BIBLIOGRAPHY

EDWARD ANTIPUESTO, EFRAIM DICKSON DULAWEN and BOBBY F. ROARING. March 2009. Multivariate Linear Regression Model for Academic Performance of the Freshmen Achiever at Benguet State University. Benguet State University, La Trinidad , Benguet.

Adviser: DR. SALVACION Z. BELIGAN

ABSTRACT

The study was conducted to determine predictors of academic performance among freshmen achievers using multivariate linear regression. The specific objectives of the study were to1) Describe the relationships existing between the different factors and the academic performance; 2) Find a suitable regression model that would predict the best factor affecting academic performance among freshmen achievers; 3) Identify the factors that may predict the student's academic performance. High school average, gender, course, age, and type of high they have attended were investigated as a possible predictor of academic performance. Multivariate linear regression analysis was used to perform to build a predictive model that could determine whether the following variables could predict the academic performance of the freshman academic achievers.

The test for the significance of the regression coefficients, the F-test did not support the rejection of the hypothesis that the different predictor variables have no significant effect on the student's performance in Math 11. In addition, none of the

regressors are contributory to the performance of the students in English and Soc Sci grade.

Generally, fitting univariate regression model on the three dependent variables, the test of significance for the beta coefficient was found not significant.

Fitting the multivariate regression model, the result showed significant result.

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INTRODUCTION

Background of the study

The very heart of a learner's education Mission is to have stable and progressing academic achievements. The indicators of the learner's academic achievements are the marks and grades written on a learner's official academic records.

Educators have long been looking for a predictor of academic performance for students as they enter college because low academic performance of students means waste not only personal and societal time, as well as resources of the educational institution. Students who can be identified as "at risk" for failure early in their academic careers can be targeted for interventions that will increase the likelihood of success. Because student academic performance are vital to students' college life, understanding factors that diminish students' satisfaction and perseverance is necessary if these problems are to be addressed and overcome.

It is therefore important that school administrators should study the factors contributory to the academic performance of every students.

A number of factors affecting academic performance have been studied by several authors.

One of the studies reviewed is on the relationship between high school grade point average (GPA) and college performance (Benford, 2006).

Results show that high school performance of students graduated from either private of public high school had a significant effect on their college performance on the same subject.

Using multivariate regression analysis, Beligan (2004) found that students' performance in Math - based subjects was affected by Age, Gender and the type of high school they had attended.

Foreign studies also showed that the academic performance of a student is multidetermined by number of contributing influences, and factors including academic factors, personality variables, family characteristics, and environmental factors (Benguiristain, 2003).

Student's academic performance is, however, affected by multiple factors and should not also be confined to one. To reach a valid generalization on students' academic performance, we need to consider different factors. This study, therefore, is expected to fill the gaps.

Statement of the problem

This study aimed to evaluate the factors of academic performance among BSU freshmen academic achievers.

Specifically the study sought to answer the following questions:

1. What are the relationships existing between the different factors and to the academic performance?

2. What is the suitable regression model that would predict the best factor affecting academic performance among freshmen achievers?

3. What are the factors that may predict the student's academic performance?

Objectives of the study

The purpose of this study is to determine the predictors of academic performance among freshmen achievers using multivariate linear regression. The specific objectives of the study were to:

1. Describe the relationships existing between the different factors and to the academic performance.

2. Find a suitable regression model that would predict the best factor affecting academic performance among freshmen achievers.

3. Identify the factors that may predict the student's academic performance.

Significance of the study

This study would shed the light to further strengthen the existing foundation by determining the predictors of academic performance among the freshmen achievers.

For the students, this study would help them to acquire strong determination in carrying their studies and become aware of their responsibilities and for them to be academically productive.

The study would also help school administrators as well as the parents and guardians in formulating and knowing the best predictors of academic success.

In addition, work in this area has the potential to provide important suggestions to improve standards and quality of education and also the performance of the students.

To assist faculty in helping students achieve academic success, variables should be identified to help predict whether or not students might have difficulties in achieving academic success, and therefore whether or not those students will have difficulties in completing a degree.

The results of this study would help identify students possibly risk for failure so that interventional measures can be developed and implemented to promote educational productivity and reduce attrition.

Scope and Delimitation

Several limitations to this study existed. A population consisted of freshmen academic achievers enrolled at Benguet State University during school year 2008-2009. They were chosen because they have a minor subject which was used as their output variable. In addition, independent variables were also limited.

REVIEW OF RELATED LITERATURE

What makes a successful person? Vince Lombardi observed, “The difference between a successful person and others is not a lack of strength, not a lack of knowledge, but rather in a lack of will” (The Official Site of Vince Lambordi, n.d.). He recognized, as do so many of us, that motivation may be the most important factor in determining success. In the field of research, however, motivation and biographical factors conceptually related to success can not be directly measured and are difficult to manipulate as variables. Therefore, a limited number of studies have successfully linked such factors to success in specific areas. In educational environment, a student motivation, success orientation, and network of support can surpass the importance of writing and reading skills.

Analyzing multivariate context data using a series of univariate methods compromises the very essence and richness of a multifaceted phenomenon, such as education production.

The measurements often involves the use of linear regression, correlation, or multivariate-discriminant analysis to indicate the nature of the relationship (Goldhaber & Brewer, 1997a; Monk, 1992; Montmarquette & Majseredjian, 1989; Montimore, Simmons, Stoll, Lewis, & Ecob, 1988; Murnane, 1975;Smith & Tomlinson 1989; Walberg, 1982; Walberg & Fowler, 1989; Walberg & Weintien, 1982; Wenglinsky, 1997). Approximately 400 studies have been reported including those that have been evaluated and summarized using meta-analysis (Greenwald, et al., 1996; Hanushek, 1997; Hedges, Laine & Greenwald , 1994).

Most of these academic performance studies examined the relationship between two or more variables and one educational output measure (usually student achievement) using univariate analysis (Hanushek, 1997).

In education, there is often more than one output measure for a given set of inputs. Academic performance studies must examine the relationship between sets of variables and sets of outputs measures as multivariate composites (Pedhazur, 1997).

Heinbuch and Samuels (1995) and Tatsuoka (1988) have noted that very little concerted effort has been made to establish the nature of the relationship between multiple educational inputs and multiple measures of student achievement using multivariate methods. Pedhazur also noted that simply calculating zero-order correlations for all possible pairs of variables using univariate tests on data with multivariate constructs " . . . affects the prescribed α level" (p.895) thus increasing the chance for a Type 1 error. Moreover, analyzing multivariate context data using a series of univariate methods compromises the very essence and richness of a multifaceted phenomenon, such as education production.

In a multivariate context, education production examines the relationship between a set of two or more educational input variables and a set of two or more educational output variables (Pedhazur 1997; Tatsuoka, 1973; Tatsuoka, 1988).

