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APPLICATION OF LOGISTIC MODEL FOR STUDYING THE FACTORS AFFECT ACADEMIC ACHIEVEMENT OF THE STUDENT - CASE STUDY OF FACULTY OF SCIENCES AND HUMANITIES (THADIQ) -SHAQRAA UNIVERSITY-KSA

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ABSTRACT

This paper aims at studying the factors that affect academic achievement of the student in Faculty of Sciences and Humanities (Thadiq) -Shaqraa University-KSA. The Logistic Regression (Lo.R.) was used to analyze the data. The important result was, there is significant relationship between the academic achievement of the student on one hand and the studied factors on the other hand.

In consequence of the above mentioned results, there are two discussions: The first is to conduct similar studies in the other faculties, and the second is to take the advantages of this study in the planning and improvement of student's academic rate.

KEYWORDS: Academic rate, logistic regression, academic achievement, Shaqraa University.

INTRODUCTION

This paper deals with the factors which affect the academic achievement of the student in Faculty of Sciences and Humanities (Thadiq) -Shaqraa University-KSA. The Binary Logistic Regression (B.Lo.R.) was used to analyze the data. Binary logistic function is used in this paper because; the sample size is large and the numbers of levels of the independent variables are two.

The problem of the study is that, there is no previous study about the factors that affect the Students' Academic Rate in Shaqraa University; therefore there is no sure information about effect of these factors.

The variables in this study were sixteen one is dependent variable - Students' Academic Rate-which denoted by (Y_i), and the others were independent variables. These variables are configured in Appendix (1) and denoted by X_1, $X_2,\ldots,X_{15}$.

In this paper we will test the hypothesis:

$$H_0: \ \beta_i = 0 \quad against \quad H_1: \ \beta_i \neq 0$$

$$where: \ i = 0,1,2,3,.......,15$$

The importance of this paper is that, it will determine important factors that may affect in the academic level of the students.

This paper aims at testing the significance of the factors that may affect in the academic level of the students, through logistic model.

There are many studies that have used the analysis of the Logistic Model (Lo.M). The first one who used the logistic function in 1838 was Verhulst, and named it growth function. The term logistic function was used by (Pearl and Read, 1920). (Berkson; 1944) made comparison between the Logistic Model (LO.M.) and Normal Distribution Model (NDM) and reached to the result that the LO.M. was better than the NDM. Also the LO.M. and NDM were used by (Cox; 1970) for data consisted of three dose levels of drug, and found that, the LO.M. has better fitted than

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the NDM. According to (Berkson; 1951), if the data has binomial distribution, LO.M. is better than NDM in fitting of the data, and the estimates of LO.M. are better than the estimates of NDM because, Lo. M estimates are sufficient and efficient. In 1972 Ashton wrote a book in which he explained how to transform LO.M. to Linear Model (Li. M.). In 1983 Mc Cullagh and Nelder; were used Chi-Square Test, (CST) and Deviance (D) tests for fitting Lo. M. and found that the two tests approached to CST. Mc Cullagh and Nelder used the Weighted Least Square Method (WLSM), because there was heterogeneity of variance. In 1987 Richard and Little introduced some results appeared that Lo. M for binary data was the best (Richard and Little; 1987). In 1989 Lemeston and Hosmer were used equation (1) to test the suitable partial group of Lo. M.

$$C(q) = \frac{SSE(q)}{SSE(p)/(n-p-1)} + 2(q+1) - n \rightarrow (1)$$

SSE(q) = Sum of Squares due to Error of the suitable model that contains "q" variables.
SSE(p) = Sum of Squares due to Error that belongs to the Linear Regression of the model which contains "p" variables.

If C(q) is small enough that means the model of "q" variables is the best.

In 1995 Minard authored a book entitled "Applied Logistic Regression Analysis", which contains important applications in social sciences. In 1999 Sequeiria and Taylor transformed the binary Lo.M to study treatment effect by using binary variable "I" for the treatment, with " γ " factor and continuous variable X; such that:

$$Ln(\frac{P}{q}) = \alpha + BX^{(2)} + \gamma I \rightarrow (2)$$

Where: $\alpha, \beta, and\ \gamma$ are parameters, p is the probability of success, "q" is equal to one minus "p" which is the probability of failure. Finally $Ln(\frac{P}{q})$ is the linear transformation of the proportion of the response in the Lo.M.

