, it was important for the researcher to first test the three basic multivariate assumptions. Assumption one was that the observations were independent. Assurance in regard to this assumption could be achieved in designing safeguards into the design of the research and/or changing the unit of analysis to unit of instruction, for example, the classroom. The distribution of scores for the dependent variables should follow a multivariate normal distribution was the second assumption. Various graphs were available on the statistical package that allowed the researcher to test this assumption. The final assumption was that the covariance-variance matrices were equal among the cells in the design. Homogeneity of variance, tested using the Box M statistic, was found to be significant at an alpha level of .05. The significance of this statistic implied that the covariance-variance matrices were not equal among the various cells; therefore, a data transformation procedure could have been necessary. After a review of the literature on this topic, it was concluded the significance of the Box M statistic is quite common and is often caused by trivial differences in the dependent variables. The test statistics for multivariate procedures, like the t and F statistic, are generally robust, thus a violation of this assumption was acceptable. This fact, coupled with the large and near equal sample size, reduced the necessity for a data transformation.

Along with the analysis of the data with respect to the three assumptions, it was important to examine the correlation matrix of the dependent variables. Using the Bartlett's test of sphericity, it was concluded that the variables were correlated and thus a multivariate procedure would be appropriate. To test the null hypothesis that the response measures were independent, a Bartlett's test of sphericity was used analyzing the three basic designs used in the research. In each design, the statistic was proven to be significant; therefore, the null hypothesis was rejected and it was concluded that the variables were correlated, thus a multivariate technique was appropriate.

When the 33 univariate t-tests were compared with the multivariate Hotelling T^2 statistic followed by discriminant analysis, the results were found to be very similar. At a preset alpha level of .05, the researcher expected two of the 33 univariate t-tests to be significant. Therefore, of the 19 areas found to be significant, two could possibly be significant only due to chance. This is the major flaw behind multiple univariate procedures. The multivariate test statistics for comparing two groups, the Hotelling T^2, was also found to be significant. This result implied that there was a significant difference between the vector of means comparing those that were to be certified at the elementary level to those certified at the secondary level. The T^2 statistic did not locate the areas that contributed the most to the difference, thus a significant multivariate test statistic discriminant analysis was used to discover the contributing variables. All 19 variables found to be significant in the univariate tests were part of the discriminant function. In addition, ten other areas loaded into the function. By examining the variables in the equation and the correlation of the items to the function, it was concluded that there were 16 areas in which there was a significant difference between the two teaching certification levels.

A comparison was also made between univariate one-way analysis of variance and the multivariate approach examining the five graduation years. Nine areas were discovered to be significant using the univariate approach, yet in the multivariate approach 13 areas were found to be significant. A significant difference did appear between the two methodologies when it was noted that three variables found to be significant in the univariate tests were not part of the discriminant functions. This was the first true indication that multiple univariate tests did identify areas to be significant when in fact they were not, thus a Type I error. The discriminant analysis procedure also indicated four areas that the univariate design failed to find significant. It was concluded that of the 33 areas of preparations, there were eight in which there was a significant difference among the five graduation years. The determination of significance included a combination of a multivariate test, used to maintain Type I error rate of .05, and the correlations between the item and the discriminant function.

The final univariate/multivariate comparison was made between two factorial designs, one for each methodology. In particular, the researcher looked for a significant interaction effect between the graduation years and the teaching certification level as measured by the 33 areas of preparation. The results to the interaction effects were in general very inconclusive. Two variables, using media and using a variety of instructional techniques, showed a significant interaction effect using the univariate methodology. Each area also appeared to be part of the discriminant functions that demonstrated an interaction effect using the multivariate methodology. In addition, the area of selecting and organizing material loaded into the function with the instruction techniques area. Therefore, three areas appear to have had an interaction effect between teaching level and graduation year: using media, using a variety of instructional techniques, and selecting and organizing material.

It was noted throughout the course of the research that it was possible to have insignificant univariate tests but significant multivariate tests. This is possible because of the accumulation of evidence from individual variables. It was also seen that the converse was also possible. That was variables could be judged to be insignificant when the univariate tests are significant. This is possible when real differences between groups on a variable were hidden or masked by the lack of difference from the other variables.

The final analysis examined the possible relationship between the graduates' satisfaction with student teaching and the overall teacher preparation program and the 33 areas of preparation. Research has shown that teacher satisfaction is strongly correlated with the teacher's preparation, which in turn affects the retention rate of teachers. Two relationships, calculated by the canonical correlation technique, were discovered. The first was a positive relationship between the teacher's preparation with various measures on instructional techniques and their overall satisfaction with the teacher preparation program. The second, although much lower, related satisfaction with the cooperating teacher with an overall high rating with the teacher education program in general.

In this research, the researcher compared three designs using the two methodological approaches, univariate and multivariate. The first design compared two teaching certification levels, the second compared five years of graduation, and the third was the factorial design of the two previous main effects. Others attempting similar research would be well advised to concentrate on only the factorial design. The factorial design allowed the researcher to not only examine the possible interaction effect, but also the two main effects. Therefore, there was a redundancy of tests between the first two designs and the factorial design. The same conclusions were possible using only the factorial design.

