BIBLIOGRAPHY

ASTODILLO, LIEZYL T., BUASEN, PAMELA P. and DAO-ANIS, JOSEPHINE A. March. 2009. Discriminant Analysis on the Performance of Academic Scholars and Non-Scholars in Benguet State University. Benguet State University, La Trinidad Benguet

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ABSTRACT

This study was conducted to determine the discriminant functions that will clearly separate the academic scholars and non-academic scholars. Specifically, the study aimed to: 1) determine the subjects that highly discriminate the academic scholars and non-academic scholars; 2) estimate the chance of misclassification given that the derived discriminant function is used as a classification tool; and 3) identify the non-academic scholars who will be considered academic scholars based on discriminant analysis.

The variables observed from the 200 non-scholars and 87 scholars were final grades in Social Science 11, English 11, Math 11 and Filipino 11. The data on the aforementioned variables were obtained from the Dean's Office of College of Arts and Sciences at Benguet State University and analyzed using the SAS Discriminant Analysis Procedure.

The results showed that Math, English and Filipino 11 grades have high discriminating powers in differentiating academic scholars and non-scholars. From the derived discriminant functions, 86.5 percent of the non-scholars and 97.7 percent of the academic scholars were correctly classified. Thus, there was 13.5 percent and 2.3 percent misclassification in the grouping of non-scholars and academic scholars respectively into its correct classification.

Out of 200 non-academic scholars, 27 could be considered academic scholars by discriminant analysis.

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INTRODUCTION

Background of the Study

Institutions of higher learning are engaged in a sustained and continuous process of their students so as to enhance their readiness for the job market and further education. Thus, it is important for educational institutions to focus on improving the aspects of teaching and learning.

One of the schemes in improving the aspect of learning is providing scholarships to students. In most schools, a unit responsible for providing these scholarships is usually identified.

At Benguet State University, the Student Scholarship and Grant Unit (SSGU) is being recognized to administer undergraduate scholarships and awards. Some of these scholarships are based on leadership abilities, skills and talents, but mostly, based on academic performance.

The individual grades are used as academic performance indicators. Every scholar has to maintain a minimum grade requirement set by the school or university. Some scholarship granting body, an average grade of 75 or 3.0 or higher is considered as the cut-off point to become a scholar. However, for academic achiever scholarship award, an average grade of 1.75 or better must be maintained.

To become an academic achiever awardee, he has to prove that he has the capability to excel in all the subject areas he is enrolled in for a given semester.

Based on the university code of Benguet State University, academic achievers must have an average grade of 1.75 or better with no grade lower than 3.0 in any subject and no dropped subject(s). Based on this policy code, the researchers of this study are challenged to determine if an individual who incurred lower than 3.0 because of some unavoidable circumstances cannot be an academic achiever.

To mitigate the problem of deleting or not an academic scholar from the list of scholars because of an incurred grade lower than 3.0 in one of the subjects enrolled through the average is still within the set range, a discriminant analysis may give solutions to the problem.

Discriminant analysis linearly combines discriminating variables to develop the basis for assigning an individual of unknown origin to one of the distinct groups. It is a method of studying group differences on several variables simultaneously.

Statement of the Problem

This study sought to answer the following problems:

1. Which of the subjects or variables highly discriminate the academic scholars from the non-academic scholars?

2. What would be the chance of misclassification given that the derived estimated discriminant function is used as a classification tool?

3. Who are those non-scholars who can be classified as academic scholars based on discriminant analysis?

Objectives of the Study

This study aimed to discriminate academic scholars and non-scholars based on their performance using the grades in the basic subjects.

Specifically, the study aimed to:

1. determine which of the subjects or variables highly discriminate academic scholars and non-scholars;

2. estimate the chance of misclassification given that the derived estimated discriminant function is used as a classification tool.

3. identify the non-academic scholars who will be considered academic scholars based in discriminant analysis.

Significance of the Study

Results of this study can be utilized in future researches, by teachers and administrators, students – scholars and non-scholars, and even by parents.

The identification of variables that may have a contribution on the academic performance of the students could be of great help to teachers and administrators. They would have a better insight on how to motivate their students.

The results could also help the students to realize and reflect on their study habits and learning weaknesses, thus, they would be encouraged to find ways to improve their performance.

The findings could also convince the parents to cooperate and coordinate with the school in guiding their children on their studies. These could motivate them to devote more time, attention and guidance needed by their children in order for their children to improve their performance in school.

Result of this study will serve as guide for administrators and other sponsoring agencies to revise scholarships' rules and regulations and for further improvement in the management of scholarships.

Scope and Delimitation

This study was limited to the academic scholars and non-scholars at Benguet State University enrolled during the first semester of School Year 2008-2009. Only the first year and first semester grades for the general education courses namely: English 11, Filipino 11, Social Science 11 and Math 11 were gathered for this study.

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REVIEW OF LITERATURE

Scholarship

A scholarship is an award of access to an institution, or a financial aid award for an individual student called a scholar, for the purpose of furthering their education. Scholarships are awarded based on a range of criteria which usually reflect the values and purposes of the donor or founder of the award.

Scholarships may be classified into the following primary groups:

Academic: A scholarship which is purely based on the academic performance of the students. Percentage discounts are awarded to the scholars depending on their grades and their grade point average. This scholarship may be classified to University or College level.

Merit: A financial aid for which financial need is not used to determine the recipient. The recipient may be determined by students' athletic, academic, artistic or other abilities. The actual monetary value of the scholarship may be negligible, the scholarship being meant to motivate the student and promote the study of the subject.

Need: A financial aid for which the student and family's financial situation is a primary factor in determining the recipient. Usually, such scholarship will cover all or part of the tuition and may even cover living costs.

Sociology: A financial aid where applicants must initially qualify by race, religion, or national origin. After filtering the applicants based on their ethnicity, additional factors are taken into consideration to determine the final and deserving recipients.

Institutional: These are scholarships awarded by a specific college or university (institution) to a student planning to attend that institution.

General: These are other scholarships which are awarded for a variety of reasons that do not fall into one of the above categories. These may be for reasons of the student's association with the objectives of the sponsoring organization or affiliations.

Some scholarships have a "bond" requirement. Recipients may be required to work for a particular employer for a specified period of time or to work in rural or remote areas; otherwise they may be required to repay the value of the support they received from the scholarship.

It is also typical for persons to find scholarships in their home region. Information on these can be found by asking local persons and organizations. Typically, these are less competitive as the eligible population is smaller: sponsored by Non-profit Organizations or Charitable Trusts, Community Foundations, Foundations, Labor Unions, Houses of Worship, Chamber of Commerce and other Volunteer Organizations.

Academic Performance

Several researches have been made regarding the academic performance of students, and though many significant findings have been made, it still remains as a subject of great interest for researchers.

The study of Agustin (2002) aimed to identify the factors affecting the academic performance of Grade I pupils at Lucban Elementary School. As a result, six significant factors were extracted, namely: educational and financial support, sibling number and order, health and geographical location, sex and technology exposure, parents' concern, age and guardian. Using regression analysis, it was found out that the six factors mentioned have only a very small contribution to the academic performance of the pupils. The R^2 indicates only a 4.9% of the pupils' variations on performance can be explained by the extracted factors.

Milo (2003) conducted a study on determining the indicators of students' performances and the effects on the performance in school. Factors seen were the school, facilities, teacher, high school performance, gender and age. It was found out that these factors contribute highly on the academic performance of students using regression analysis. The R^2 value indicates that 68.6% of the students were explained by these factors.

Another study conducted by Candiao (2002) determined factors affecting the academic performance of the SFAO Grantees of BSU under four subjects: Biology, Communication Arts, Chemistry and Mathematics. Using factor analysis, the study revealed two factors having significant relationship in Biology with an R^2 of 34.2% and in Communication Arts with 7.7% - father's educational attainment and health problems; three factors in Chemistry with an R^2 of 49% - average family income, organization affiliation and serious relationship with someone; and only the provincial factor was found to have a significant relationship in the performance in Mathematics with R^2 of 11.9%.

Application of Discriminant Analysis

Discriminant function analysis is used to classify cases into the values of a categorical dependent, usually a dichotomy. If discriminant function analysis is effective for a set of data, the classification table of correct and incorrect estimates will yield a high percentage correct. This technique has been applied widely in the field of education, biological and medical sciences. Here are some of its application:

Cochran (1964) investigated the problem of estimating the discriminating power of the linear discriminant function from knowledge of the discriminating powers of the individual variables includes in the linear discriminant function. His examination suggested that in practice, (a) most correlation is positive; (b) it is usually safe to exclude from a discriminant before computing it, a group of variables whose individual discriminatory power are poor except for any such variable that has negative correlation with most of the good discriminators; (c) the performance of the discriminant function can be predicted satisfactorily from a knowledge of individual powers plus the average correlation coefficient.

Cornelio and Dacus (2007) employed stepwise discriminant analysis in identifying the variables that discriminate between the sophomore student of BSAS as below average and above average using the students' high school grades (Math, Science, English, General Weighted Average), and their freshmen college grades (Math 11. Statistics 11, Biology, Chemistry, Physics, English 11). The results revealed that grades in high school English and Statistics 11 had the highest discriminating power in classifying the students into below average and above average.

Bodong (2001), applying the discriminant analysis, was able to classify a qualified from non-qualified freshmen applicants in Benguet State University. The variables utilized were the fourth year weighted average, high school Math, Science and English grades, and IQ scores. Results showed that the IQ score and English grade in high school gave clear separation between admitted and not admitted freshmen applicants.

Antiyag and Tognaon (2006) used discriminant analysis to show the performance indicators of Benguet State University student achievers and non-achievers to select the 'best' from among possible discriminating variables that will give clear separation between achiever and non-achiever, and estimate the chance of misclassification tools. The study was therefore concluded that the Physics and

English grades are the most important variables to consider in the selection of achievers and non-achievers. The results also indicated that classification of the subject into group membership is important.