However, colleges and universities do not currently acknowledge such factors in their selection process, which is intended to choose student most likely to succeed at their school. Most colleges and universities limit their admission decisions to the traditional cognitive predictors of academic performance, usually high school general weighted average (GWA), scores in standardized tests such as the SAT, and high school rank (Aiken, 1964).

Another study conducted by Reiter (1964) tried to determine if there was a relationship between non-academic factors and academic performance of college freshmen and sophomore students. Participants were 76 randomly selected male and female college students from an introductory psychology course. His study shows that high school achievements were a superior predictor of academic success (Reiter, 1964). Also, Reiter (1964) stated that non-intellectual factors, such as anxiety, academic discipline, and SAT composite scores, were not proven to be true predictors of academic success.

A number of studies are shown that several variables other than academic characteristics are associated with success in college. Larose, Robertson, Roy, and Legault (1998) argue that the frequency and quality of the interactions between students and their faculty are related to higher levels of college success. Other variables related to college success are the ability to adapt to the college environment, personal motivation, and students' relationship with their peers (Larose et al., 1998). In addition to these findings, Aiken (1964) suggests that students who withdraw from classes are less motivated to achieve than students who do not withdraw.

A study conducted buy Naumann, Bendalos, and Gutkin (2003) at Midwestern University implies that first-generation college students rely more heavily on motivational factors in order to succeed than do second-generation students. These results were not surprising given "first-generation students did not typically have the same source of support throughout careers as did second-generation students" (Naumann, Bendalos, and Gutkin, 2003, p.8).

Gregorc (1979) described a person's learning style as consisting of distinct behaviors which serve as stable indicators of how a person learns and adapts to his/her learning environment. The most extensively researched and applied learning style construct has been the field-dependence/independence dimension (Guild and Garger, 1985).

THEORETICAL FRAMEWORK

Multivariate Linear Regression

Multivariate linear models are, in one sense, like repeated measures models – in both cases, it may be helpful to think of the analysis as involving multiple dependent measures. In repeated measures analysis, the multiple dependent variables are the same measure, repeated (usually over time). In multivariate models, the multiple dependent variables are measures of multiple outcomes, usually measured with different metrics, and usually measured at the same point in time.

The coefficient of the linear regression model is estimated under the assumption that the random term assumes normal distribution with zero mean and constant variance. The values of the random term are also assumed to be independent.

The general multivariate model may be expressed as:

$$a_1Y_1 + a_2Y_2 + a_3Y_3 + \ldots\ldots + a_kY_k = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots\ldots\ldots b_mX_m$$

Where $a_1, a_2, a_{3,\ldots,}$ a_k are the coefficients associated with $Y_1, Y_2, Y_3, \ldots, Y_k$ the linear composite of educational output measures : b_0 is the intercept of the composite regression line on line linear composite f output measures, and

$b_1,b_2,b_3,\ldots,b_m$ are the regression coefficients associated with $X_1,X_2,X_3,\ldots,X_m$ the linear composite of educational input variables.

This study used multivariate methods to examine the relationships between a set of three educational input variables and two educational output measures. Based on the multivariate model explained above, the overall production function model for this study is:

$$a_1Y_1 + a_2Y_2 + a_3Y_3= b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots\ldots b_5X_5$$

Where $X_{1,}$ $X_{2,}$ $X_{3,}$ $X_{4,}$ $X_{4,}$ $X_{5,}$ are thirteen educational input variables; Y_1,Y_2,Y_3 are the four output measures a_1,a_2,a_3 are the coefficients or weights of the linear composite of outputs in the regression model ; b_1, b_2, $b_3,\ldots,b_5$ are the coefficients or weights of the linear composite of inputs in the regression model.

Let us assume that there are p response variates $Y'=Y_1, Y_2,\ldots Y_p$ and that these variables and linearly related with r-fixed variates $X_1, X_2,\ldots,X_r$. The theoretical model for response variables is

$$E(Y_k/X)= \beta_{ok} + \beta_{1k}X_1+\ldots+\beta_{rk}X_r.$$

In matrix notation, the above model can be expressed as

$$Y_j'= X_j'\beta+ e_j', \qquad j=1,2,\ldots,N$$

$$Y=X\beta + \epsilon$$

Where

$$Y = \begin{pmatrix} Y_{11} & Y_{12}\ldots\ldots\ldots Y_{1p} \\ Y_{21} & Y_{22}\ldots\ldots\ldots Y_{2p} \\ : & : \qquad\qquad : \\ Y_{N1} & Y_{N2}\ldots\ldots\ldots Y_{Np} \end{pmatrix}_{N \times p}$$

$$X = \begin{pmatrix} 1 & X_{11}\ldots\ldots\ldots X_{1r} \\ 1 & X_{21}\ldots\ldots\ldots X_{2r} \\ : & : \qquad\qquad : \\ 1 & X_{N1}\ldots\ldots\ldots X_{Nr} \end{pmatrix}_{N \times r + 1}$$

β= is the unknown parameter

$$= \begin{pmatrix} \beta_o \\ \beta_1 \\ : \\ \beta_{rk} \end{pmatrix}$$

Є = is the matrix of random error

Where

$$Є = \begin{pmatrix} e_{11} & e_{12}\ldots\ldots\ldots e_{1p} \\ e_{21} & e_{22}\ldots\ldots\ldots e_{2p} \\ : & : \qquad\qquad : \\ e_{N1} & e_{N2}\ldots\ldots\ldots e_{Np} \end{pmatrix}_{N \times p}$$

$$= \begin{bmatrix} e_1' \\ e_2' \\ \vdots \\ e_N' \end{bmatrix}$$

Each vector ej' will be assumed to have the following properties:

(1) $E(e_j)= 0$ for all j

(2) $E(e_j\ e_j')= \sum$ for all j and j'

Where $\sum$ is the variance-covariance matrix of the random vector ej defined as

$$\sum = \begin{pmatrix} \sigma_{11} & \sigma_{12} \dots\dots & \sigma_{1p} \\ \sigma_{21} & \sigma_{22} \dots\dots & \sigma_{2p} \\ \vdots & \vdots & \vdots \\ \sigma_{N1} & \sigma_{N2} \dots\dots & \sigma_{Np} \end{pmatrix}$$

(3) $e_j \sim N_p(0\ \ \sum)$ for all j

(4) For any I1 the N x 1 random vector e_j will be assume to satisfy $E(e_j)= 0$ and $E(e_j\ e_j')= \sigma_i^2\ (I_N)$

Estimation of the parameters β

Similar to the multiple linear regression, the method of least squares is need to estimate the matrix β.

Using the model

$$Y_j' = X'_j\beta + e_j' \qquad \text{for } j=1, 2, \ldots, N$$

The matrix to be minimized is (e' e) Є Є' which is the matrix of error sums of squares and sums of products.