Limitations

1. This research concentrated on the statistical aspects of multivariate analyses; it did not attempt to explore the full range of possible meanings of the teacher preparation variables and satisfaction variables.
2. The intended reader of this paper was determined to be individuals with limited statistical and mathematical background; therefore, the derivations and the theory of the statistics were not presented.
3. Although the procedures used in the application of the various multivariate techniques could and should be generalized to other research, the conclusions regarding the relationships between teaching certification level, graduation year, and overall teacher satisfaction to other institutions should not.

Recommendations

This research's purpose was to present clear, concise, and practical guidelines for the application of multivariate statistical techniques to the field of education. It was, by design, not a complete review of all the multivariate techniques nor did it take a strongly mathematical or statistical approach to the infusion of the methodology. Rather it attempted to demonstrate using a meaning data set an alternative and quite possibly a more applicable approach to the analysis of data. To further the understanding of multivariate statistics and its infusion as a possible alternative analysis, the following recommendations are presented:

1. It is recommended that future educational researchers examine the design of the research and correlations of the variables of concern to determine the possible application of a multivariate analysis, and then, if appropriate, apply these techniques to insure against inflated Type I error rates.
2. Research into the specifics of the violation of the assumption of homogeneity of variance should be explored as it relates to the data collected through RISE. A possible analysis and discussion of the data using transformed scores would be appropriate.
3. RISE should encourage others using data collected as part of the longitudinal study to explore the data from the multivariate approach.
4. In order to encourage the infusion of multivariate techniques into more educational research at Iowa State University, the material

necessary for the application of the techniques should be introduced into the advanced educational statistics course.

5. If the goal is to provide an understanding of the relationship between teacher preparation and satisfaction, other research should be conducted concentrating on the teacher preparation variables, and not the methodology behind the analysis.
6. In research similar to this, the researcher should use only the factorial design, univariate or multivariate, to test the various hypotheses.
7. Other researchers should be encouraged to use educational data to provide further guides as to the application of multivariate techniques.

BIBLIOGRAPHY

Ashton, P. T., Webb, R. B., and Doda, N. (1983). A study of teacher's sense of efficacy. (Report No. 400-79-0075). University of Florida, Gainesville, Florida. (ERIC ED 231 833)

Barcikowski, R. S. (1981). Statistical power with group mean as the unit of analysis. Journal of Educational Statistics 6:267-364.

Barcikowski, R., and Stevens, J. P. (1975). A Monte Carlo study of the stability of canonical correlations, canonical weights and canonical variate-variable correlations. Multivariate Behavioral Research 10:353-364.

Bartlett, M. S. (1941). The statistical significance of canonical correlations. Biometrika 32:29-32.

Bay, James J., and Maxwell, Scott, E. (1982). Analyzing and interpreting significant MANOVA's. Review of Educational Research 52(3):340-367.

Berger, Dale E., and Selhorst, Susan, C. A simulation comparison of univariate and multivariate analyses of a multi-factor repeated measures design. Research Report. (ERIC ED 229389)

Bernstein, Ira H. (1988). Applied Multivariate Analysis. Springer-Verlag, New York.

Boatwright, M. A. (1988). A factor analysis to job characteristics items of Iowa State teacher education students and graduates using selected variables. Unpublished doctoral dissertation, Iowa State University, Ames, Iowa.

Bock, R. Darrell. (1980). Multivariate Statistical Methods in Behavioral Research. McGraw-Hill, London.

Borg, Walter R., and Gall, Meredith D. (1983). Educational Research in Introduction (4th Edition). Longman, Inc., New York.

Box, G. E. P. (1953). Nonnormality and tests on variance. Biometrika 6:318-335.

Browne, M. W. (1968). A comparison of factor analytic techniques. Psychometrika 33:267-334.

Cattell, R. B. (1966). The scree test for the number of factors. Multivariate Behavioral Research 1:245-276.

Cattell, R. B., and Jaspers, J. A. (1967). A general plasmode for factor analytic exercises and research. Multivariate Behavioral Research Monographs.

Chapman, D. W. (1983). A model of the influences on teacher retention. Journal of Teacher Education 35(5):43-49.

Chatfield, Christopher, and Collins, Alexander. (1980). Introduction to Multivariate Analysis. Chapman and Hall, London.

Cooley, William W., and Lohnes, Paul K. (1985). Multivariate Data Analysis. Robert E. Krieger Publishing Company, Malabar, Florida.

Cramer, Elliot M., and Bock, R. Darrell. (1966). Chapter VIII, Multivariate Analysis. Review of Educational Research 36(5):604-617.

DeSarbo, Wayne S. (1982). Constrained canonical correlation. Psychometrika 47(4):489-516. (EJ 284854)

Dillman, D. A. (1978). Mail and Telephone Surveys: The Total Design Method. New York: Wiley.

Glass, G. V., and Hopkins, K. (1984). Statistical Methods in Education and Psychology. Prentice-Hall, Englewood Cliffs, N.J.