Benito and Cabasoy (2006) applied stepwise discriminant analysis on the body measurement of graduating student, in determining the set of body measurement of young male and female adults that allows for the best discrimination between sizes (small, medium, large) and the accuracy of predicting cases classified into correct classification. They concluded that the neck, hip, waists and length of arms are the variables with high discriminating power in the separation between sizes.

Domiles and Tamayo (2005) also used discriminant analysis in classifying admitted and not admitted high school freshmen applicants at Benguet State University-Secondary Laboratory School, and in classifying the admitted high school freshmen applicants with regard to what section (Science, Vo-Ag and HE) they will be placed. They concluded that IQ scores and aptitude scores are the most important variables to be considered in the selection of high school freshmen applicants. Also, general point average and IQ scores are the most important variables to be considered in the classification of section.

Inciong (2001) used discriminant analysis to classify the nutritional status (overweight, normal, underweight) of pre-school age at La Trinidad, Benguet. The variables considered were the weight, sex, age, date first seen (months), number of brothers and sisters, barangay where they belong, parents' educational attainment and occupation. It was concluded that the weight of the child has the greatest contribution in determining the nutritional status of the selected pre-school age children. The researcher relates this study to find similarities especially in the tool applied through the variables considered are different.

Castillo (2003), as cited by Cornelio and Dacus (2007), employed discriminant analysis in classifying food security in selected indicators in certain regions in the Philippines. A total of 65 variables were considered describing the 1,200 households from the National Capital Region, Region IV and Region VII with regard to their food consumption, energy and nutrient intake, and other socio-economic characteristics. These three regions were selected to represent high, middle and low income regions. Results showed that the three regions with three different economic conditions have different food security indicators. Household, thus, be classified according to level of food security in ways unique to each region.

The business environment of Korean housing industry has changed recently from a supplier's market to a buyer's. Kim, J. (2000) attempted to offer a characteristics profile and a forecasting model classifying the housing purchase consumers into three groups: a single-family housing purchase group, an apartment housing purchase group, and a non-purchase group. These groups were classified by employing discriminant analysis and were predicted using the discriminant function: a linear combination of demographic, socio-economic and residential characteristics.

Another application of discriminant analysis is the study of Coleman and Taylor (1996) entitled, “Determination of a Discriminant Function as a Prediction Model for Effectiveness of Speed Zoning in Urban Areas”. Speed zoning is the application of a different speed limit to a section of roadway than is applicable to adjoining highway segments. Speed zoning traditionally has been based on one of two similar procedures, one relying primarily on the 85th percentile speed and engineering judgment and the second, which includes 85th percentile speed, with some form of quantification of environmental and geometric variables to reduce the speed limit below the 85th percentile speed. Three problems exist with the current practice of establishing speed zones. First is that traffic engineers have no way of predicting if their speed zoning actions will result in better compliance with the speed limit. Second it is unclear whether the section will make the driving environment safer resulting in fewer accidents. The third problem is that where states have procedures which quantify and use environmental and geometric variables, the empirical basis for their exclusion or inclusion has not been validated. Coleman and Taylor utilized discriminant analysis to determine if a quantifiable relationship between accident parameters, speed parameters, roadside friction, and environmental/geometric variables can be used to predict the effectiveness of proposed speed zoning actions. The findings are that the most significant variables identified by the discriminant functions for effective zones were: skewness index (negatively skewed), signalization, driveway frequency, and 85th percentile speed.

As cited by Bellovary (2000), one of the most well-known bankruptcy prediction models was developed by Altman using discriminant analysis. Thus, Bellovary summarized and analyzed existing research on bankruptcy prediction studies in order to facilitate more productive future researches in this area. Moreover, analysis of accuracy of the models suggests that multivariate discriminant analysis and neural networks are the most promising methods for bankruptcy prediction models.

Discriminant analysis applied to SAR studies using topological descriptors allowed Galvez (1996) to plot frequency distribution diagrams: a function of the number of drugs within an interval of values of discriminant function against these values. Galvez used these representations, pharmacological distribution diagrams (PDDs), in structurally heterogeneous groups where generally they adopt skewed Gaussian shapes or present several maxima. The maxima afford intervals of discriminant function in which existed a good expectancy to find new active drugs. A set of beta-blockers with contrasted activity had been selected to test the ability of PDDs as a visualizing technique, for the identification of new beta-blocker active compounds.

Alcohol dependence often cannot be diagnosed based on self-report alone. Various biochemical and haematological parameters to screen alcohol use disorders. Hence, Vaswani and Rao (2005) a study to develop discriminant equations based on lipid and liver measures independently for identifying alcohol dependent and non-dependent subjects. One hundred subjects fulfilling the criteria of alcohol dependence and seventy healthy controls were included. The socio-demographic details, caloric intake, height, weight and blood pressure were recorded, and samples were analyzed for various lipid measures as well as liver function using diagnostic values such as sensitivity, specificity, positive predictive value (PV+), negative predictive value (PV-), and discriminant analysis. Two equations were constructed based on liver and lipid measures independently. 84.7% of the subjects on the basis of total cholesterol (TC), apolipoprotein B (ApoB) and low density lipoprotein-cholesterol (LDL?HDL-c) and 89.1% on the basis of aspartate amino transferase (AST) and gamma glutamyl transferase (GGT) were correctly classified into their respective groups.

THEORETICAL FRAMEWORK

Discriminant Analysis

Discriminant analysis is the appropriate statistical technique when the dependent variable is categorical (nominal or non-metric) and the independent variables are metric. It is capable of handling either two or multiple groups. When three or more classifications are involved, the technique is referred to as multiple discriminant analysis (MDA).

Discriminant analysis involves deriving the linear combination of the two or more independent variables that will discriminate best between the prior defined groups. This is achieved by the statistical decision rule of maximizing the between-group variance relative to the within-group variance; this relationship is expressed as the ratio of between-group to within-group variance.

Discriminant analysis is appropriate for testing the hypothesis that the group means of the two or more groups are equal. It multiplies each independent variable by its corresponding weight and adds these products together.

The discriminant analysis procedure starts from the assignment of the individual observation to its prior grouping by letting C_1 denotes the first population, C_2 the second population, and $X = (x_1, x_2, \ldots, x_p)$ be column vector of observations in a full set of *p* measurement that has a multi-normal distribution with mean μ_c in the C^{th} group and common positive covariance matrix Σ.

The linear discriminant function based on *q* of the *p* variables for discriminating the groups is given by:

$$DF = a_1X_1 + a_2X_2 + \ldots + a_pX_p = a'X \quad (1)$$

where: DF = discriminant score

a_i = discriminant weight for independent variable

X = independent variable

Such that, the vector of coefficients maximizes $a'\Sigma a$, where Σ is the common covariance matrix of the groups and is a vector coefficient which indicates the contribution of the variables to differentiation along the function. The signs of Σ are important because it indicates whether the variables are making positive or negative contribution.

<u>Measure of the Discriminatory Power of Variables and Functions</u>

The discriminatory power of a discriminant function refers to the distance of the group centroids relative to the amount of the dispersion within the groups based on the given variables. If the magnitude is too small, then it is meaningless to use the variable to discriminate between groups. Wilk's lambda (λ) statistic is a generalized likelihood criterion used in determining the variable that contributes most to the discriminatory power of a model which is a linear combination of *p* variables. The formula is given by:

$$\lambda = \prod_{i=k+1}^{q} \left[\frac{1}{(1 + e_i)} \right] \quad (2)$$

where: e_i = eigenvalue of the i^{th} model

k = number of derived functions

If λ approaches 0, this indicates that the two groups are well separated and if λ is close to 1, this indicates that no group differences exist. This criterion is based on the overall multivariate F-ratio for the test of differences between the group centroids. The variable which maximizes the F-ratio also minimizes λ, a measure of group discrimination. The significance of λ is tested using the formula:

$$\frac{1 - \lambda^{1/2}}{\lambda^{1/2}} = \frac{ms - p\,(k\text{-}1) / 2 + 1}{p\,(k\text{-}1)} \quad (3)$$

where: m = $N - 1\,(p + k) / 2$

$$s = \frac{\sqrt{p^2\,(k\text{-}1)^2 - 4}}{\sqrt{p^2 + (k\text{-}1)^2 - 5}}$$

This is found to be distributed as F with p (k-1) numerator degrees of freedom and ms – p (k+1) / 2 + 1 denominator degrees of freedom.

Another statistic that can be used to judge the substantive utility of a discriminant function is the canonical coefficient r_i* defined as:

$$r_i* = \sqrt{e_i / (1 + e_i)} \quad (4)$$

where: e_i = eigenvalue of the i^{th} model

This coefficient is a measure of association which summarizes the degrees of relatedness between the group and the discriminant function. A value of zero denotes no relationship at all, and a value close to 1 represents a high degree of association. The square of the canonical coefficient is the average squared canonical coefficient (ASCC). This ASCC is the proportion of variation in the discriminant function explained by the variable.

Case Classification and Misclassification Probabilities

Classification can be achieved through a series of classification functions, one for each group. The equation for one group would be of the form:

$$C_i = C_{i0} + \sum C_{ij}X_j = C_{i0} + C_{i0} + C_{i1}X_1 + C_{i2}X_2 + \ldots + C_{ip}X_p \qquad (5)$$

where: C_i is the classification score for the group I,

C_{ij}'s are the classification coefficients

X_j's are the raw scores of the discriminating variables.

Problem of Classification

For two groups situation, let $X_t = (x_1, x_2 \ldots X_p)$ denotes the vector of measurements which are the basis for classifying an individual into one of two groups C_1 and C_2. According to Fisher (1936), the p-multivariate variables need to be transformed into a multivariate variable by finding the linear combination of the X's which maximally discriminates the group.