Since

$$\epsilon = Y - X\beta \text{ and } \epsilon' = Y' - \beta'X'$$

Then

$$\epsilon'\epsilon = (Y' - \beta'X')(Y - X\beta)$$

$$= Y'Y - 2\beta'X'Y + \beta'X'X\beta$$

Taking the partial derivation of Є'Є with respect to β and equates the results to 0, we would get

$$\frac{\partial \epsilon'\epsilon}{\partial \beta} = -2Y'Y + 2X'X\beta = 0$$

The resulting normal equations are:

$$X'X\beta = X'Y$$

Where,

X'X is the (r+1) x (r+1) matrix of unconnected sum of squares and sums of products

$$X'X = \begin{pmatrix} N & \sum X_{j1} \ldots\ldots\ldots\ldots \sum X_{jr} \\ \sum X_{j1} & \sum X_{j12} \ldots\ldots\ldots \sum X_{j1}X_{jr} \\ & : \quad\quad : \quad\quad : \\ \sum X_{jr} & \sum X_{jr}X_{jl} \ldots\ldots \sum X_{jr2} \end{pmatrix}$$

$\beta = (\beta_{im})$ is the (r+1) x p matrix of estimated intercepts and partial regression coefficients

$$\beta = \begin{pmatrix} \beta_{01} & \beta_{02} \ldots\ldots\ldots \beta_{0p} \\ \beta_{11} & \beta_{12} \ldots\ldots\ldots \beta_{1p} \\ : & : \quad\quad : \\ \beta_{r1} & \beta_{r2} \ldots\ldots\ldots \beta_{rp} \end{pmatrix}$$

$$\beta = \begin{pmatrix} \beta_1 & \beta_2 \ldots\ldots\ldots \beta_p \end{pmatrix}$$

And

X'Y is the (r+1) x p matrix of uncorrected sums of products of X and Y:

$$\beta = \begin{pmatrix} 1 & 1 \ldots\ldots\ldots & 1 \\ \beta_{11} & \beta_{12}\ldots\ldots\ldots & \beta_{1p} \\ : & : & : \\ \beta_{r1} & \beta_{r2}\ldots\ldots\ldots & \beta_{rp} \end{pmatrix} \begin{pmatrix} Y_{11} & Y_{12}\ldots\ldots\ldots & Y_{1p} \\ Y_{21} & Y_{22}\ldots\ldots\ldots & Y_{2p} \\ : & : & : \\ Y_{N1} & Y_{N2}\ldots\ldots\ldots & Y_{Np} \end{pmatrix}$$

$$X'X = \begin{pmatrix} \sum Y_{j1} & \sum Y_{j2}\ldots\ldots\ldots\ldots\ldots & \sum Y_{jp} \\ \sum X_{j1}Y_{j1} & \sum X_{j1}Y_{j2}\ldots\ldots\ldots & \sum X_{j1}Y_{jp} \\ : & : & : \\ \sum X_{jn}Y_{j1} & \sum X_{jr}Y_{j2}\ldots\ldots\ldots\ldots & \sum X_{jr}Y_{jp} \end{pmatrix}$$

$$= \begin{pmatrix} g_{01} & g_{02}\ldots\ldots\ldots & g_{0p} \\ g_{11} & g_{12}\ldots\ldots\ldots & g_{1p} \\ : & : & : \\ g_{r1} & g_{r2}\ldots\ldots\ldots & g_{rp} \end{pmatrix}$$

It will be assumed that the matrix X'X is nonsingular so that the solution to the equation $(X'X)\beta=X'Y$ is

$$\beta = (X'X)^{-1}X'Y$$

$$= WG$$

Where

$$W = (X'X)^{-1} = \begin{pmatrix} w_{00} & w_{01} \ldots\ldots\ldots & w_{0r} \\ w_{10} & w_{11} \ldots\ldots\ldots & w_{1r} \\ \vdots & \vdots & \vdots \\ w_{r0} & w_{r1} \ldots\ldots\ldots & w_{rn} \end{pmatrix}$$

After multiplying W x G, we would get these particular solutions:

Intercepts: β_0

$$\beta_{oi} = \sum (W_{ok})(g_{ki}), \qquad i = 1, 2, \ldots p$$

Partial regression coefficients

$$\beta_i = \beta_{im} = \sum (W_{ik})(g_{km}), \qquad i.m = 2, \ldots\ldots$$

Finally, the estimated p regression equations are:

$$\hat{Y}_1 = \beta_{01} + \beta_{11} X_1 + \beta_{r1} X_r$$

$$\hat{Y}_2 = \beta_{02} + \beta_{12} X_1 + \beta_{r2} X_r$$

$$\hat{Y}_p = \beta_{0p} + \beta_{1p} X_1 + \beta_{rp} X_r$$

Estimation of ∑

The estimate of the variance-covariance matrix ∑ will be derived from the estimate residual matrix $\epsilon = Y - X\beta$.

$$\epsilon'\epsilon = (Y - X\beta)'(Y - X\beta)$$

$$= (Y' - \beta'X')(Y - X\beta)$$

$$= Y'Y - \beta X'Y - Y'X\beta + \beta'X'X\beta$$

From the normal equation $(X'X)\beta = X'Y$

$$\epsilon'\epsilon = Y'Y - \beta'X'Y$$

The elements of $\epsilon'\epsilon$ are defined:

$$e_{il} = Y_i' Y_l - \sum_{k=0}^{r}(\beta_{ik})(g_{ki})$$

$$e_{im} = Y_i' Y_m - \sum_{k=0}^{r}(\beta_{ik})(g_{ki})$$

From the previous section, the residual matrix $\epsilon'\epsilon$ can be written as

$$\epsilon'\epsilon = E' [I - XWX']E$$

And

$$E(e'e) = E\{ \epsilon'[I - XWX']\epsilon\}$$

$= \sum t_r$ [I –XWX’]

$= \sum$ [t_r (I_N) – tr (XWX’)]

$= \sum$ (N – (r+1)) = $\sum$ (N-r-1)

Therefore, the unbiased estimator of $\sum$ is $\sum$’

$$\sum' = S = \frac{(Y'Y - \beta'X'y)}{N-r-1}$$

The elements of S are:

Sample variances= $S_{i/x}{}^{2} = Y_i' \, Y_i - \beta_{igi}$

$$= \sum_{j=1}^{N} Yij\, 2 - \sum_{l=0}^{r} \beta irgli$$

Sample covariance: S_{im}

$S_{im} = Y_i'Y_m - \beta_i'g_m$

$$= \sum Y_{ji}Y_{jm} - \sum_{l=0}^{r} (\beta_{il})(g_{lm})$$

Estimate of the variance of β

By definition,

V(β) = E[β’ – β][β’ – β]’