Gnanakesikan, Ram. (1980). Statistical data analysis. Proceedings of Symposia in Applied Mathematics. American Mathematical Society. Vol. 28.

Hakstian, A. R., Roed, J. C., and Lind, J. C. (1979). Two sample T^2 procedures and the assumption of homogeneous covariance matrices. Psychological Bulletin 86:1255-1263.

Harris, R. J. (1976). The invalidity of partitioned U tests in canonical correlation and multivariate analysis of variance. Multivariate Behavioral Research 11:3553-3565.

Holloway, L. N., and Dunn, O. J. (1967). The robustness of Hotelling's T^2. Journal of the American Statistical Association 58:1048-1053.

Hotelling, Harold. (1935). The most predictable criterion. Journal of Educational Psychology 26(1):139-142.

Huberty, C. J. (1975). Discriminant analysis. Review of Educational Research 45(4):543-598.

Hubble, L. M. (1984). Univariate analysis of multivariate outcomes in educational psychology. Contemporary Educational Psychology 9(1):8-13. (EJ 296204)

Hummel, Thomas J., and Johnston, Charles B. (1986). An empirical comparison of size and power of seven methods of analyzing multivariate data in the two-sample case. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, April 16-20. (ERIC ED 269480)

Hummel, Thomas J., and Sligo, Joseph R. (1971). Empirical comparison of univariate and multivariate analysis of variance procedures. Psychological Bulletin 76:49-57.

Isaacson, L. E. (1978). Career information in counseling and teaching (3rd ed.). Allyn and Bacon, Inc., Boston, MA.

Johnson, John E., and Walpole, Ronald. (1987). Mathematical Statistics, 4th Edition. Prentice-Hall, Inc., Englewood Cliffs, N.J.

Kaiser, J. F. (1960). The application of electronic computers to factor analysis. Educational and Psychological Measurement 20:141-151.

Kang, S. H. (1987). Career satisfaction of beginning teachers in Iowa. Unpublished doctoral dissertation, Iowa State University, Ames, Iowa.

Keeves, John P. (1988). Multivariate analysis. Educational Research, Methodology, and Measurement: An International Handbook. Pergamon Press, Oxford, 1988.

Klecka, W. R. (1980). Discriminant analysis. Series: Quantitative Applications in the Social Sciences. Sage Publications, Beverly Hills, CA.

Kyriacou, C., and Sutcliffe, J. (1979). Teacher stress and satisfaction. Education Research 21(2):89-96.

LaSalle, Joseph. (1974). The influence of computing on mathematical research. Proceedings of Symposia in Applied Mathematics, Vol. 20. American Mathematical Society, Providence, Rhode Island.

Lawley, D. N. (1971). Factor analysis as a statistical method. Butterworths, London.

Leary, Mark R., and Altmaier, Elizabeth Mitchell. (1980). Error in counseling research: A plea for multivariate analyses. Journal of Counseling Psychology 27(6):611-615.

Levine, Mark S. (1977). Canonical analysis and factor comparison. Series: Quantitative Applications in the Social Sciences. Editor, Eric M. Uslaner. A Sage University Paper, Sage Publications, Beverly Hills.

Manly, Bruan F. J. (1986). Multivariate Statistical Methods, A Primer. Chapman and Hall, London.

McDonald, Roderick P. (1986). A survey of some studies in methods for the structural analysis of multivariate data in the social sciences. Interchange 17(2):25-40.

McLean, James E., and Chissom, Brad S. (1986). Multivariate analysis of ipsative data: Problems and solutions. Paper presented at the annual meeting of the Mid-South Educational Research Association, Memphis, Tenn., November 19-21. (ERIC ED 278717)

Meredith, W. (1964). Canonical correlation with fallible data. Psychometrika 29:55-65.

Moran, James D. (1986). Methodological note: Let the t-test rest in peace--A note on the control of error rates. Home Economics Research Journal 14(4):380-383. (EJ 337069)

Murphy, J. F. (1982). Why teachers drop out. Illinois Schools Journal 61(1-4):35-41.

National Education Association. (1980). Teacher opinion poll: Job satisfaction. Today's Education 69(4):8.

Norusis, Marija J. (1985). Advanced Statistical Guide SPSSX. McGraw-Hill Book Company, New York.

Olson, C. L. (1974). Comparative robustness of six tests in a multivariate analysis of variance. Journal of the American Statistical Association 69:894-908.

Ostle, Bernard, and Mensing, Richard. (1975). Statistics in Research (Third Edition). Iowa State University Press, Ames, Iowa.

Pedhazur, Elazar J. (1982). Multiple Regression in Behavioral Research (Second Edition). Holt, Rinehart & Winston, New York.

Pillai, K., and Jayachandian, K. (1967). Power comparisons of tests of two multivariate hypotheses based on four criteria. Biometrika 54:195-210.

Porebski, O. R. (1966). Discriminatory and canonical analysis of technical college data. British Journal of Mathematical and Statistical Psychology 19:215-236.