Let X_1 and X_2 denotes the vectors of means for the subjects on the p variables in group 1 and 2. The location of group 1 on the discriminant function is then given by $Y_1 = a^t x_1$ and the location of group 2 by $y_2 = a^t x_2$. The midpoint between the two groups on the discriminant function is the given by:

$$M = \frac{1}{2}(y_1 + y_2) = (\frac{1}{2})(x_1 - x_2)^t S^{-1}(x_1 - x_2) \quad (6)$$

If we let Z_i denote the score for the i^{th} subject on the discriminant function, then the decision rule is as follows:

If $Z_i \geq m$, then classify subject in group 1;

If $Z_i \leq m$, then classify subject in group 2;

On the classification probability, let $f_1(x)$ and $f_2(x)$ be the probability distribution function associated with the p x 1 random vector X for the populations C_1 and C_2, respectively. Let Ω be the sample space for x. Let R_1 be the set of X values for which we classify objects as G_1 in $R_2 = \Omega - R_1$ be the remaining values for which we classify objects to G_2. The conditional probability, p (2/1), of classifying an object in G_2 when in fact, it is from G_1 is

$$P(2/1) = p(X \varepsilon R_2 G_1) = \int R_2 = \Omega - R_1 f_1(x)\, d_x$$

$$P(1/2) = p(X \varepsilon R_1 G_2) = \int R_2 f_1(x)\, d_x$$

Let P_1 be the prior probability of C_1 and P_2 be the prior probability of C_2; thus, $P_1 + P_2 = 1$. The following are the classification probabilities for X:

$$P\text{ (correct classifying as } C_1) = P(C_1/C_1) * P_1$$

$$P\text{ (misclassifying as } C_1) = P(C_1/C_2) * P_2$$

$$P\text{ (correct classifying as } C_2) = P(C_2/C_2) * P_2$$

$$P\text{ (misclassifying as } C_2) = P(C_2/C_1) * P_1$$

The Huberty one sided Z –test was used to determine the hit-ratio or how good the discriminant function to correct new cases in the group. The formula is given as:

$$Z = \frac{(O - E)\sqrt{N}}{\sqrt{[E(N - E)]}} \quad (7)$$

where: O = actual frequency of the individuals belonging to the correct group

E = expected frequency of the individuals that should belong to the group

N = sample size

Definition of Terms

Academic Performance. It is the grade point average or the general weighted average (GWA) of the students at the end of the semester or school year involving the grades in all the subjects enrolled in.

Centroid. This is the mean value of the discriminant Z-scores of a particular category or group.

Criterion Variable. This is the dependent variable, also called the *grouping variable*. It is the object of classification efforts.

Discriminant Analysis. This is a technique for distinguishing or classifying observations into groups. It provides sorting procedures into previously chosen variables, and reveals which combinations of variables discriminate among the groups.

Discriminant Function. The model of equation formed using discriminant analysis usually in the form of $Y = C_1X_1 + C_2X_2 + \ldots + C_pX_p$, where: Y represents the dependent categorical variable, the C's are the discriminant weight, and the X's are the independent variables.

Discriminant Score. It is the value resulting from applying a discriminant function formula to the data for a given case.

Discriminating Variables. These are the independent variables, also called *predictors*.

Eigenvalue. The *characteristic root* of each discriminant function reflects the ratio of importance of the dimensions which classify cases of the dependent variable.

General Weighted Average. This is the grade point average or the weighted mean grade of all grade points a student earned by enrolment.

Hit Rate. It is the percentage of group cases correctly classified.

Misclassification Probability. This is the probability of given individual to be classified in the incorrect group.

Non-Scholars. These are students who are unable to acquire financial aid or scholarship.

Scholars. These are individuals or students who are awarded scholarship or financial aid to further their studies.

Scholarship. It is an award usually based on academic achievement, community involvement, or similar factors. It may be awarded regardless of financial need. Some scholarships must be applied for, while others are awarded automatically.

Test. This refers to a systematic procedure for observing a behavior or describing it with the aid of a numerical scale or category system.

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METHODOLOGY

Respondents of the Study

The respondents of the study consisted of a total of 287 freshmen students of Benguet State University. Out of the 287 students, 87 are academic scholars and 200 are non-academic scholars.

Sampling Method

The selection of the 87 academic scholars was done by total sampling while the selection of the 200 non-academic scholars was made using simple random sampling. This means that each member of the target population has an equal chance of being included in the sample.

Data Collection

The grades of the non-academic scholars on the following subjects: English11, Filipino11, Social Science11 and Mathematics11, were obtained from the College of Arts and Sciences Dean's Office while the grades of the academic scholars on the aforementioned general education subjects were obtained at the Students Scholarship Grant Unit-Office of Student Affairs, Benguet State University.

<u>Statistical Analysis</u>

The respondents were first classified as academic scholars and non-academic scholars. The gathered data on the four general education courses were then subjected for discriminant analysis.

Discriminant analysis usually identifies which subject or variable contributes most to the discrimination between the scholars and non-scholars, and also to determine the chances of all the elements to be in the correct classification.

Discriminant analysis works by creating a new variable, which is a combination of the original variables. This is known as the Discriminant Function with the formula given as:

$$DF = W_1X_1 + W_2X_2 + \ldots + W_pX_p.$$

(DF – score, W – weight, X – independent variable)

The means and standard deviation of the variables under each group were first obtained. To generate the discriminant function and to estimate the chance of correct classification, discriminant analysis using the SAS program was employed.

Statistical Packages for Social Sciences or SPSS was also utilized in obtaining the Covariance Matrices and the Canonical Discriminant Functions.

The flow of the analysis is shown in Figure 1.

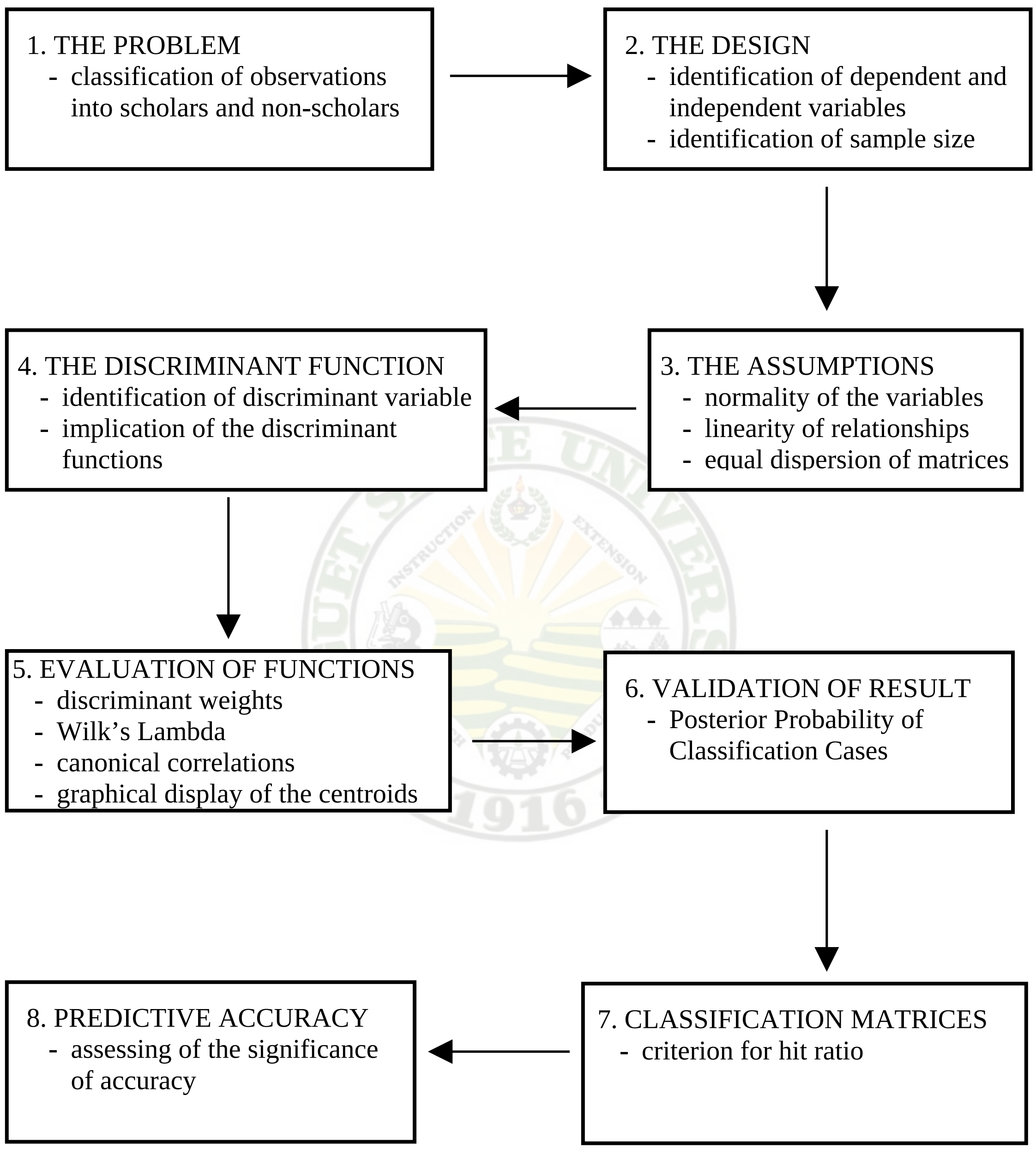

Figure 1. Flow chart for discriminant analysis

RESULTS AND DISCUSSION

Summary Statistics

Table 1 shows the grade point average of the scholars and non-scholars in the four subject areas under test. Mathematics had the highest mean of 2.50 with a standard deviation of 0.53 while Filipino had the lowest mean and standard deviation of 2.02 and 0.51 respectively. For the scholars, Filipino had the highest mean of 1.80 with standard deviation of 0.42 and Mathematics had the lowest mean of 1.39 with 0.31 standard deviation.