But β’=WX’Y = WX’(Xβ+Є)

$$=WX'X\beta + WX'\epsilon$$

Therefore,

$$\beta' - \beta = WX'\epsilon \text{ and}$$

$$(\beta' - \beta)(\beta' - \beta) = (WX'\epsilon)(WX'\epsilon)'$$

$$=WX'(\epsilon\epsilon')XW'$$

$$E(\beta' - \beta)(\beta' - \beta)' = E[WX'(\epsilon\epsilon')XW'$$

$$= WX' E(\epsilon\epsilon') XW'$$

$$= WX' (\sum(IN)XW'$$

$$=\sum(W)$$

Hence,

$$V(\beta) = \sum(W)$$

Where

$$V(\beta) = Var(\beta_1, \beta_2, \ldots\ldots \beta_p)$$

$$= \begin{pmatrix} Var(\beta_1) & Cov(\beta_1\beta_2) & \ldots\ldots & Cov(\beta_1\beta_p) \\ Cov(\beta_1\beta_2) & Var(\beta_2) & \ldots\ldots & Cov(\beta_2\beta_p) \\ : & : & & : \\ Cov(\beta_p\beta_1) & Cov(\beta_p\beta_2) & & Var(\beta_p) \end{pmatrix}$$

$$\sum(W) = \begin{pmatrix} S_{1/x}^{2} & S_{12/x} & S_{1p/x} \\ S2_{1/x} & S_{2/x}^{2} & S_{2p/x} \\ : & : & : \\ S_{p1/x} & S_{p2/x} & S_{p/x}^{2} \end{pmatrix} W$$

Therefore,

$$Var(\beta_i) = (S_{i/x})(W) \qquad \text{for } i=1,2,\ldots\ldots p$$

$$Cov(\beta_i\beta_m)= (S_{im/x})(W) \qquad i\neq m=1,2,\ldots..p$$

<u>Test of hypothesis</u>

Ho: CB=K

Where:

C is the n_h x (r+1) of rank n_h

K is the n_h x p matrix of constants = 0

A. The Union-Intersection Test

1. Compute the matrix of sum of squares due to the hypothesis

   Ho :

   $$H= (C\beta'-K)' [CWC'] (C\beta'-K)$$

2. Compute the matrix of sums of squares and sums of products,E.

   $$E=Y'Y -\beta'X'X$$

3. Obtain the largest characteristics root of HE^{-1}. Let $C=char_{(max)}\ HE^{-1}$. The numbers of characteristics roots of HE^{-1}. Since rank of H is $\min(n_h,p)$, hence rank HE^{-1} is $\min(n_h,p)$. Therefore the degree of the characteristics polynomial is n_h.
4. Compute the statistics θ,

   $\Theta=\frac{c}{1+C}$

5. Compare the value of θ with the tabular value $\theta_{\alpha(s,m,n)}$ where

   $s=\min(V_H,p)$ $V_H=n_h$

   $m=\frac{|VH-p|-1}{2}$

   $n=\frac{N-r-p-2}{2}$

   Reject Ho: CB=K if $\theta \geq \theta_{\alpha(s,m,n)}$

   The equivalent F-statistics is

   $$Fc= c(n+1)/(m+1)$$

   which follows an F-distribution with 2m+2 and 2n+2 degrees of freedom

B. The Likelihood Ratio Test or Wilk's Lambda

After computing H and E as given above obtain the statistic U

$U=\frac{|E|}{|H+E|} \sim U_{\alpha(p,VH,VE)}$

The table below gives the transform of U to provide upper tail tests using F-distribution.

Table 1. Transformation of U with upper tail tests using F-distribution.

Parameters	Statistics having F-distribution	Degrees of Freedom
$V_H = 1$ for any p	$\frac{1-U}{U} x \frac{V_E + V_H - p}{p}$	p, $V_E + V_H$ -p
$V_H = 2$ for any p	$\frac{1-\sqrt{U}}{\sqrt{U}} x \frac{V_E + V_H - p - 1}{p}$	2p,2($V_E + V_H$ -p)
p=1 any V_H	$\frac{1-U}{U} x \frac{V_E}{V_H}$	V_H, V_E
p=2 any V_H	$\frac{1-\sqrt{U}}{\sqrt{U}} x \frac{V_E{}^{-1}}{V_H}$	$2V_H$, $2V_E$

Definition of terms

Academic Performance - refers to the performance that is characterized by a narrow concern for book learning and formal rules, without knowledge or experience of practical matters.

Community Ability - refers to the performance of students in Basic English subjects.

Dummy variables-These variables may be thought of as additional variables for which statistical adjustment is desired.

<u>Mathematical Ability</u> - refers to the performance of the students in mathematics.

<u>Multivariate Analysis</u> - comprises a set of techniques dedicated to the analysis of data sets with more than one variable.

<u>Predictor Variables</u> - refers to the variables from which projections are made in a prediction study.

<u>Regression Analysis</u> - refers to the estimation of the linear relationship between a dependent variable and one or more independent variables or covariates.

<u>Study Habits</u> - giving proper time and energy to your studies and various "tricks" to help you study more effectively.

<u>Predictor Variable</u> - refer to the variable that are use to predict the values of another variable in a mode.

METHODOLOGY

Location of the study

The study was conducted at Benguet State University during the 2^{nd} semester of the school year 2008-2009 at La Trinidad, Benguet.

Respondents of the Study

The respondents of the study were all the forty eight freshmen academic achievers of School Year 2008-2009.

Data gathering procedure

The grades of the selected achievers were obtained from the Office of the University Registrar and Office of the Students' Affairs of Benguet State University instrumentation.

A questionnaire was prepared and floated to obtain the age, course, school attended, and high school average and gender data.

Statistical analysis of data

The gathered and tabulated data were analyzed using of descriptive and inferential methods. The descriptive method includes the analysis of the data using frequency, percentage, mean, and rank.

The inferential method utilized in determining the influence of different factors on the grades of the student's achievers. The dependent variables are the grades in the subjects namely: Math, English and Social Science. The independent variables include the High School Grade, Age of the respondents, Gender, Type of High School attended and the course. For qualitative independent variables, dummies were defined and entered into the model.

Fitting the multiple regression and multivariate regression models, the use of the PROC REG procedure of the SAS software was compelled to facilitate the computations.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 2 shows the computed means and standard deviation of the grades on the three dependent variables (Math 11, English 11, and Social Science 11) and two independent variables, (High school grade and Age). The respondents' earned grades in the three subjects as the dependent variables ranged from 1.26 to 1.60 with social science having the least grades of 1.26 and math having the highest average of 1.68. Their high school mean grade and age of the respondents were 90.2% and 16.98% respectively.

Table 2. Mean and standard deviation of the variables.

VARIABLE	N	MEAN	STANDARD DEVIATION	MAX	MIN
Math 11	49	1.68	0.35	1.00	2.75
English 11	49	1.60	0.24	1.25	2.25
Soc sci 11	49	1.26	0.25	1.00	1.75
HS GRADE(X1)	49	90.28	2.43	84.33	95.59
AGE(X2)	49	16.98	1.49	16.00	24

Table 3 presents the distribution of achievers by course. About 35 percent of the achievers are enrolled in the nursing course and about 29 and 14 percent are taking up BSE and BEE respectively. The remaining 22 percent of the achievers are taking up other degree programs such as: DVM, AET, BSF, BSAS, BLIS, BSES, and BSA. It can be seen in the table that most of the achiever are dominated by Nursing and Education students

On the distribution of achievers according to type of High School attended, majority of the respondents are graduates of the National High School (67.35%). Achievers from private schools comprise the 20 percent of the respondents. The remaining 10 percent of the achiever respondents are from Barangay/Regional High School.