Pruzek, R. M. (1971). Methods and problems in the analysis of multivariate data. Review of Educational Research 41:163-190.

Ramsey, Phillip H. (1982). Empirical power of procedures for comparing two groups on p variables. Journal of Educational Statistics 7(2):139-156.

Reddon, John R. (1985). Distribution of the determinant of the sample correlation matrix: Monte Carlo type one error rates. Journal of Educational Statistics 10(4):384-388. (EJ 328971)

Research Institute for Studies in Education. (1988). Profile VIII: Teacher education students (RISE Research Report No. 18). Iowa State University, Ames, Iowa.

Research Institute for Studies in Education. (1987). Teacher education program enhancement: An analysis of Profile VII (RISE Research Report No. 18). Iowa State University, Ames, Iowa.

Ryan, T. A. (1959). Multiple comparisons in psychological research. Psychological Bulletin 56:201-210.

Schalock, D. (1983). Methodological considerations in future research and development in teacher education. In K. P. Howey and W. E. Gardner (Eds.). The Education of Teachers: A Look Ahead (pp. 38-73). Longman, New York.

Snedecor, George W., and Cochran, William S. (1980). Statistical Methods, Seventh Edition. Iowa State University Press, Ames, Iowa.

Stevens, James. (1986). Applied Multivariate Statistics for the Social Sciences. Lawrence Erlbaum Associates Publishers, Hillsdale, N.J.

Sweeney, J. C. (1987). Development and testing of a longitudinal model designed to examine the factors that influence the career paths of Iowa State University teacher education graduates. Unpublished doctoral dissertation, Iowa State University, Ames, Iowa.

Tatsuoka, Maurice. (1973). Multivariate Analysis in Educational Research. In Fred N. Kerlinger (Editor). Review of Research in Education (pp. 273-319). F. E. Peacock Publishers, Itasca, Illinois.

Thompson, Bruce. (1984). Canonical Correlation Analysis, Uses and Interpretations. Series: Quantitative Applications in the Social Sciences. Ed. John L. Sullivan. A Sage University Paper, Sage Publications, Beverly Hills.

Thompson, Bruce. (1987). Fundamentals of canonical correlation analysis: Basics and three common fallacies in interpretation. Paper presented at the annual meeting of the Society for Multivariate Experimental Psychology, Southwestern Division, New Orleans, La., April 16. (ERIC ED 282904)

Timm, N. H. (1975). Multivariate Analysis with Applications in Education and Psychology. Brooks-Cole, Monterey, California.

Wiersma, William. (1986). Research Methods in Education: An Introduction (Fourth Edition). Allyn and Bacon, Inc., Boston.

ACKNOWLEDGMENTS

Sincere thanks are extended to Dr. Tony Netusil, my major professor, for providing the knowledge, insights, patience, and encouragement throughout this project. I would also like to extend my appreciation to my committee members: Dr. Richard Carter, Dr. Roy Hickman, Dr. Ann Thompson, and Dr. Richard Warren. I enjoyed and learned from our lively discussions. Thank you for your time and suggestions.

I am also very grateful to the RISE staff, under the guidance of Dr. Richard Warren, for providing the support for this task. Special thanks go to all the research and teaching assistants that I had the pleasure to work with for the past four years.

Finally, I want to pay special thanks to my family. First to my mother and father who offered many forms of encouragement throughout my life, and in particular to this advanced degree. Thanks is never enough, but it will have to do. A special thanks to my wife, Ruthie, and our boys, Matt and Joel, for their love, encouragement, patience, sacrifice, and their endurance that was displayed during these years. My family's enthusiasm for this achievement has helped make this a reality.

APPENDIX A.

SURVEY INSTRUMENTS AND VARIABLE DESCRIPTIONS

FIRST, we would like information about your teacher preparation program.

1. How long did you student teach? (check one)

   ___ 8 weeks or less

   ___ 12 weeks

   ___ 16 weeks

   ___ Other (Please specify ---> ____________________________).

2. Based on the length of your student teaching experience, should student teaching have been longer or shorter?

	How many additional weeks?	How many fewer weeks?	Total suggested weeks
___ Longer --->	__________	xxxxxxxxxx	__________
___ Shorter --->	xxxxxxxxxx	__________	__________
___ About right	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx

3. At what level did you student teach?

   ___ Prekindergarten/Kindergarten (N-K)

   ___ Elementary (K-6)

   ___ Secondary (7-12)

   ___ K-12

4. In what teaching area(s) of specialization do you expect to get teaching approval?

   (a) Prekindergarten/Kindergarten Level
   ___ Prekindergarten/Kindergarten ___ Other (Specify ________)
   (b) Elementary Level
   ___ Elementary ___ Other (Specify ________)
   (c) K-12 Level
   ___ Art ___ Health ___ Music ___ P.E.
   (d) Secondary Level

___ Agriculture	___ Health	___ Physical Science
___ Art	___ Home Economics	___ Physics
___ Biology	___ Industrial Arts	___ Psychology
___ Chemistry	___ Journalism	___ Safety Education
___ Earth Science	___ Mathematics	___ Social Science
___ English	___ Music	___ Speech
___ Foreign Language	___ Physical Education	___ Other
___ General Science		