Generally, Mathematics had the highest mean of 1.95 while Filipino with the mean of 1.91 was the lowest. For the overall mean, non-scholars had higher mean of 2.25 while the scholars had lower mean of 1.60.

Table 1. Grade point average of scholars and non-scholars

SUBJECT	NON-SCHOLAR		SCHOLAR		TOTAL
	Mean	*Standard Deviation*	*Mean*	*Standard Deviation*	*Mean*
SS	2.16	0.67	1.68	0.32	1.92
ENG	2.32	0.90	1.52	0.23	1.92
MATH	2.50	0.53	1.39	0.31	1.95
FIL	2.02	0.51	1.80	0.42	1.91
Overall Mean	2.25		1.60		1.93

<u>The Two Group Discriminant Function</u>

The derived discriminant functions for the non-scholars and academic scholars in Benguet State University are shown as equation 1 and equation 2, respectively.

$$Y_1 = -22.36 - 2.91SS + 7.29Eng + 9.43Math + 5.39Fil \quad (1)$$

$$Y_2 = -10.51 - 0.06SS + 3.99Eng + 3.34Math + 5.68Fil \quad (2)$$

The constant values of -22.36 and -10.51 in equation 1 and equation 2, in that order, corresponds to the y-intercept of the multiple regression model. The coefficients for X_1, X_2, X_3 and X_4 correspond to the regression coefficients in Multiple Regression. The computed values of the coefficients for Social Science, English, Mathematics and Filipino in equation 1 are as follows: -2.90, 7.29, 9.43 and 5.39, respectively.

Moreover, the computed coefficient values for Social Science, English, Mathematics and Filipino in equation 2 are as follows: -0.059, 3.99, 3.34 and 5.68, respectively.

In function 1 and 2, the academic subjects English, Math and Filipino were found to have large weights or large discriminatory power. This result suggests that English, Math and Filipino grades are the three subjects that contribute highly in differentiating non-scholars and scholars.

<u>Discriminatory Power of Academic Subjects in the Derived Discriminant Function</u>

Based on computed Wilk's Lambda (λ), a criterion used in choosing the variable contributes most to the discriminatory power of the model, Mathematics grade had the lowest value of 0.458 and Filipino grade had the highest value of 0.961. Based on the significance of the variables' discriminatory power in discriminating academic scholars and non-academic scholars, a computed Wilk's lambda approaching zero indicates high separation between the groups. These findings are supported by the Multivariate F-tests which are all significant at 1% level of significance (Table 2). From the above results, Math and English grades of the students are the best indicators for separating academic scholars and non-academic scholars.

Table 2. Discriminatory power of the different academic subjects in classifying individuals into group membership

ACADEMIC SUBJECT	*Wilk's Lambda*	*F - value*	*Significance*
Social Science 11	0.879	39.379	0.000
English 11	0.630	167.675	0.000
Mathematics 11	0.458	337.296	0.000
Filipino 11	0.961	11.713	0.001

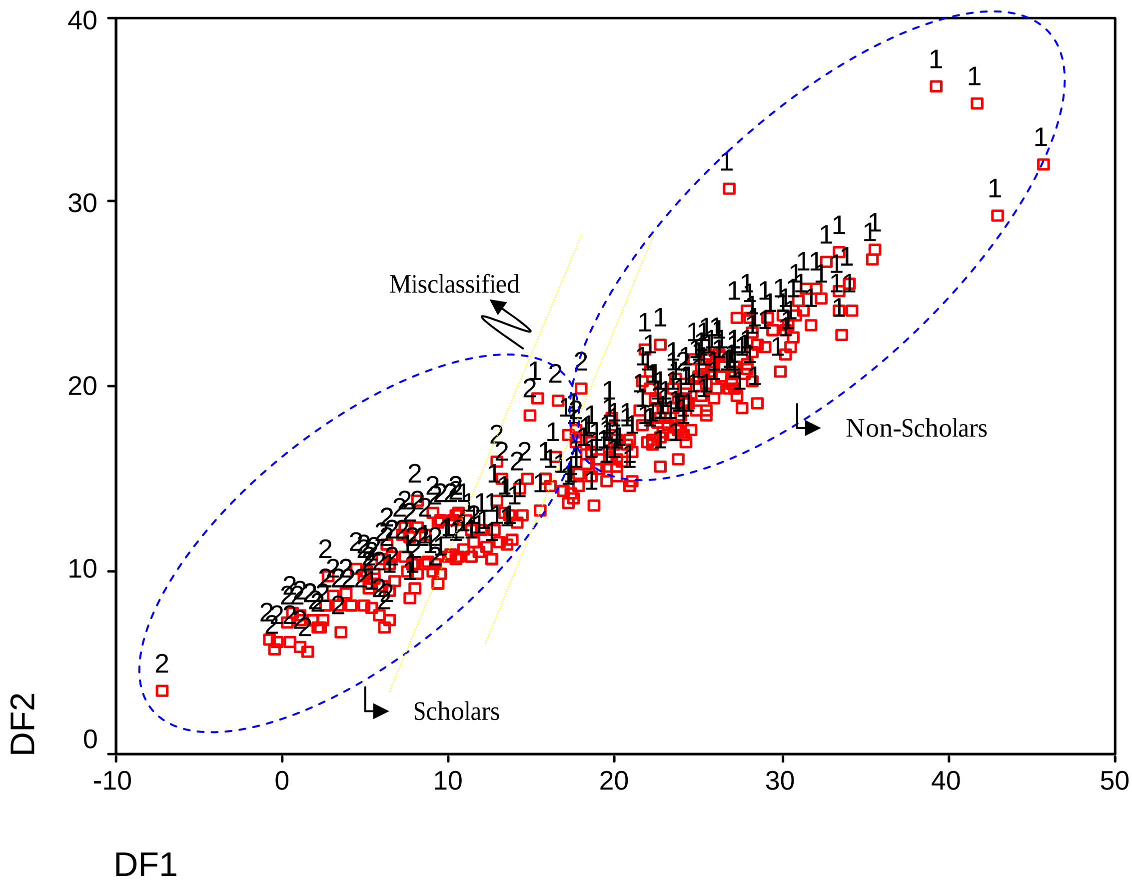

Figure 2. Scatter plot of the derived discriminant functions

Classification into Group Membership

In the analysis of discriminant functions, 287 samples (200 non-scholars and 87 academic scholars) were utilized. The number of individuals and percents classified into groups for the original samples, including the computed value of Z are presented in Table 3.

Table 3. Classification matrix for the discriminant function

FROM GROUP	NON-SCHOLARS	SCHOLARS	TOTAL
Non-Scholars	173*	27	200
Percent	86.5	13.5	100
Scholars	2	85*	87
Percent	2.3	97.7	100

* *Correctly classified cases*

Hit Rate:	89.90 %
Z:	13.46
Significance:	0.000

The table shows the result of classification computed from derived discriminant functions. Out of 287, 89.90 percent of the sample size was correctly classified and 10.10 percent of the samples were misclassified.

Among the non-scholars, 173 or 86.50 percent of the individuals were classified correctly, while 27 or 13.50 percent of the original 200 samples were incorrectly classified as non-scholars. For the group of academic scholars, 85 or

97.70 percent of the students were in the correct classification and two or 2.30 percent of the individuals originally classified as scholars were assigned to non-academic scholars.

A test on the 95 percent hit-rate ratio obtained a Z-value of -4.11 ($p<.01$) suggests that the hit-rate ratio of 90% is significantly lower than the assumed hit-rate of 95%. This result indicates that the derived function can classify the individuals into its correct classification by less than 95% at a time.

Presented in Table 4 is the list of misclassified non-academic scholars to academic scholars with corresponding probabilities of misclassification. In this study, 27 out of 200 non-academic scholars could probably be academic scholars by discriminant analysis.

Table 4. Posterior probability of membership in each group

OBSERVATION	MISCLASSIFIED		POSTERIOR PROBABILITY OF MEMBERSHIP	
	From Group	*Classified into Group*	*Non-Academic Scholar*	*Academic Scholar*
14	NS	AS	0.2402	0.7598
25	NS	AS	0.4602	0.5398
36	NS	AS	0.2558	0.7442
38	NS	AS	0.4088	0.2912
51	NS	AS	0.2722	0.7278
63	NS	AS	0.0670	0.9330
65	NS	AS	0.2402	0.7598
71	NS	AS	0.0123	0.9877
76	NS	AS	0.0143	0.9857
85	NS	AS	0.2639	0.7361
88	NS	AS	0.3791	0.6209
92	NS	AS	0.1240	0.8760
98	NS	AS	0.4189	0.5811
115	NS	AS	0.4946	0.5054
131	NS	AS	0.4395	0.5605
139	NS	AS	0.3912	0.6088
143	NS	AS	0.2499	0.7501
144	NS	AS	0.3134	0.6866
170	NS	AS	0.4114	0.5886
174	NS	AS	0.1275	0.8725
176	NS	AS	0.0670	0.0167
179	NS	AS	0.2700	0.0167
180	NS	AS	0.4166	0.0167
183	NS	AS	0.0619	0.0167
185	NS	AS	0.0724	0.0167
193	NS	AS	0.2442	0.0167
194	NS	AS	0.4088	0.0167

AS – Academic Scholars
NS – Non-Academic Scholars

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

The variables observed from the 200 non-scholars and 87 scholars were final grades in Social Science 11, English 11, Math 11 and Filipino 11. The data on the aforementioned variables were obtained from the Dean's Office of College of Arts and Sciences at Benguet State University and analyzed using the SAS Discriminant Analysis Procedure.