Table 3. Distribution of respondents by course, type of high school graduated, and gender

COURSE	COURSE	PERCENT	CUMULATIVE PERCENT	CUMULATIVE FREQUENCY
BSN	17	0.35	0.35	17
BEE&BSE	21	0.43	0.78	38
OTHERDEGREE	11	0.22	100.00	49
REGIONAL HS	5	0.10	0.12	6
NATIONAL HS	33	0.67	0.80	39
PRIVATE HS	10	0.20	100.00	49
FEMALE	36	0.73	0.73	39
MALE	13	0.27	100.00	49

As to gender, female achievers outnumbered male achievers. About 73 percent of the academic achievers of the Benguet State University are females and the remaining are males.

Univariate Multiple Regression Model

Before fitting a multivariate regression model, a univariate multiple linear model was first fitted for each dependent variable. Taking Math as the first dependent variable, the univariate multiple linear regression model gave the following results in Table 4.

Table 4. Beta coefficients for Math grade

DEPENDENT VARIABLE	β_0 INTERCEPT	HS AVERAGE (β_1)	AGE (β_2)
Y_{C1T1}	0.612	0.010279	-0.00607
Y_{C1T2}	0.603	0.010279	-0.00607
Y_{C1T3}	0.472	0.010279	-0.00607
Y_{C2T1}	0.948	0.010279	-0.00607
Y_{C2T2}	0.940	0.010279	-0.00607
Y_{C2T3}	0.808	0.010279	-0.00607
Y_{C3T1}	0.887	0.010279	-0.00607
Y_{C3T2}	0.878	0.010279	-0.00607
Y_{C3T3}	0.747	0.010279	-0.00607

Where: C_1= CN; C_2=CTE; C_3=OTHER DEGREE

T_1=REGIONAL HIGH SCHOOL; T_2=NATIONAL HIGH SCHOOL; T_3=PRIVATE HIGH SCHOOL

As to the goodness – of – fit of the fitted regression model given below,

Math = HGWA + Age + Gender (Dummy) + Course (Dummy) + Type of HS (Dummy)

only 11 percent of the variability in Math grades can be explained by the independent variables in the model.

Moreover, the test for the significance of the regression coefficients, the F-test did not support the rejection of the hypothesis that the different predictor variables have no significant effect on the student's performance in Math 11.

Regressing the same predictors on the student's performance in English as the dependent variable, the independent variables in the fitted model,

English = HGWA + Age + Gender (Dummy) + Course (Dummy) + Type of HS (Dummy)

they explained only 18.06 percent of the variability in the English grades obtained by the respondents.

The significance of the effects of the different regressors was found not significant. This means that none of the regressors are contributory to the performance of the students in English. The models derived for the combination of the different dummy variables are shown in Table 5.

Table 5. Beta coefficients for English grade

DEPENDENT VARIABLE	β_0 INTERCEPT	HS AVERAGE (β_1)	AGE (β_2)
Y_{C1T1}	2.995	-0.02024	0.015401
Y_{C1T2}	2.957	-0.02024	0.015401
Y_{C1T3}	3.088	-0.02024	0.015401
Y_{C2T1}	3.097	-0.02024	0.015401
Y_{C2T2}	3.059	-0.02024	0.015401
Y_{C2T3}	3.190	-0.02024	0.015401
Y_{C3T1}	3.152	-0.02024	0.015401
Y_{C3T2}	3.114	-0.02024	0.015401
Y_{C3T3}	3.245	-0.02024	0.015401

Where: C_1= CN — T_1=REGIONAL HIGH SCHOOL
C_2=CTE — T_2=NATIONAL HIGH SCHOOL
C_3=OTHER DEGREE — T_3=PRIVATE HIGH SCHOOL

Moreover, using the third dependent variable, the Social Science grade, with the same predictor variables, about 53% in the variability in Social Science grade can be attributed to HGWA, Age, Gender, Course and Type of High School attended.

English = HGWA + Age + Gender (Dummy) + Course (Dummy) + Type of HS (Dummy)

Table 6. Beta coefficients for Social Science grade

DEPENDENT VARIABLE	β_0 INTERCEPT	HS AVERAGE (β_1)	AGE (β_2)
Y_{C1T1}	2.466	-0.009	-0.022
Y_{C1T2}	2.340	-0.009	-0.022
Y_{C1T3}	2.331	-0.009	-0.022
Y_{C2T1}	2.764	-0.009	-0.022
Y_{C2T2}	2.638	-0.009	-0.022
Y_{C2T3}	2.629	-0.009	-0.022
Y_{C3T1}	2.908	-0.009	-0.022
Y_{C3T2}	3.114	-0.009	-0.022
Y_{C3T3}	3.245	-0.009	-0.022

Where: C_1= CN; C_2=CTE; C_3=OTHER DEGREE; T_1=REGIONAL HIGH SCHOOL; T_2=NATIONAL HIGH SCHOOL; T_3=PRIVATE HIGH SCHOOL

However, the test of significance for the beta coefficient is not significant. Taking Social Science as the third dependent variable, the univariate multiple linear model gave the following results in Table 6.

Multivariate Regression Model

Fitting a multivariate regression model with the grades in the three subjects as dependent variables using the same predictor variables, the MANOVA test gave significant result as shown in table 7

Generally, fitting univariate regression model on the three dependent variables, the test of significance for the beta coefficient was found not significant.

Fitting the multivariate regression model, the result showed significant result.

Table 7. Multivariate test for the overall model.

Statistic	Value	F	Pr>F
Wilks' Lambda	0.31987	2.2229	0.0028
Pillai's Trace	0.85308	1.9867	0.0083
Hotelling-Lawley Trace	1.61989	2.4748	0.0008
Roy's Greatest Root	1.26915	6.3457	0.0001
Eigenvalues	Math: 0.56	English : 0.19	SocSci : 0.10

SUMMARY, RECCOMENDATION AND CONCLUSION

This study was conducted to determine the predictors of academic performance among academic achievers using Multivariate Linear Regression. Specifically the study aim to 1) describes the relationship existing between the different factors and to the academic performance. 2) Find a suitable regression model that would predict the best factors affecting academic performance of achievers. 3) Identify the factors that may predict the student's academic performance.

The variables collected are information about to those freshmen achievers on there grade in Math 11, English 11, Soc Sci 11, High School grade, Gender, Age, Course and Type of High School. These variables are gathered using a questionable while the number of student was gathered from the Registrar's office and the Office of the Student's Affairs. Out of the thousand students of the university, we just selected the 49 freshmen academic achievers.