   If you checked more than one, what is your major area? ______________

5. Using the rating scale below, indicate how satisfied you were with aspects of your student teaching experience.

Very Satisfied. . . . 5
Satisfied 4
Neutral 3
Dissatisfied. 2
Very Dissatisfied . . 1

	Please circle your response				
a. Getting your choice of geographical location for your student teaching assignment.	5	4	3	2	1
b. Your cooperating teacher.	5	4	3	2	1
c. Your university supervisor.	5	4	3	2	1
d. Based on your student teaching experience, what is your reaction to teaching as a career for you?	5	4	3	2	1

6. At what age did you decide to become a teacher? _______ years old.

7. If you had it to do over again, would you prepare to become a teacher?

___ Yes

___ No

___ Undecided

8. Do you feel you will be ...

___ ... an excellent teacher?

___ ... a better than average teacher?

___ ... an average teacher?

___ ... a below average teacher?

___ ... an inadequate teacher?

9. On a scale of 0 to 10, how would you rate the quality of the Teacher Preparation Program at Iowa State University? (Please circle the appropriate number.)

Very Poor										Very High
0	1	2	3	4	5	6	7	8	9	10

10. In what ways did the program provide the most valuable professional preparation for you?

(1) ____________________

(2) ____________________

(3) ____________________

11. In what ways should the program have offered more preparation?

(1) ____________________

(2) ____________________

(3) ____________________

12a. During your academic program at Iowa State University, have you done any work with computers or had training with applications of computers to teaching?

___ No ----> go to Q. 13
___ Yes ---> please answer Q. 12b

12b. If yes, please check <u>all</u> experiences that apply.

___ 1. Introductory lecture(s)/demonstration(s) on computers and educational applications
___ 2. Viewing available Computer Assisted Instruction (CAI) materials
___ 3. Selecting and evaluating Computer Assisted Instruction (CAI) materials
___ 4. Using computers to manage instruction (grades, attendance, etc.)
___ 5. Entire course(s) in educational computing or computer science
___ 6. Word processing
___ 7. Computer programming
___ 8. Using microcomputers (Apples, Pets, etc.)
___ 9. Using minicomputers (VAX)
___ 10. Using mainframe computers through terminal and batch processing
___ 11. Other (Please specify ---> ____________________).

13a. Please indicate how adequate your professional education preparation program was in the following areas. Use the following response categories.

Very Adequate . . . 5
Adequate. 4
Neutral 3
Inadequate. 2
Very Inadequate . . 1
Not Applicable. . . N

	Please circle your response					
1) Planning units of instruction and individual lessons.	5	4	3	2	1	N
2) Preparing and using media	5	4	3	2	1	N
3) Maintaining student interest.	5	4	3	2	1	N
4) Understanding and managing behavior problems in the classroom	5	4	3	2	1	N
5) Teaching basic skills	5	4	3	2	1	N
6) Consultation skills in interacting with other professionals	5	4	3	2	1	N
7) Developing student-student relationships. . . .	5	4	3	2	1	N
8) Referring students for special assistance . . .	5	4	3	2	1	N
9) Skills for mainstreaming handicapped students .	5	4	3	2	1	N
10) Methods of working with children with learning problems.	5	4	3	2	1	N
11) Assessing learning problems	5	4	3	2	1	N
12) Developing tests.	5	4	3	2	1	N
13) Interpreting and using standardized tests . . .	5	4	3	2	1	N
14) Content preparation in your area of specialization.	5	4	3	2	1	N
15) Professional ethics and legal obligations . . .	5	4	3	2	1	N
16) Psychology of learning and its application to teaching	5	4	3	2	1	N
17) Evaluating and reporting student work and achievement.	5	4	3	2	1	N
18) Relating activities to interests and abilities of students	5	4	3	2	1	N

Very Adequate	5
Adequate	4
Neutral	3
Inadequate	2
Very Inadequate	1
Not Applicable	N

	Item	Please circle your response					
19)	Locating and using materials and resources in your specialty area	5	4	3	2	1	N
20)	Evaluating your own instruction	5	4	3	2	1	N
21)	Individualizing instruction	5	4	3	2	1	N
22)	Selecting and organizing materials	5	4	3	2	1	N
23)	Using a variety of instructional techniques	5	4	3	2	1	N
24)	Understanding teachers' roles in relation to administrators, supervisors and counselors	5	4	3	2	1	N
25)	Working with parents	5	4	3	2	1	N
26)	Working with other teachers	5	4	3	2	1	N
27)	Assessing and implementing innovations	5	4	3	2	1	N
28)	Appreciating and understanding individual and intergroup differences in values and lifestyles	5	4	3	2	1	N
29)	Using community resources	5	4	3	2	1	N
30)	Techniques of curriculum construction	5	4	3	2	1	N
31)	Influence of laws and policies related to schools	5	4	3	2	1	N
32)	Techniques of infusing multicultural learning	5	4	3	2	1	N
33)	Using written communication effectively	5	4	3	2	1	N
34)	Developing your own teaching style by observing others	5	4	3	2	1	N

13b. In rank order (1 highest rank), please list from the above items the corresponding numbers for the three areas of preparation with highest adequacy.