The results showed that Math, English and Filipino 11 grades have high discriminating powers in differentiating academic scholars and non-scholars. From the derived discriminant functions, 86.5 percent of the non-scholars and 97.7 percent of the academic scholars were correctly classified. Thus, there was 13.5 percent and 2.3 percent misclassification in the grouping of non-scholars and academic scholars respectively into its correct classification.

Out of 200 non-academic scholars, 27 could become academic scholars by discriminant analysis.

Conclusion

From the above findings, it can be concluded that Mathematics, English and Filipino are the three subjects that can be used to differentiate an academic scholars from non-academic scholars.

The derived discriminant function was able to classify individuals into its correct grouping by only 90%.

Out of the 200 non-academic scholars, 27 of them could be classified as academic scholars.

Recommendation

Based on the above results, the researchers have come up with the following recommendations:

1. Include other performance related variables to come up with a good discriminant function with 100% hit-rate.

2. The derived function may be utilized by the registrar's office in determining academic scholars.

3. Revisions of the guidelines on scholarship in the Benguet State University code is suggested.

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APPENDIX A.

DISCRIMINANT ANALYSIS OF SCHOLARS AND NON-SCHOLARS CLASSIFICATION OF TEST DATA

Discriminant Analysis   Classification Results for Test Data: WORK.TEST

Classification Results using Linear Discriminant Function

Posterior Probability of Membership in GRP:

Obs.	Classified into GRP	1	2
1	1	0.9377	0.0623
2	1	0.9696	0.0304
3	1	0.8993	0.1007
4	1	0.9943	0.0057
5	1	0.9934	0.0066
6	1	0.9997	0.0003
7	1	0.9866	0.0134
8	1	0.8647	0.1353
9	1	0.9994	0.0006
10	1	0.9875	0.0125
11	1	0.9899	0.0101
12	1	0.9987	0.0013
13	1	0.9884	0.0116
14	2	0.2402	0.7598
15	1	0.7897	0.2103
16	1	0.6121	0.3879
17	1	0.9997	0.0003
18	1	0.9973	0.0027
19	1	0.9970	0.0030
20	1	0.9977	0.0023
21	1	0.9971	0.0029
22	1	0.9853	0.0147
23	1	0.8925	0.1075
24	1	0.9962	0.0038
25	2	0.4602	0.5398
26	1	0.9973	0.0027
27	1	0.9874	0.0126
28	1	0.9931	0.0069
29	1	0.9952	0.0048
30	1	0.9940	0.0060
31	1	0.7586	0.2414
32	1	0.5999	0.4001
33	1	0.9987	0.0013
34	1	0.9871	0.0129
35	1	0.9714	0.0286
36	2	0.2558	0.7442

Classification Results using Linear Discriminant Function

Posterior Probability of Membership in GRP:

Obs.	Classified into GRP	1	2
37	1	0.9988	0.0012
38	2	0.4088	0.5912
39	1	0.9851	0.0149
40	1	0.9867	0.0133
41	1	0.9447	0.0553
42	1	0.9838	0.0162
43	1	0.9997	0.0003
44	1	0.9986	0.0014
45	1	0.9750	0.0250
46	1	0.9974	0.0026
47	1	0.9977	0.0023
48	1	0.9785	0.0215
49	1	0.9395	0.0605
50	1	0.9988	0.0012
51	2	0.2722	0.7278
52	1	0.7683	0.2317
53	1	0.8787	0.1213
54	1	0.9988	0.0012
55	1	0.7772	0.2228
56	1	0.7791	0.2209
57	1	0.9988	0.0012
58	1	0.9755	0.0245
59	1	0.6486	0.3514
60	1	0.9971	0.0029
61	1	0.9869	0.0131
62	1	0.9771	0.0229
63	2	0.0670	0.9330
64	1	0.9860	0.0140
65	2	0.2402	0.7598
66	1	0.9974	0.0026
67	1	0.9892	0.0108
68	1	0.9943	0.0057
69	1	0.9984	0.0016
70	1	0.9999	0.0001
71	2	0.0123	0.9877
72	1	0.9513	0.0487
73	1	0.9941	0.0059
74	1	0.9677	0.0323
75	1	0.6121	0.3879
76	2	0.0143	0.9857
77	1	0.9941	0.0059
78	1	0.9918	0.0082
79	1	0.9677	0.0323
80	1	0.6440	0.3560

Classification Results using Linear Discriminant Function

Obs.	Classified into GRP	Posterior Probability of Membership in GRP: 1	2
81	1	0.6440	0.3560
82	1	0.9972	0.0028
83	1	0.9962	0.0038
84	1	0.9867	0.0133
85	2	0.2639	0.7361
86	1	0.9657	0.0343
87	1	0.9997	0.0003
88	2	0.3791	0.6209
89	1	0.9989	0.0011
90	1	0.9991	0.0009
91	1	0.9999	0.0001
92	2	0.1240	0.8760
93	1	0.9974	0.0026
94	1	0.9995	0.0005
95	1	0.9649	0.0351
96	1	0.9995	0.0005
97	1	0.9967	0.0033
98	2	0.4189	0.5811
99	1	0.9886	0.0114
100	1	0.9999	0.0001
101	1	0.8741	0.1259
102	1	0.5670	0.4330
103	1	0.9489	0.0511
104	1	0.9998	0.0002
105	1	0.9992	0.0008
106	1	0.9938	0.0062
107	1	1.0000	0.0000
108	1	1.0000	0.0000
109	1	0.9974	0.0026
110	1	0.9869	0.0131
111	1	0.9937	0.0063
112	1	0.9504	0.0496
113	1	0.9991	0.0009
114	1	0.9972	0.0028
115	2	0.4946	0.5054
116	1	0.9220	0.0780
117	1	0.7754	0.2246
118	1	0.9988	0.0012
119	1	0.9997	0.0003
120	1	0.9952	0.0048
121	1	0.9873	0.0127
122	1	0.9473	0.0527
123	1	0.9776	0.0224
124	1	0.9853	0.0147

Classification Results using Linear Discriminant Function

Posterior Probability of Membership in GRP:

Obs.	Classified into GRP	1	2
125	1	1.0000	0.0000
126	1	0.9987	0.0013
127	1	0.9970	0.0030
128	1	0.9345	0.0655
129	1	0.7472	0.2528
130	1	0.9994	0.0006
131	2	0.4395	0.5605
132	1	0.9673	0.0327
133	1	0.9938	0.0062
134	1	0.9997	0.0003
135	1	0.9975	0.0025
136	1	0.9986	0.0014
137	1	0.8694	0.1306
138	1	0.9990	0.0010
139	2	0.3912	0.6088
140	1	0.9968	0.0032
141	1	0.9967	0.0033
142	1	0.9551	0.0449
143	2	0.2499	0.7501
144	2	0.3134	0.6866
145	1	0.9723	0.0277
146	1	0.9702	0.0298
147	1	0.9833	0.0167
148	1	0.9943	0.0057
149	1	0.9436	0.0564
150	1	0.9970	0.0030
151	1	0.9031	0.0969
152	1	0.9995	0.0005
153	1	0.9997	0.0003
154	1	0.9686	0.0314
155	1	0.9973	0.0027
156	1	0.8694	0.1306
157	1	0.9636	0.0364
158	1	0.9985	0.0015
159	1	0.9871	0.0129
160	1	0.9986	0.0014
161	1	0.8873	0.1127
162	1	0.9999	0.0001
163	1	0.9988	0.0012
164	1	0.9985	0.0015
165	1	0.5946	0.4054
166	1	0.9970	0.0030
167	1	0.9975	0.0025
168	1	0.9699	0.0301

Classification Results using Linear Discriminant Function

Obs.	Classified into GRP	Posterior Probability of Membership in GRP: 1	2
169	1	0.8478	0.1522
170	2	0.4114	0.5886
171	1	0.9925	0.0075
172	1	0.6046	0.3954
173	1	0.7624	0.2376
174	2	0.1275	0.8725
175	1	0.8925	0.1075
176	2	0.0670	0.9330
177	1	0.9499	0.0501
178	1	0.9988	0.0012
179	2	0.2700	0.7300
180	2	0.4166	0.5834
181	1	0.8993	0.1007
182	1	0.9736	0.0264
183	2	0.0619	0.9381
184	1	0.8694	0.1306
185	2	0.0724	0.9276
186	1	0.9988	0.0012
187	1	0.8787	0.1213
188	1	0.9986	0.0014
189	1	0.9948	0.0052
190	1	0.6676	0.3324
191	1	0.9974	0.0026
192	1	0.9941	0.0059
193	2	0.2442	0.7558
194	2	0.4088	0.5912
195	1	0.8532	0.1468
196	1	0.8895	0.1105
197	1	0.9457	0.0543
198	1	0.9997	0.0003
199	1	0.9931	0.0069
200	1	0.9968	0.0032
201	2	0.0299	0.9701
202	2	0.0035	0.9965
203	2	0.0074	0.9926
204	2	0.4292	0.5708
205	2	0.0992	0.9008
206	1	0.5512	0.4488
207	2	0.0128	0.9872
208	2	0.0034	0.9966
209	2	0.0055	0.9945
210	2	0.0328	0.9672
211	2	0.1357	0.8643
212	2	0.0139	0.9861

Classification Results using Linear Discriminant Function

Posterior Probability of Membership in GRP:

Obs.	Classified into GRP	1	2
213	2	0.0035	0.9965
214	2	0.0545	0.9455
215	2	0.0139	0.9861
216	2	0.0128	0.9872
217	2	0.0154	0.9846
218	2	0.0626	0.9374
219	2	0.0034	0.9966
220	2	0.0265	0.9735
221	2	0.0034	0.9966
222	2	0.0032	0.9968
223	2	0.3765	0.6235
224	2	0.0074	0.9926
225	2	0.2271	0.7729
226	2	0.0078	0.9922
227	2	0.0139	0.9861
228	2	0.0066	0.9934
229	2	0.0143	0.9857
230	2	0.0167	0.9833
231	2	0.0066	0.9934
232	2	0.0146	0.9854
233	2	0.0034	0.9966
234	2	0.1206	0.8794
235	2	0.0072	0.9928
236	2	0.0008	0.9992
237	2	0.0034	0.9966
238	2	0.0083	0.9917
239	2	0.0499	0.9501
240	2	0.2761	0.7239
241	2	0.0312	0.9688
242	2	0.0341	0.9659
243	2	0.0030	0.9970
244	2	0.0154	0.9846
245	2	0.0007	0.9993
246	2	0.0065	0.9935
247	2	0.0008	0.9992
248	2	0.1499	0.8501
249	2	0.0167	0.9833
250	2	0.0154	0.9846
251	2	0.0124	0.9876
252	2	0.0626	0.9374
253	2	0.0060	0.9940
254	2	0.0345	0.9655
255	2	0.0578	0.9422
256	2	0.0071	0.9929

Classification Results using Linear Discriminant Function

Obs.	Classified into GRP	Posterior Probability of Membership in GRP: 1	2
257	2	0.0312	0.9688
258	2	0.0013	0.9987
259	2	0.0076	0.9924
260	2	0.0118	0.9882
261	2	0.0129	0.9871
262	2	0.4039	0.5961
263	2	0.2458	0.7542
264	2	0.0632	0.9368
265	2	0.0059	0.9941
266	2	0.0007	0.9993
267	2	0.0299	0.9701
268	1	0.9833	0.0167
269	2	0.0017	0.9983
270	2	0.0016	0.9984
271	2	0.0535	0.9465
272	2	0.4472	0.5528
273	2	0.0234	0.9766
274	2	0.0137	0.9863
275	2	0.0070	0.9930
276	2	0.0632	0.9368
277	2	0.0026	0.9974
278	2	0.4395	0.5605
279	2	0.0014	0.9986
280	2	0.0318	0.9682
281	2	0.0029	0.9971
282	2	0.0545	0.9455
283	2	0.0055	0.9945
284	2	0.0658	0.9342
285	2	0.1228	0.8772
286	2	0.0149	0.9851
287	2	0.1395	0.8605

APPENDIX B.

DISCRIMINANT ANALYSIS OF SCHOLARS AND NON-SCHOLARS

OUTPUT CLASSIFICATION RESULTS OF TEST DATA

OBS	SS	ENG	MATH	FIL	1	2	INTO
1	2.75	2.00	2.75	2.25	0.93767	0.06233	1
2	2.75	2.25	2.75	2.50	0.96962	0.03038	1
3	2.25	2.25	2.25	1.50	0.89933	0.10067	1
4	1.50	2.50	2.25	1.75	0.99432	0.00568	1
5	2.00	2.00	2.75	2.00	0.99335	0.00665	1
6	2.00	2.50	3.00	2.25	0.99970	0.00030	1
7	1.75	2.00	2.50	1.75	0.98658	0.01342	1
8	2.50	2.00	2.50	2.50	0.86472	0.13528	1
9	2.25	3.00	2.75	2.50	0.99940	0.00060	1
10	2.50	1.75	3.00	1.50	0.98751	0.01249	1
11	2.75	2.50	2.75	1.50	0.98985	0.01015	1
12	2.50	2.50	3.00	2.25	0.99868	0.00132	1
13	2.25	3.00	2.25	2.25	0.98841	0.01159	1
14	1.00	1.50	1.50	1.50	0.24015	0.75985	2
15	1.75	2.00	2.00	1.50	0.78967	0.21033	1
16	1.25	1.75	1.75	1.50	0.61208	0.38792	1
17	1.75	2.75	2.75	2.75	0.99967	0.00033	1
18	2.25	2.50	2.75	2.00	0.99731	0.00269	1
19	2.50	2.25	3.00	2.25	0.99698	0.00302	1
20	2.00	2.25	2.75	1.25	0.99765	0.00235	1
21	2.25	3.00	2.50	2.75	0.99705	0.00295	1
22	2.50	2.25	2.75	2.50	0.98528	0.01472	1
23	2.25	2.25	2.25	1.75	0.89252	0.10748	1
24	2.00	1.75	3.00	2.50	0.99616	0.00384	1
25	3.00	1.75	2.50	1.50	0.46017	0.53983	2
26	2.50	2.75	2.75	2.25	0.99734	0.00266	1
27	2.00	2.75	2.25	2.25	0.98740	0.01260	1
28	1.50	2.00	2.50	2.00	0.99307	0.00693	1
29	2.75	2.75	2.75	1.75	0.99519	0.00481	1
30	2.75	2.75	2.75	2.50	0.99402	0.00598	1
31	3.00	1.75	2.75	2.25	0.75856	0.24144	1
32	1.75	2.25	1.75	2.25	0.59988	0.40012	1
33	2.00	3.00	2.50	2.50	0.99869	0.00131	1
34	2.25	2.00	2.75	1.75	0.98712	0.01288	1
35	2.50	2.00	2.75	2.00	0.97139	0.02861	1
36	1.25	1.75	1.50	1.50	0.25583	0.74417	2
37	1.75	2.75	2.50	2.00	0.99877	0.00123	1
38	1.25	1.50	1.75	1.50	0.40877	0.59123	2
39	2.25	2.00	2.75	2.25	0.98512	0.01488	1
40	2.00	2.25	2.50	2.00	0.98672	0.01328	1
41	2.75	2.50	2.50	2.25	0.94466	0.05534	1
42	2.00	1.75	2.75	2.25	0.98384	0.01616	1
43	2.50	3.00	3.00	2.50	0.99973	0.00027	1
44	2.25	2.25	3.00	2.25	0.99856	0.00144	1
45	2.75	2.75	2.50	2.25	0.97497	0.02503	1
46	1.75	2.50	2.50	1.75	0.99739	0.00261	1

OUTPUT CLASSIFICATION RESULTS OF TEST DATA

OBS	SS	ENG	MATH	FIL	1	2	INTO
47	2.75	3.00	2.75	2.00	0.99773	0.00227	1
48	3.00	3.00	2.50	2.00	0.97854	0.02146	1
49	2.25	2.00	2.50	2.00	0.93948	0.06052	1
50	2.25	2.75	2.75	2.00	0.99882	0.00118	1
51	1.50	2.00	1.50	1.50	0.27217	0.72783	2
52	2.25	2.50	2.00	2.50	0.76830	0.23170	1
53	1.25	1.75	2.00	1.50	0.87867	0.12133	1
54	1.75	2.75	2.50	2.00	0.99877	0.00123	1
55	2.50	1.75	2.50	1.75	0.77717	0.22283	1
56	2.75	2.00	2.50	2.00	0.77907	0.22093	1
57	2.00	2.50	2.75	1.75	0.99881	0.00119	1
58	2.00	2.50	2.25	1.75	0.97547	0.02453	1
59	2.25	1.75	2.25	1.25	0.64855	0.35145	1
60	2.00	1.75	3.00	1.50	0.99713	0.00287	1
61	3.00	2.25	3.00	2.25	0.98686	0.01314	1
62	2.75	2.25	2.75	1.50	0.97714	0.02286	1
63	1.50	1.50	1.50	1.50	0.06699	0.93301	2
64	1.75	3.00	2.00	2.75	0.98605	0.01395	1
65	1.00	1.50	1.50	1.50	0.24015	0.75985	2
66	2.75	3.00	2.75	2.50	0.99737	0.00263	1
67	3.00	2.75	2.75	2.00	0.98921	0.01079	1
68	1.50	2.50	2.25	1.75	0.99432	0.00568	1
69	1.50	2.00	2.75	2.25	0.99837	0.00163	1
70	1.75	3.00	2.75	1.50	0.99990	0.00010	1
71	2.50	2.00	1.50	3.00	0.01229	0.98771	2
72	1.75	2.50	2.00	1.50	0.95135	0.04865	1
73	2.00	2.50	2.50	2.00	0.99414	0.00586	1
74	1.75	1.75	2.50	2.00	0.96768	0.03232	1
75	1.25	1.75	1.75	1.50	0.61208	0.38792	1
76	2.25	2.00	1.50	5.00	0.01434	0.98566	2
77	2.50	2.00	3.00	1.75	0.99407	0.00593	1
78	1.00	1.50	2.50	2.00	0.99181	0.00819	1
79	1.00	2.00	2.00	2.00	0.96770	0.03230	1
80	2.25	2.25	2.00	1.75	0.64404	0.35596	1
81	2.25	2.25	2.00	1.75	0.64404	0.35596	1
82	2.25	2.00	3.00	1.75	0.99717	0.00283	1
83	2.00	1.75	3.00	2.50	0.99616	0.00384	1
84	2.00	2.25	2.50	2.00	0.98672	0.01328	1
85	1.75	1.75	1.75	1.50	0.26387	0.73613	2
86	2.00	2.00	2.50	2.50	0.96568	0.03432	1
87	2.50	3.00	3.00	2.75	0.99971	0.00029	1
88	1.75	2.00	1.75	2.50	0.37912	0.62088	2
89	3.00	3.00	3.00	2.25	0.99888	0.00112	1
90	3.00	3.00	3.00	1.50	0.99910	0.00090	1
91	2.25	3.00	3.00	2.25	0.99988	0.00012	1
92	1.50	1.75	1.50	2.00	0.12401	0.87599	2
93	3.00	2.75	3.00	2.25	0.99745	0.00255	1
94	2.00	2.75	2.75	1.75	0.99948	0.00052	1
95	1.50	1.50	2.50	2.00	0.96494	0.03506	1
96	2.50	2.75	3.00	1.75	0.99950	0.00050	1
97	2.00	1.75	3.00	2.00	0.99668	0.00332	1