The statistical tool used in this study was Multivariate Regression Analysis. This statistical was used to accommodate the multivariate nature of educational input and output measures. Prior to analysis, all variables in the data set were examined through SAS program for accuracy of data entry. A Multivariate Regression Analysis was performed in order to determine the predictive capabilities of the independent variables. The Multivariate Regression Analysis indicated that the composite of predictor had a highly significant linear relationship with the output measures (Math 11, English 11 and Soc Sci. In addition, there are more given effect of the independent variable that contributes to the model.

Based on the conclusion, it is recommended that the result of this study may be out of great help to the college. It maybe of help in counseling and guidance among the university on some factors that might predict academic performance to the student. Knowledge of the student’s predictor’s will guide in strengthening their stat. Strategies to suit the need of student’s.

Based on the results, the researchers recommend the following:

1. The results of the study could help in fostering student’s awareness on the factors that could affect their academic performance.

2. The results of the study may also be of great help to parents and guardians in motivating their children as well as in knowing the factors that affect their children’s’ achievement.

3. Further investigation of this study is also recommended.

In conclusion, if a goal of the university is to be efficient and effective at educating its students, and subsequently have them graduate, then further research is needed to identify if other variables exist that can predict students' ability to improve their academic performance. Future studies should continue to explore additional variables as well as investigate student performance beyond the first year in order to confirm the trend for effectiveness of these predictors.

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APPENDIX

Appendix A

COLLEGE OF ARTS AND SCIENCES
MATH-PHYSICS-STATISTICS DEPARTMENT

APPLICATION FOR MANUSCRIPT/PROJECT DEFENSE

Date: ________

Group Members:
Edward Antipuesto
Efraim Dickson Dulawen
Bobby F. Roaring

Major Field: Statistics
Minor Field: Info. Tech.

Degree: Bachelor of Science in Applied Statistics

Title of Thesis:
"Multivariate Linear Regression Model for Academic Performance of the Freshmen Achiever at Benguet State University"

Endorsed: Dr. Salvacion Z. Beligan
(Adviser)

Date and Time of Defense: March 19, 2009, 11:00 AM
Place of Defense: CAS An 210

Noted: Maria Azucena B. Lubrica
Department Chairman

Report of result of manuscript/project defense

Name and Signature	Remarks*
____________________ Adviser	____________________
____________________ Member	____________________
____________________ Member	____________________
____________________ MARIA AZUCENA B. LUBRICA Department chairman	____________________

Appendix B

Benguet State University
College of Arts and Sciences
Math-Physics-Statistics Department
La Trinidad, Benguet

February 9, 2009

DR. EDNA CHUA
Office of the Student Affairs
Benguet State University

MADAME:

We, the undersigned fourth year students taking up Bachelor of Sciences in Applied Statistics at Benguet State University, are conducting a research entitled "MULTIVARIATE REGRESSION ANALYSIS OF ACADEMIC PERFORMANCE OF THE FRESHMEN ACHIEVERS AT BENGUET STATE UNIVERSITY".

In view hereof, we would like to request permission from your good office to gather the following:

a) High school average
b) IQ
c) Entrance Exam Results of the Freshmen Academic Achievers.

Attached to this letter are the names and course of the freshmen academic achiever.

Thank you very much for your favorable consideration.

Respectfully yours,

EDWARD ANTIPUESTO

EFRAIM DICKSON L. DULAWEN

BOBBY F. ROARING
Researchers

Noted:

DR. SALVACION Z. BELIGAN
Adviser

Approved:

DR. EDNA CHUA
Office of the Student Affairs

Appendix C

Benguet State University
College of Arts and Sciences
Math-Physics-Statistics Department
La Trinidad, Benguet

February 9, 2009

DR. MARLENE B. ATINYAO
Office of the University Registrar
Benguet State University

MADAME:

We, the undersigned fourth year students taking up Bachelor of Sciences in Applied Statistics at Benguet State University, are conducting a research entitled "MULTIVARIATE REGRESSION ANALYSIS OF ACADEMIC PERFORMANCE OF THE FRESHMEN ACHIEVERS AT BENGUET STATE UNIVERSITY".

In view hereof, we would like to request permission from your good office to gather the following:

a) High school average
b) IQ
c) Entrance Exam Results of the Freshmen Academic Achievers.

Attached to this letter are the names and course of the freshmen academic achiever.

Thank you very much for your favorable consideration.

Respectfully yours,

EDWARD ANTIPUESTO

EFRAIM DICKSON L. DULAWEN

BOBBY F. ROARING
Researchers

Noted:

DR. SALVACION Z. BELIGAN
Adviser

Approved:

DR. MARLENE B. ATINYAO
Director, OUR

Appendix D

Benguet State University
College of Arts and Sciences
Math-Physics-Statistics Department
La Trinidad, Benguet

Dear Respondents,

The undersigned Bachelor of Science in Applied Statistics students are conducting a research entitled, "MULTIVARIATE REGRESSION ANALYSIS OF ACADEMIC PERFORMANCE OF THE FRESHMEN ACHIEVERS AT BENGUET STATE UNIVERSITY". In this connection, may we request that you provide us with the information needed?

Your truthful and complete answers will help the success of this study. Rest assured that answers would be treated confidentially.

Heartfelt thanks for your anticipated cooperation.

Reverently yours,

____
EDWARD ANTIPUESTO

____
EFRAIM DICKSON L. DULAWEN

____
BOBBY F. ROARING
Researchers

Noted:

____
DR. SALVACION Z. BELIGAN
Adviser

SURVEY QUESTIONNAIRE

INSTRUCTION: Please fill in the blank or put a check (☑) mark on the given space with the correct entries. All entries will be regarded as strictly confidential.

RESPONDENTS PROFILE

1. Name: ______________________
2. Age: _______________________
3. Gender: [ ]-Male [ ]-Female
4. Course: _____________________
5. Type of high school graduated:
   [ ]-Barangay High School
   [ ]-City/Regional High School
   [ ]-National High School
   [ ]-Private High School
6. What was your High School average (Pls. specify)? ________

Appendix E

RAW DATA

MATH 11	ENGLISH 11	SOC SCI 11	HS GRADE	AGE	GENDER	COURSE	TYPE OF HS
1.75	1.50	1.00	91.36	17	0	1	3
1.75	1.25	1.00	93.13	17	0	1	3
1.75	1.25	1.00	94.00	16	0	1	4
1.50	1.50	1.00	89.24	16	1	1	3
1.50	1.50	1.00	91.94	16	0	1	4
1.50	1.50	1.00	90.80	16	0	1	3
1.50	1.50	1.00	92.83	17	0	1	3
1.50	1.25	1.00	91.26	16	0	1	3
1.50	1.50	1.50	92.51	16	0	1	2
1.50	1.50	1.25	89.69	17	0	1	3
1.50	1.50	1.25	91.72	17	0	1	3
1.50	1.50	1.25	89.55	16	1	1	3
1.50	2.00	1.00	90.08	17	0	1	3
1.50	1.50	1.00	8.54	17	1	1	4
1.50	1.50	1.25	90.77	16	0	1	3
1.50	1.75	1.00	91.62	17	0	1	4
2.00	1.50	1.00	95.59	17	0	1	4
1.50	1.25	1.00	87.75	17	1	2	3
1.25	1.25	1.25	88.00	16	0	2	2
1.50	1.75	1.25	93.33	16	0	2	4
1.50	1.75	1.25	91.79	22	1	2	3
2.25	1.50	1.25	89.65	19	0	2	3
1.75	1.25	1.50	89.59	18	1	2	3
2.75	2.00	1.25	91.07	17	0	2	2
1.50	2.00	1.25	86.00	18	0	2	3
2.00	1.75	1.50	90.03	16	0	2	3
1.75	1.50	1.50	91.38	16	0	2	3