	1	2	3
Adequacy of Preparation	___	___	___

14. We would like your reactions to using selected components within the teacher preparation program. Some of these components are recent additions and therefore, may not have been included in your program. First, for each component, please check ( ) whether or not you participated. Then, for those you participated in, use the scale below to rate the extent to which the component helped you prepare to be a teacher. Finally, comment on the component (such as, explain what you liked or disliked, how it helped you, the extent of your participation, its strengths or weaknesses, etc.)

No Help at All										A Great Deal of Help
0	1	2	3	4	5	6	7	8	9	10

Component	Participate	Rating	Comments
Teacher on Television (TOT)	____Yes ____No	____	____________________ ____________________ ____________________
Performance Element Modules (PEMs)	____Yes ____No	____	____________________ ____________________ ____________________
Teaching Assessment Modules (TAMs)	____Yes ____No	____	____________________ ____________________ ____________________
Writing Clinic	____Yes ____No	____	____________________ ____________________ ____________________
Field Experiences (including pre-student teaching practicums, but not student teaching)	____Yes ____No	____	____________________ ____________________ ____________________

15. What are your employment plans for the next academic school year (1989/1990)?

___ Have obtained a teaching position for 1989/90 school year.

___ Currently seeking or plan to seek a teaching position.

___ Currently seeking or plan to seek a non-teaching position.

___ Graduate study (Please specify area ---> ______________________).

___ Other (Please specify ---> ______________________________________).

16. What is your long-range career plan? (Please check the most appropriate response. Check only <u>one</u>.)

___ Teaching ---> skip to Q. 18

___ Employment in education other than teaching ---> skip to Q. 18

Please specify ---> ______________________________

___ Employment outside the field of education ---> please answer Q. 17

Please specify ---> ______________________________

___ Other ---> please answer Q. 17

Please specify ---> ______________________________

17. (Non-teaching) Why do you plan not to enter the field of education? Check as many as apply.

___ Lack of teaching positions available.
___ Greater career opportunities in nonacademic jobs.
___ Higher salaries and benefits in nonacademic jobs.
___ Marriage/family obligations.
___ Had not planned to enter education.
___ Experiences in student teaching.
___ General working conditions (nonteaching duties, hours, classroom size, work load).
___ Student related (motivation, lack of discipline, general attitudes).
___ General administrative framework in local schools.
___ Lack of respect.
___ Emotional aspects (stress, burnout, frustration, boredom).
___ Lack of support from parents and community.
___ Lack of advancement opportunities.
___ Other (Please specify ---> ______________________________).

ALL RESPONDENTS

18. How important is it that a job provide you with the following characteristics? Please circle one number for each characteristic. Use the following response categories.

Very Important . . . 5
Important. 4
Neutral. 3
Unimportant. 2
Very Unimportant . . 1

	Please circle your response				
a. Opportunity to be creative and original. . .	5	4	3	2	1
b. Opportunity to use special abilities or aptitudes.	5	4	3	2	1
c. Opportunity to work with people rather than things.	5	4	3	2	1
d. Opportunity to earn a good deal of money . .	5	4	3	2	1
e. Social status and prestige	5	4	3	2	1
f. Opportunity to effect social change.	5	4	3	2	1
g. Relative freedom from supervision by others.	5	4	3	2	1
h. Opportunity for advancement.	5	4	3	2	1
i. Opportunity to exercise leadership	5	4	3	2	1
j. Opportunity to help and serve others	5	4	3	2	1
k. Adventure.	5	4	3	2	1
l. Opportunity for a relatively stable and secure future.	5	4	3	2	1
m. Fringe benefits (health care, retirement benefits).	5	4	3	2	1
n. Variety in the work.	5	4	3	2	1
o. Responsibility	5	4	3	2	1
p. Control over what I do	5	4	3	2	1
q. Control over what others do.	5	4	3	2	1
r. Challenge.	5	4	3	2	1

19. In self-appraisal and teacher evaluation, certain teaching behaviors are often identified. We would like you to rate your perception of your student teaching behavior in each of the following areas. Using the scale below, circle a number for each area.