OUTPUT CLASSIFICATION RESULTS OF TEST DATA

OBS	SS	ENG	MATH	FIL	1	2	INTO
98	1.75	1.50	2.00	1.50	0.41890	0.58110	2
99	3.00	2.25	3.00	1.75	0.98863	0.01137	1
100	2.00	3.00	3.00	2.25	0.99994	0.00006	1
101	1.50	1.50	2.25	1.50	0.87408	0.12592	1
102	2.00	2.50	1.75	3.00	0.56703	0.43297	1
103	3.00	2.75	2.50	2.25	0.94890	0.05110	1
104	2.25	2.75	3.00	1.50	0.99978	0.00022	1
105	1.00	1.75	2.75	2.00	0.99921	0.00079	1
106	1.00	2.00	2.25	1.50	0.99376	0.00624	1
107	5.00	3.00	5.00	2.00	1.00000	0.00000	1
108	5.00	3.00	5.00	2.50	1.00000	0.00000	1
109	1.75	2.50	2.50	1.75	0.99739	0.00261	1
110	2.25	2.50	2.50	2.25	0.98687	0.01313	1
111	2.75	2.25	3.00	2.25	0.99369	0.00631	1
112	2.50	2.75	2.25	2.00	0.95040	0.04960	1
113	3.00	3.00	3.00	1.50	0.99910	0.00090	1
114	2.25	2.00	3.00	1.75	0.99717	0.00283	1
115	2.50	2.75	1.75	1.75	0.49459	0.50541	2
116	2.25	1.50	2.75	2.50	0.92198	0.07802	1
117	1.50	1.75	2.00	1.50	0.77536	0.22464	1
118	2.75	2.75	3.00	2.25	0.99878	0.00122	1
119	2.00	3.00	2.75	2.25	0.99973	0.00027	1
120	2.75	2.75	2.75	1.75	0.99519	0.00481	1
121	2.50	2.25	2.75	2.00	0.98726	0.01274	1
122	2.25	2.00	2.50	1.50	0.94727	0.05273	1
123	2.50	3.00	2.25	2.00	0.97764	0.02236	1
124	2.50	2.25	2.75	2.50	0.98528	0.01472	1
125	1.75	3.00	3.00	2.00	0.99997	0.00003	1
126	2.00	2.50	2.75	2.00	0.99872	0.00128	1
127	2.50	2.25	3.00	2.25	0.99698	0.00302	1
128	2.00	1.75	2.50	2.00	0.93451	0.06549	1
129	1.75	2.50	1.75	2.75	0.74722	0.25278	1
130	1.50	2.25	2.75	1.50	0.99942	0.00058	1
131	2.00	1.75	2.00	1.50	0.43950	0.56050	2
132	1.50	1.50	2.50	1.75	0.96733	0.03267	1
133	2.25	2.75	2.50	2.50	0.99377	0.00623	1
134	2.25	2.75	3.00	2.00	0.99974	0.00026	1
135	2.50	2.75	2.75	2.00	0.99753	0.00247	1
136	2.25	2.25	3.00	2.25	0.99856	0.00144	1
137	1.00	1.50	2.00	1.50	0.86941	0.13059	1
138	2.00	2.50	2.75	1.25	0.99897	0.00103	1
139	1.25	1.50	1.75	1.75	0.39122	0.60878	2
140	2.25	3.00	2.50	3.00	0.99683	0.00317	1
141	5.00	5.00	2.75	3.00	0.99674	0.00326	1
142	2.75	2.50	2.50	1.50	0.95507	0.04493	1
143	1.75	1.75	1.75	1.75	0.24991	0.75009	2
144	5.00	2.50	3.00	2.25	0.31343	0.68657	2
145	2.00	2.00	2.50	1.75	0.97225	0.02775	1
146	2.00	2.00	2.50	2.00	0.97021	0.02979	1
147	2.50	1.75	3.00	2.50	0.98333	0.01667	1
148	2.25	2.25	2.75	1.75	0.99432	0.00568	1

OUTPUT CLASSIFICATION RESULTS OF TEST DATA

OBS	SS	ENG	MATH	FIL	1	2	INTO
149	2.25	2.75	2.25	5.00	0.94357	0.05643	1
150	2.25	2.00	3.00	2.00	0.99695	0.00305	1
151	2.75	2.25	2.50	1.50	0.90305	0.09695	1
152	2.75	3.00	3.00	2.00	0.99950	0.00050	1
153	2.50	3.00	3.00	2.50	0.99973	0.00027	1
154	1.25	1.75	2.25	1.75	0.96865	0.03135	1
155	2.25	3.00	2.50	2.50	0.99726	0.00274	1
156	1.00	1.50	2.00	1.50	0.86941	0.13059	1
157	2.25	2.25	2.50	3.00	0.96356	0.03644	1
158	2.00	2.00	3.00	2.00	0.99854	0.00146	1
159	1.50	2.25	2.25	1.75	0.98713	0.01287	1
160	2.00	2.00	3.00	1.75	0.99865	0.00135	1
161	2.25	1.75	2.50	1.50	0.88729	0.11271	1
162	1.75	2.50	3.00	2.00	0.99987	0.00013	1
163	2.50	2.50	3.00	2.00	0.99877	0.00123	1
164	1.75	2.25	2.75	2.25	0.99850	0.00150	1
165	1.25	1.75	1.75	1.75	0.59458	0.40542	1
166	2.50	2.25	3.00	2.25	0.99698	0.00302	1
167	2.50	2.75	2.75	2.00	0.99753	0.00247	1
168	3.00	2.50	2.75	2.75	0.96994	0.03006	1
169	2.25	1.25	2.75	2.25	0.84782	0.15218	1
170	1.50	1.75	1.75	1.75	0.41143	0.58857	2
171	2.25	1.75	3.00	2.25	0.99255	0.00745	1
172	1.75	1.75	2.00	1.75	0.60461	0.39539	1
173	1.50	1.75	2.00	1.75	0.76237	0.23763	1
174	1.00	1.75	1.25	1.75	0.12746	0.87254	2
175	2.25	2.25	2.25	1.75	0.89252	0.10748	1
176	1.50	1.50	1.50	1.50	0.06699	0.93301	2
177	2.25	2.50	2.25	1.75	0.94988	0.05012	1
178	2.50	3.00	2.75	2.25	0.99883	0.00117	1
179	1.25	1.75	1.50	1.25	0.27000	0.73000	2
180	2.75	2.00	2.25	2.25	0.41662	0.58338	2
181	2.25	2.25	2.25	1.50	0.89933	0.10067	1
182	2.75	2.25	2.75	2.00	0.97364	0.02636	1
183	1.25	1.25	1.50	1.50	0.06192	0.93808	2
184	1.00	1.50	2.00	1.50	0.86941	0.13059	1
185	1.75	1.75	1.50	1.50	0.07244	0.92756	2
186	1.50	2.50	2.50	1.75	0.99876	0.00124	1
187	1.25	1.75	2.00	1.50	0.87867	0.12133	1
188	2.00	3.00	2.50	2.75	0.99859	0.00141	1
189	2.50	2.50	2.75	1.75	0.99477	0.00523	1
190	1.75	2.25	1.75	1.25	0.66761	0.33239	1
191	3.00	2.75	3.00	2.25	0.99745	0.00255	1
192	2.00	2.50	2.50	2.00	0.99414	0.00586	1
193	1.50	2.00	1.50	2.00	0.24419	0.75581	2
194	1.25	1.50	1.75	1.50	0.40877	0.59123	2
195	2.00	1.50	2.50	2.25	0.85320	0.14680	1
196	2.00	2.50	2.00	2.00	0.88953	0.11047	1
197	2.75	2.00	2.75	1.75	0.94569	0.05431	1
198	2.25	2.75	3.00	3.00	0.99966	0.00034	1
199	2.50	2.00	3.00	2.25	0.99314	0.00686	1

OUTPUT CLASSIFICATION RESULTS OF TEST DATA

OBS	SS	ENG	MATH	FIL	1	2	INTO
200	3.00	2.75	3.00	3.00	0.99683	0.00317	1
201	1.50	1.75	1.25	2.00	0.02992	0.97008	2
202	2.00	1.50	1.25	1.50	0.00354	0.99646	2
203	1.75	1.50	1.25	1.50	0.00740	0.99260	2
204	1.50	1.75	1.75	1.50	0.42924	0.57076	2
205	2.75	1.50	2.25	3.00	0.09919	0.90081	2
206	1.75	1.75	2.00	2.50	0.55117	0.44883	1
207	1.75	1.25	1.50	2.00	0.01279	0.98721	2
208	1.50	1.50	1.00	1.50	0.00340	0.99660	2
209	1.50	1.25	1.25	2.25	0.00547	0.99453	2
210	2.75	2.00	1.75	2.25	0.03279	0.96721	2
211	1.75	1.50	1.75	1.50	0.13574	0.86426	2
212	2.00	1.50	1.50	2.00	0.01390	0.98610	2
213	2.00	1.50	1.25	1.50	0.00354	0.99646	2
214	1.50	1.50	1.50	2.25	0.05452	0.94548	2
215	2.00	1.50	1.50	2.00	0.01390	0.98610	2
216	1.75	1.25	1.50	2.00	0.01279	0.98721	2
217	1.50	1.50	1.25	1.50	0.01540	0.98460	2
218	1.50	1.50	1.50	1.75	0.06256	0.93744	2
219	1.50	1.50	1.00	1.50	0.00340	0.99660	2
220	1.50	1.25	1.50	2.00	0.02646	0.97354	2
221	1.50	1.50	1.00	1.50	0.00340	0.99660	2
222	1.50	1.50	1.00	1.75	0.00316	0.99684	2
223	1.50	1.75	1.75	2.25	0.37654	0.62346	2
224	1.75	1.50	1.25	1.50	0.00740	0.99260	2
225	1.00	1.50	1.50	1.75	0.22707	0.77293	2
226	1.75	2.00	1.00	1.75	0.00780	0.99220	2
227	2.00	1.50	1.50	2.00	0.01390	0.98610	2
228	1.25	1.50	1.00	1.75	0.00660	0.99340	2
229	1.50	1.50	1.25	1.75	0.01433	0.98567	2
230	1.75	1.75	1.25	1.50	0.01673	0.98327	2
231	1.25	1.50	1.00	1.75	0.00660	0.99340	2
232	1.50	1.00	1.50	1.25	0.01461	0.98539	2
233	1.50	1.50	1.00	1.50	0.00340	0.99660	2
234	2.00	1.75	1.75	2.25	0.12065	0.87935	2
235	1.50	1.75	1.00	1.75	0.00718	0.99282	2
236	2.25	1.75	1.00	1.75	0.00078	0.99922	2
237	1.50	1.50	1.00	1.50	0.00340	0.99660	2
238	1.50	1.75	1.00	1.25	0.00830	0.99170	2
239	2.25	1.75	1.75	3.00	0.04990	0.95010	2
240	1.50	1.50	1.75	1.00	0.27610	0.72390	2
241	2.00	1.75	1.50	2.00	0.03116	0.96884	2
242	1.25	1.50	1.25	1.25	0.03411	0.96589	2
243	1.50	1.00	1.25	1.50	0.00299	0.99701	2
244	1.50	1.50	1.25	1.50	0.01540	0.98460	2
245	1.75	1.25	1.00	1.75	0.00066	0.99934	2
246	1.75	1.00	1.50	1.50	0.00653	0.99347	2
247	2.00	1.50	1.00	1.50	0.00077	0.99923	2
248	1.50	1.75	1.50	1.25	0.14987	0.85013	2
249	1.75	1.75	1.25	1.50	0.01673	0.98327	2
250	1.50	1.50	1.25	1.50	0.01540	0.98460	2