2.25	1.50	1.75	88.75	16	0	2	3
2.00	1.75	1.50	93.40	17	0	2	4
2.25	1.50	1.50	89.93	18	0	2	3
2.00	2.00	1.75	86.74	16	1	2	4
1.00	1.50	1.75	91.20	18	1	3	4
1.25	2.00	1.25	85.95	18	1	3	4
1.50	1.75	1.75	88.38	17	0	3	2
2.00	1.50	1.50	85.20	16	1	3	3
1.75	1.75	1.50	88.26	16	1	3	3
2.50	1.75	1.50	90.10	17	0	3	3
2.00	1.75	1.50	84.33	24	0	3	3
1.25	1.50	1.00	88.75	16	0	4	3
1.75	1.50	1.00	92.38	17	0	4	3
1.25	1.25	1.00	92.67	17	1	4	3
1.50	1.50	1.25	87.84	16	0	5	3
1.50	1.50	1.00	91.15	18	0	5	3
2.25	1.75	1.50	88.35	16	0	6	2
1.25	2.00	1.25	90.53	17	0	7	3
1.75	1.75	1.00	94.82	16	0	8	3
1.50	1.75	1.25	88.59	18	1	9	3
1.75	2.25	1.00	92.00	16	0	10	3
1.75	1.25	1.50	91.00	16	0	11	3

Appendix F

SAMPLE RESULT OF MULTIVARIATE REGRESSION ANALYSIS

Model: MODEL1

Dependent Variable: MATH

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	1.49237	0.18655	1.714	0.1251
Error	40	4.35457	0.10886		
C Total	48	5.84694			

Root MSE	0.32995	R-square	0.2552
Dep Mean	1.68367	Adj R-sq	0.1063
C.V.	19.59678		

NOTE: Model is not full rank. Least-squares solutions for the parameters are not unique. Some statistics will be misleading. A reported DF of 0 or B means that the estimate is biased. The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

T3 = +1.0000 * INTERCEP -1.0000 * T1 -1.0000 * T2

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	B	0.694579	2.43541495	0.285	0.7770

HGWA	1	0.010279	0.02512236	0.409	0.6846
AGE	1	-0.006073	0.03506443	-0.173	0.8634
GENDER	1	-0.227511	0.12190480	-1.866	0.0693
C1	1	0.004804	0.13286341	0.036	0.9713
C2	1	0.341181	0.14171705	2.407	0.0208
C3	1	0.279586	0.19160862	1.459	0.1523
T1	B	0.140017	0.19766260	0.708	0.4828
T2	B	0.102657	0.13157800	0.780	0.4399
T3	0	0	.	.	.

Dependent Variable: ENG

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F

Model	8	0.51518	0.06440	1.102	0.3821
Error	40	2.33686	0.05842		
C Total	48	2.85204			

Root MSE	0.24171	R-square	0.1806
Dep Mean	1.59694	Adj R-sq	0.0168
C.V.	15.13556		

NOTE: Model is not full rank. Least-squares solutions for the parameters are not unique. Some statistics will be misleading. A reported DF of 0 or B means that the estimate is biased. The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

T3 = +1.0000 * INTERCEP -1.0000 * T1 -1.0000 * T2

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	B	3.384601	1.78409146	1.897	0.0651
HGWA	1	-0.020236	0.01840368	-1.100	0.2781
AGE	1	0.015401	0.02568685	0.600	0.5522
GENDER	1	-0.111806	0.08930277	-1.252	0.2178
C1	1	-0.164187	0.09733063	-1.687	0.0994
C2	1	-0.062799	0.10381647	-0.605	0.5487
C3	1	-0.007576	0.14036511	-0.054	0.9572
T1	B	-0.113289	0.14480003	-0.782	0.4386
T2	B	-0.151477	0.09638899	-1.572	0.1239
T3	0	0	.	.	.

Dependent Variable: SOC

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	1.55410	0.19426	5.622	0.0001
Error	40	1.38212	0.03455		
C Total	48	2.93622			

Root MSE	0.18588	R-square	0.5293
Dep Mean	1.25510	Adj R-sq	0.4351
C.V.	14.81031		

NOTE: Model is not full rank. Least-squares solutions for the parameters are not unique. Some statistics will be misleading. A reported DF of 0 or B means that the estimate is biased. The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

T3 = +1.0000 * INTERCEP -1.0000 * T1 -1.0000 * T2

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	B	2.382049	1.37206180	1.736	0.0902
HGWA	1	-0.009449	0.01415341	-0.668	0.5082
AGE	1	-0.022418	0.01975457	-1.135	0.2632
GENDER	1	-0.021456	0.06867861	-0.312	0.7564

C1	1	-0.062635	0.07485246	-0.837	0.4077
C2	1	0.235317	0.07984042	2.947	0.0053
C3	1	0.379675	0.10794828	3.517	0.0011
T1	B	0.125302	0.11135897	1.125	0.2672
T2	B	-0.000142	0.07412829	-0.002	0.9985
T3	0	0	.	.	.

Multivariate Test:

L Ginv(X'X) L'   LB-cj

0.0057974335	0.0005044996	0.0086155014	-0.001313812	0.0058847404	0.0163624548
0.0005044996	0.0112940136	0.0006179345	-0.000140828	-0.008479562	-0.015947632
0.0086155014	0.0006179345	0.1365074533	0.0039390604	-0.003122265	-0.021829978

-0.001313812	-0.000140828	0.0039390604	0.1621532104	0.0978031711	0.0967026652
0.0058847404	-0.008479562	-0.003122265	0.0978031711	0.1844841043	0.1359956205
0.0163624548	-0.015947632	-0.021829978	0.0967026652	0.1359956205	0.3372444604
0.011761556	0.0063620468	0.0698618214	0.0383235684	0.0154849678	0.0259728851
0.0089674611	-0.004563661	0.0269253009	0.0391040946	0.0439800302	0.0704872815