	Very Low 0	1	2	3	4	5	6	7	8	9	Very High 10
a. Providing a setting conducive to learning	0	1	2	3	4	5	6	7	8	9	10
b. Motivating students	0	1	2	3	4	5	6	7	8	9	10
c. Demonstrating knowledge of subject matter	0	1	2	3	4	5	6	7	8	9	10
d. Monitoring and evaluating student progress and understanding	0	1	2	3	4	5	6	7	8	9	10
e. Providing clear, concise explanations and examples	0	1	2	3	4	5	6	7	8	9	10
f. Managing instructional activities efficiently and ensuring student time on task	0	1	2	3	4	5	6	7	8	9	10
g. Communicating effectively with students	0	1	2	3	4	5	6	7	8	9	10
h. Demonstrating sensitivity toward students	0	1	2	3	4	5	6	7	8	9	10
i. Demonstrating effective planning and organization skills	0	1	2	3	4	5	6	7	8	9	10
j. Exhibiting a positive self-concept	0	1	2	3	4	5	6	7	8	9	10
k. Accommodating a variety of ability levels	0	1	2	3	4	5	6	7	8	9	10
l. Implementing the lesson plans effectively	0	1	2	3	4	5	6	7	8	9	10
m. Maintaining high expectations for student achievement	0	1	2	3	4	5	6	7	8	9	10
n. Incorporating effective questioning techniques	0	1	2	3	4	5	6	7	8	9	10
o. Using a variety of instructional resources	0	1	2	3	4	5	6	7	8	9	10
p. Maintaining high standards for student behavior	0	1	2	3	4	5	6	7	8	9	10

Now we would like to ask you some general questions about yourself and your family.

20. Up to the present, where have you spent the majority of your life?
    ___ ... on a farm?
    ___ ... in a non-farm country home?
    ___ ... in a town with population less than 2,500?
    ___ ... in a town with population between 2,500 and 5,000?
    ___ ... in a town with population between 5,000 and 10,000?
    ___ ... in a town with population between 10,000 and 25,000?
    ___ ... in a town with population between 25,000 and 50,000?
    ___ ... in a city with population between 50,000 and 100,000?
    ___ ... in a city with population over 100,000?

21. Sex
    ___ Female
    ___ Male

22. Marital status
    ___ Single
    ___ Married

22a. Do you have any children?
    ___ Yes ---> How many?____
    ___ No

23. What was your father's occupation most of the time while you were living at home? Please be specific.

    ____

24. What was your mother's occupation most of the time while you were living at home? Please be specific.

    ____

25. Please think about the best elementary or secondary teacher you know or have known. What are the characteristics that made that teacher outstanding?

    (1)____

    (2)____

    (3)____

If you have any additional comments about teacher preparation or teaching in general, please use the space below.

The College of Education and the Research Institute for Studies in Education appreciate the time you have taken to complete this questionnaire. Postage for the questionnaire is prepaid, so all you need do is tape it and drop it in a mailbox.

Variable Descriptions

TB1	Planning units of instruction and individual lessons
TB2	Using media
TB3	Maintaining students' interest
TB4	Classroom management
TB5	Teaching the basic skills
TB6	Consultation skills in interacting with other professionals
TB7	Developing student-student relationships
TB8	Referring students for special assistance
TB9	Skills for mainstreaming handicapped students
TB10	Methods of working with children with learning problems
TB11	Assessing learning problems
TB12	Developing tests
TB13	Interpreting and using standardized tests
TB14	Content preparation in your area of specialization
TB15	Ethics and legal obligations
TB16	Learning psychology
TB17	Evaluating and reporting student work and achievement
TB18	Relating activities to interests and abilities of students
TB19	Locating and using materials
TB20	Evaluating your own instruction
TB21	Individualizing instruction
TB22	Selecting and organizing material
TB23	Using a variety of instructional techniques
TB24	Understanding teachers' roles in relation to administrators, supervisors, and counselors

TB25	Working with parents
TB26	Working with other teachers
TB27	Assessing and implementing innovations
TB28	Appreciating and understanding individual and intergroup differences in values and lifestyles
TB29	Using community resources
TB30	Techniques of curriculum construction
TB31	Influences of laws and policies related to schools
TB32	Techniques for infusing multicultural education
TB33	Learning to write effectively
TA1	Choice of student teaching geographical location
TA2	Your cooperating teacher
TA3	Your university supervisor
TA4	Reaction to teaching as a career
QTPP	Overall rating of the quality of the teacher preparation program

APPENDIX B.

MANOVA WITH FACTOR SCORES

Table 33. MANOVA test statistics for differences among graduation years and student teaching level as measured by five factor scores

Test name	Value	F statistic	Prob. of F
Interaction effect			
Pillai's	.02	1.07	.37
Hotelling's	.02	1.08	.36
Wilks'	.98	1.08	.36
Graduation year main effect			
Pillai's	.04	2.24	.01**
Hotelling's	.04	2.26	.01**
Wilks'	.96	2.25	.01**
Student teaching level main effect			
Pillai's	.10	21.98	.00**
Hotelling's	.11	21.98	.00**
Wilks'	.90	21.98	.00**

Discriminant analysis of level-graduation year factorial design (Summary table)

Variable	Step	Wilks' lambda	Sign.
Factor 3	1	.96	.00
Factor 2	2	.93	.00
Factor 1	3	.90	.00
Factor 5	4	.87	.00
Factor 4	5	.85	.00

**Significant at the level of .01.

Table 34. Discriminant analysis of level-graduation year factorial design (Standardized function coefficients)

Variable	Significant functions: Function 1	Significant functions: Function 2
Factor 1	.86	.82
Factor 2	-.87	.65
Factor 3	.76	-.05
Factor 4	.37	-.99
Factor 5	-.71	-.10