OUTPUT CLASSIFICATION RESULTS OF TEST DATA

OBS	SS	ENG	MATH	FIL	1	2	INTO
251	1.50	1.50	1.25	2.25	0.01241	0.98759	2
252	1.50	1.50	1.50	1.75	0.06256	0.93744	2
253	1.75	1.50	1.25	2.25	0.00595	0.99405	2
254	1.50	1.75	1.25	1.50	0.03447	0.96553	2
255	1.25	1.25	1.50	1.75	0.05781	0.94219	2
256	1.25	1.50	1.00	1.50	0.00710	0.99290	2
257	2.00	1.75	1.50	2.00	0.03116	0.96884	2
258	1.75	1.00	1.25	1.75	0.00133	0.99867	2
259	1.25	1.50	1.00	1.25	0.00764	0.99236	2
260	1.50	1.00	1.50	2.00	0.01177	0.98823	2
261	2.00	1.50	1.50	2.25	0.01293	0.98707	2
262	2.00	1.75	2.00	2.00	0.40386	0.59614	2
263	1.25	1.25	1.75	1.25	0.24581	0.75419	2
264	1.75	1.75	1.50	2.00	0.06321	0.93679	2
265	1.50	1.25	1.25	2.00	0.00589	0.99411	2
266	1.75	1.25	1.00	1.50	0.00071	0.99929	2
267	2.25	1.50	1.75	2.00	0.02991	0.97009	2
268	1.75	2.00	2.50	2.50	0.98334	0.01666	1
269	2.00	1.25	1.25	1.25	0.00167	0.99833	2
270	1.75	1.50	1.00	1.50	0.00162	0.99838	2
271	2.25	1.75	1.75	2.75	0.05348	0.94652	2
272	1.50	1.75	1.75	1.25	0.44723	0.55277	2
273	2.00	1.75	1.50	3.00	0.02344	0.97656	2
274	1.75	1.25	1.50	1.75	0.01375	0.98625	2
275	2.00	1.75	1.25	2.00	0.00696	0.99304	2
276	1.75	1.75	1.50	2.00	0.06321	0.93679	2
277	2.00	1.50	1.25	2.50	0.00265	0.99735	2
278	2.00	1.75	2.00	1.50	0.43950	0.56050	2
279	1.75	1.00	1.25	1.50	0.00143	0.99857	2
280	1.25	1.50	1.25	1.50	0.03178	0.96822	2
281	1.50	1.50	1.00	2.00	0.00294	0.99706	2
282	1.50	1.50	1.50	2.25	0.05452	0.94548	2
283	1.50	1.25	1.25	2.25	0.00547	0.99453	2
284	1.50	2.00	1.25	2.00	0.06577	0.93423	2
285	1.25	1.50	1.50	1.75	0.12282	0.87718	2
286	2.00	1.50	1.50	1.75	0.01493	0.98507	2
287	1.25	1.50	1.50	1.25	0.13946	0.86054	2

APPENDIX C.

Discriminant Analysis of Scholars and Non-Scholars
Classification of Test Data

Discriminant Analysis

287	Observations	286	DF Total
4	Variables	285	DF Within Classes
2	Classes	1	DF Between Classes

Class Level Information

GRP	Output SAS Name	Frequency	Weight	Proportion	Prior Probability
1	_1	200	200.0000	0.696864	0.500000
2	_2	87	87.0000	0.303136	0.500000

Discriminant Analysis   Pooled Covariance Matrix Information

Covariance Matrix Rank	Natural Log of the Determinant of the Covariance Matrix
4	-6.6095354

Discriminant Analysis   Pairwise Generalized Squared Distances Between Groups

$$D^2(i|j) = (\bar{X}_i - \bar{X}_j)' \, COV^{-1} \, (\bar{X}_i - \bar{X}_j)$$

Generalized Squared Distance to GRP

From GRP	1	2
1	0	7.80453
2	7.80453	0

Discriminant Analysis   Linear Discriminant Function

$$\text{Constant} = -.5 \, \bar{X}_j' \, COV^{-1} \, \bar{X}_j \qquad \text{Coefficient Vector} = COV^{-1} \, \bar{X}_j$$

	GRP 1	2
CONSTANT	-22.35626	-10.51363
SS	-2.90547	0.05859
ENG	7.28604	3.98555
MATH	9.43072	3.33555
FIL	5.38761	5.68003

Discriminant Analysis Classification Summary for Calibration Data: WORK.GRADE

Resubstitution Summary using Linear Discriminant Function

Generalized Squared Distance Function:

$$D_j^2(X) = (X-\bar{X}_j)' \, COV^{-1} (X-\bar{X}_j)$$

Posterior Probability of Membership in each GRP:

$$Pr(j|X) = \exp(-.5\, D_j^2(X)) \,/\, SUM_k \exp(-.5\, D_k^2(X))$$

Number of Observations and Percent Classified into GRP:

From GRP	1	2	Total
1	173 86.50	27 13.50	200 100.00
2	2 2.30	85 97.70	87 100.00
Total Percent	175 60.98	112 39.02	287 100.00
Priors	0.5000	0.5000	

Error Count Estimates for GRP:

	1	2	Total
Rate	0.1350	0.0230	0.0790
Priors	0.5000	0.5000	

APPENDIX D.

TWO-GROUP DISCRIMINANT ANALYSIS

Group Statistics

GROUP		Mean	Std. Deviation	Valid N (listwise) Unweighted	Valid N (listwise) Weighted
1.00	SS	2.1550	.6671	200	200.000
	ENG	2.2700	.5175	200	200.000
	MATH	2.4987	.5272	200	200.000
	FIL	2.0175	.5096	200	200.000
2.00	SS	1.6839	.3200	87	87.000
	ENG	1.5201	.2326	87	87.000
	MATH	1.3851	.3093	87	87.000
	FIL	1.8046	.4201	87	87.000
Total	SS	2.0122	.6225	287	287.000
	ENG	2.0427	.5673	287	287.000
	MATH	2.1611	.6965	287	287.000
	FIL	1.9530	.4934	287	287.000

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Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
SS	.879	39.379	1	285	.000
ENG	.630	167.675	1	285	.000
MATH	.458	337.296	1	285	.000
FIL	.961	11.713	1	285	.001

Analysis 1

Box's Test of Equality of Covariance Matrices

Log Determinants

GROUP	Rank	Log Determinant
1.00	4	-5.862
2.00	4	-9.877
Pooled within-groups	4	-6.610

The ranks and natural logarithms of determinants printed are those of the group covariance matrices.

Test Results

Box's M		132.136
F	Approx.	12.964
	df1	10
	df2	134083.8
	Sig.	.000

Tests null hypothesis of equal population covariance matrices

Summary of Canonical Discriminant Functions

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.660[a]	100.0	100.0	.790

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.376	276.891	4	.000

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Standardized Canonical Discriminant Function Coefficients

	Function
	1
SS	-.620
ENG	.533
MATH	1.030
FIL	-.051

Structure Matrix

	Function
	1
MATH	.844
ENG	.595
SS	.288
FIL	.157

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions
Variables ordered by absolute size of correlation within function.

Functions at Group Centroids

	Function
GROUP	1
1.00	.847
2.00	-1.947

Unstandardized canonical discriminant functions evaluated at group means

Classification Statistics

Classification Processing Summary

Processed		287
Excluded	Missing or out-of-range group codes	0
	At least one missing discriminating variable	0
Used in Output		287

Prior Probabilities for Groups

GROUP	Prior	Cases Used in Analysis	
		Unweighted	Weighted
1.00	.500	200	200.000
2.00	.500	87	87.000
Total	1.000	287	287.000

Classification Function Coefficients

	GROUP	
	1.00	2.00
SS	-2.905	5.859E-02
ENG	7.286	3.986
MATH	9.431	3.336
FIL	5.388	5.680
(Constant)	-23.049	-11.207

Fisher's linear discriminant functions

APPENDIX E.

COMPUTATIONS

Z- test:

$$Z = \frac{(258-273)\sqrt{287}}{\sqrt{273\,(287-273)}}$$

$$= \frac{254.1}{61.82}$$

$$= -4.11$$