0.011761556	0.0089674611	0.010279155	-0.020236126	-0.009449088
0.0063620468	-0.004563661	-0.00607292	0.0154006991	-0.022418391
0.0698618214	0.0269253009	-0.227511242	-0.111806137	-0.021455628
0.0383235684	0.0391040946	0.0048038604	-0.164186815	-0.062635445
0.0154849678	0.0439800302	0.3411810716	-0.062798934	0.2353170282
0.0259728851	0.0704872815	0.279585682	-0.007575886	0.3796746199
0.3588920024	0.1303478278	0.1400173804	-0.113288808	0.125302437
0.1303478278	0.1590308249	0.1026566118	-0.151476506	-0.000141511

Inv(L Ginv(X'X) L')   Inv()(LB-cj)

283.35573878	-43.27367347	-18.5222449	19.93244898	-6.458571429	-18.51428571
-43.27367347	106.97959184	4.2653061224	-7.653061224	4.2857142857	7.1428571429
-18.5222449	4.2653061224	9.5510204082	-1.510204082	0.2857142857	2.1428571429
19.93244898	-7.653061224	-1.510204082	11.102040816	-4.857142857	-2.428571429
-6.458571429	4.2857142857	0.2857142857	-4.857142857	10	-2
-18.51428571	7.1428571429	2.1428571429	-2.428571429	-2	6
-3.071632653	-2.897959184	-1.326530612	-0.734693878	0.5714285714	0.2857142857
-6.475102041	4.693877551	-0.020408163	-0.795918367	-0.714285714	-0.857142857

-3.071632653	-6.475102041	-0.989438776	-5.72755102	-11.49158163
-2.897959184	4.693877551	1.4336734694	2.5969387755	1.7551020408
-1.326530612	-0.020408163	-1.887755102	-0.260204082	0.6836734694

-0.734693878	-0.795918367	-1.87244898	-1.647959184	-2.836734694
0.5714285714	-0.714285714	2.6785714286	0.3928571429	1.9285714286
0.2857142857	-0.857142857	0.2142857143	0.8214285714	1.9642857143
4.4897959184	-3.469387755	0.8316326531	0.2653061224	0.9744897959
-3.469387755	10.408163265	0.0051020408	-0.795918367	-0.9234693885

T, the H + E Matrix

5.8469387755	0.7525510204	1.3290816327
0.7525510204	2.8520408163	0.4757653061
1.3290816327	0.4757653061	2.9362244898

Eigenvectors

0.0517543588	0.1270359725	0.520020392
0.4131660836	-0.289104225	-0.158534347
0.1453177832	0.5176258271	-0.298329281

Eigenvalues

0.5593056922

0.1913680346

0.1024034267

Multivariate Statistics and F Approximations

S=3 M=2 N=18

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.31986707	2.2229	24	110.8128	0.0028
Pillai's Trace	0.85307715	1.9867	24	120	0.0083
Hotelling-Lawley Trace	1.61988940	2.4748	24	110	0.0008
Roy's Greatest Root	1.26914662	6.3457	8	40	0.0001

NOTE: F Statistic for Roy's Greatest Root is an upper bound.

Appendix G

TABLE RESULTS

Table 8. Univariate ANOVA with Math grade (Y1) as dependent

Source	DF	Sum of Square	Mean Square	F Value	Prob>F
Model	8	1.49237	0.18655	1.714	0.1251
Error	48	4.35457	0.10886		
C Total	48	5.84694			
Root MSE	0.32995				
Dep Mean	1.68367				
R-square	0.2552				
Adj R-sq	0.1063				
C.V.	19.59678				

Table 9. Parameter estimates for Math grade

Parameter Variable	Parameter Estimate	Standard Error	T for HO: Parameter = 0	Prob > |T|
Intercept	0.69458	2.43541	0.285	0.7770
HGWA	0.01028	0.02512	0.409	0.6846
AGE	0.00607	0.03506	-0.173	0.8634
GENDER	-0.22750	0.12190	-1.866	0.0693
C1	0.00480	0.13286	0.036	0.9713
C2	0.34118	0.14172	2.407	0.0208
C3	0.27959	0.19161	1.459	0.1523
T1	0.14002	0.19766	0.708	0.4828
T2	0.10266	0.13158	0.780	0.4399
T3	0	-	-	-

Where: C_1= CN; C_2=CTE; C_3=OTHER DEGREE

T_1=REGIONAL HIGH SCHOOL; T_2=NATIONAL HIGH SCHOOL; T_3=PRIVATE HIGH SCHOOL

Table 10. Univariate ANOVA with English grade (Y2) as dependent

Source	DF	Sum of Square	Mean Square	F Value	Prob>F
Model	8	0.51518	0.0644	1.102	0.3821
Error	48	2.33686	0.0584		
C Total	48	2.85204			
Root MSE	0.24171				
Dep Mean	1.59694				
R-square	0.18060				
Adj R-sq	0.01680				
C.V.	15.13556				

Table 11. Parameter estimates for English grade

Parameter Variable	Parameter Estimate	Standard Error	T for HO: Parameter = 0	Prob > |T|
Intercept	3.384601	1.7840915	1.897	0.0651
HGWA	-0.020236	0.0184037	-1.100	0.2781
AGE	0.015401	0.0256869	0.600	0.5522
GENDER	-0.111806	0.0893028	-1.252	0.2178
C1	-0.164187	0.0973306	-1.687	0.0994
C2	-0.062799	0.1417171	2.407	0.5487
C3	-0.007576	0.1403651	-0.054	0.9572
T1	-0.113289	0.1448000	-0.782	0.4386
T2	-0.151477	0.096389	-1.572	0.1239
T3	0	-	-	-

Where: C_1= CN; C_2=CTE; C_3=OTHER DEGREE

T_1=REGIONAL HIGH SCHOOL; T_2=NATIONAL HIGH SCHOOL; T_3=PRIVATE HIGH SCHOOL

Table 12. Univariate ANOVA with Social Science grade (Y3) as dependent

Source	DF	Sum of Square	Mean Square	F Value	Prob>F
Model	3	1.55410	0.19426	5.622	0.0001
Error	45	1.38212	0.03455		
C Total	48	2.93622			
Root MSE	0.1858				
Dep Mean	1.2551				
R-square	0.5293				
Adj R-sq	0.4351				
C.V.	14.8103				

Table 13. Parameter estimates for Social Science grade

Parameter Variable	Parameter Estimate	Standard Error	T for HO: Parameter = 0	Prob > |T|
Intercept	2.3820	1.37206	1.736	0.0902
HGWA	0.0094	0.01415	-0.668	0.5082
AGE	-0.0224	0.01975	-1.135	0.2632
GENDER	-0.0215	0.06868	-0.312	0.7564
C1	-0.0626	0.07485	-0.837	0.4077
C2	0.2353	0.07984	2.947	0.0053
C3	0.3796	0.10795	3.517	0.0011
T1	0.1253	0.11136	1.125	0.2672
T2	-0.0001	0.07413	-0.002	0.9985
T3	0	-	-	-

Where: C_1= CN　　T_1=REGIONAL HIGH SCHOOL
C_2=CTE　　T_2=NATIONAL HIGH SCHOOL
C_3=OTHER DEGREE　　T_3=PRIVATE HIGH SCHOOL