Table 35. Discriminant analysis of level-graduation year factorial design (Item-to-function coefficients)

Variable	Discriminant functions	
	Function 1	Function 2
Factor 1	.44	.62
Factor 2	-.04	.51
Factor 3	.54	.23
Factor 4	.31	-.21
Factor 5	-.08	.27

Table 36. Discriminant analysis of level-graduation year factorial design (Canonical discriminant functions evaluated at group means)

Group	Function 1	Function 2
83/84 Elementary	.37	.18
84/85 Elementary	.31	-.03
85/86 Elementary	.19	.16
86/87 Elementary	.29	-.14
87/88 Elementary	.33	-.14
83/84 Secondary	-.37	.37
84/85 Secondary	-.38	.08
85/86 Secondary	-.38	-.20
86/87 Secondary	-.33	-.08
87/88 Secondary	-.30	-.35
Percent variance explained	64.10%	23.47%

APPENDIX C.

NORMAL PLOT OF GRADUATES' GRADE POINT AVERAGE

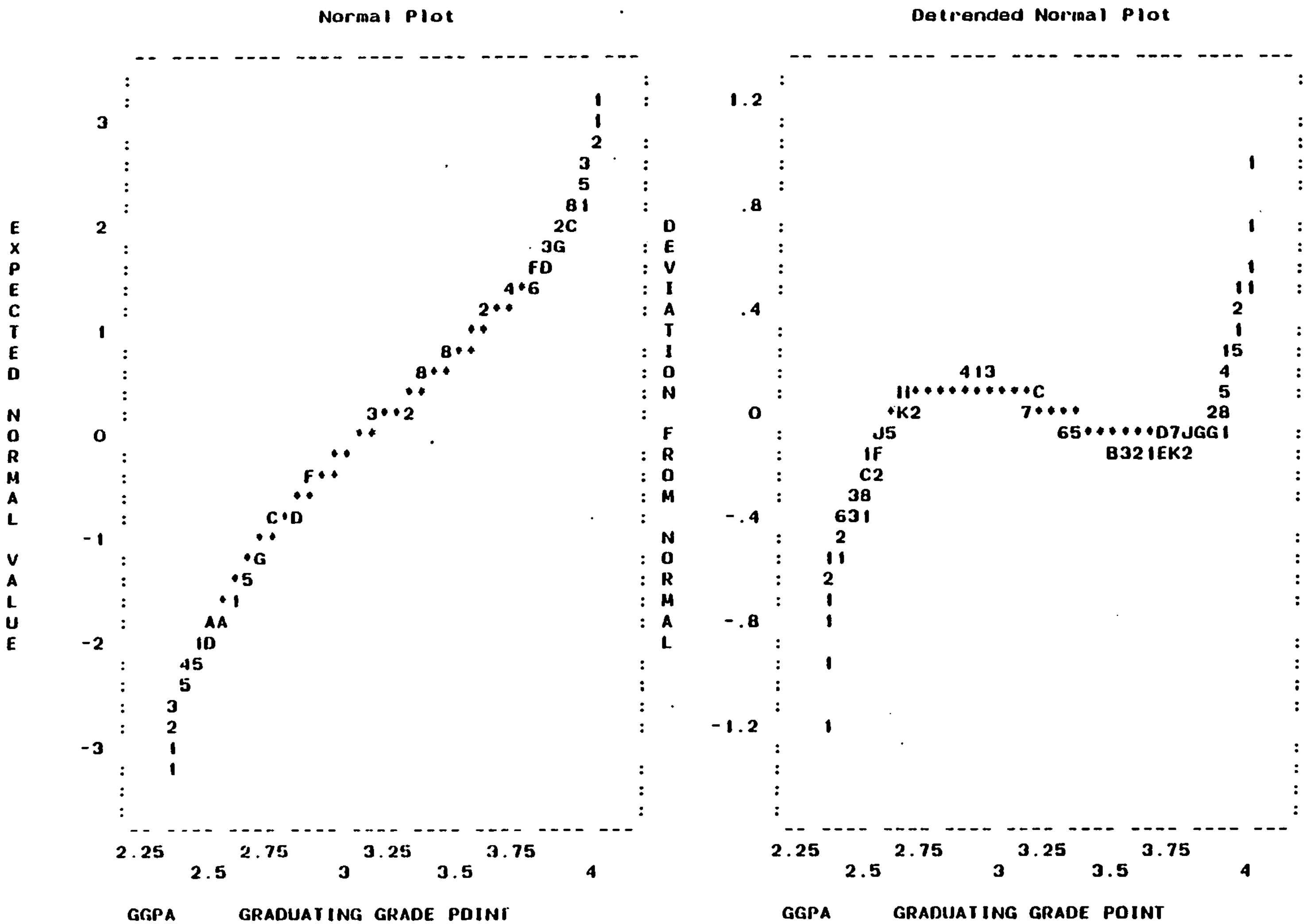


Figure 5. Normal plot of graduates' graduating grade point average