In 2000 the 2nd ed. of a book entitled "Applied Logistic Regression"; written by David and Stanley appeared. This book contains applications of Lo.M in the field of biostatistics, social science, education, and health. In 2002 Pingchao, Kuklida and Gray authored a research entitled "An Introduction to Logistic Regression Analysis and Reporting", which deals with educational data. This research is available on the internet website. Also on the internet website in 2006 Sansh and Gozde spread research entitled "Logistic Regression Analysis to Determine the Factors that Affect (Green Card) Usage for Health Services".

The Lo.M is used to represent the relationship between explanatory proportional variable with binomial distribution and dummy dependent variable. The dependent variable takes the values 1 if there is response and 0 otherwise, (Seber and Wild; 1989).

Arabi, and Husain introduced a paper entitled "Trends of Secondary Schools Students in Forming Their Choice of Future Specialization where, the Academic in two Branches, Art and Science". They have used logistic regression, and reached to students marks, actual looking, parents, fathers' job, population looking and future job were affected the choice of the future specialization. Farg, et al introduced a paper entitled " Application of the Univariate Logistic Model for Studying the Effect of the Previous Knowledge about the Studied Courses in the Success of the Student - Case Study of Faculty of Sciences and Humanities (Thadiq)-Shaqraa University, KSA " reached to existence of strong relationship between the success of the student in the studied courses and the previous knowledge about these courses, and nearly 98 % of the success of the students returned to the previous knowledge about the studied courses.

Aromolaran, Adeyemi D., et al; (2013) published a paper entitle "Binary Logistic Regression of Students Academic Performance in Tertiary Institution in Nigeria by Socio-Demographic and Economic Factors". The researchers used four factors. The factors fitted into predictive binary logistic regression model for the log-odds in favor of poor

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performance as Loge$\{\frac{\pi}{1-\pi}\}$ = 0.122 -0.092X_1+0.479X_2–0.383X_3–0.411X_4. A number of recommendations like rendering of financial support to students in need of such, family planning orientation while in school, and teaching of effect demographic and socio-economic factors on student academic performance should be regularly emphasized to students.

MATERIAL AND METHODS

The study was carried out in Faculty of Science and Humanities, Shaqraa University, KSA in February 2015. The sample size determined by proportion formula (3), and using 95% confidence interval with marginal error 5%.

$$n = \frac{(Z_{\frac{\alpha}{2}})^2 pq}{d^2} \rightarrow (3)$$

Where,
P = Probability of success of the student = 0.5
q = Probability of un success of the student = 0.5
d = Maximum estimate of the marginal error = 0.05
$Z_{\frac{\alpha}{2}} =$ Standard normal value = 1.96

Based upon the above values and formula (3), n was equal to 384.

To obtain sample size for proportional allocation a population of size "N" is divided into "L" strata of sizes N_1, N_2,…, N_L, and select samples of sizes n_1, n_2,…, n_L, respectively, from the "L" strata, the allocation is proportional if $n_i = (\frac{N_i}{N})n$ for all i=1,2,3,..,L, (Walpole: 1982).

Since the population combined of male and female, therefore the population was divided into two strata. A simple random sample of size 192 was selected from each stratum by using equal allocation, because the number of male and female students were nearly equal.

The variables used in the study were shown in questionnaire in the appendix (1).

If X_i represents the explanatory (independent) variable, n_i is the sample size of stratum "i", r_i is the sample size of the positive response of stratum "i", and (n_i - r_i) is the sample size of the negative response of stratum "i", then the probability of success is given by equation (4) as follow:

$$p_i = pr(y=1/x) = \frac{r_i}{n_i} \rightarrow (4)$$

and the probability of failure is given by equation (5) as follow:

$$q = 1 - p_i = pr(y=0/x) = \frac{n_i - r_i}{n_i} \rightarrow (5)$$

Since "p" and "1-p" are functions in "X" we can write them according to the Lo. M as in equations (6) and (7).

$$p = \frac{\exp(\beta_0 + \beta_1 X_i)}{1+\exp(\beta_0 + \beta_1 X_i)} \rightarrow (6)$$

$$1 - p = \frac{1}{1+\exp(\beta_0 + \beta_1 X_i)} \rightarrow (7)$$

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The Lo. M is intrinsically linear model, so it can be transformed to L.M and obtain BLUE estimators (Draper and Smith; 1981) and (Rat and David; 1983). In 1944 Berkson transformed the Lo. M to L.M. according to equation (8) by dividing equation (6) by equation (7) and taking logarithm (Berkson; 1944).

$$Ln(\frac{p}{1-p}) = Z_i = \beta_0 + \beta_1 X_i \rightarrow (8)$$

From equation (8), "p" is a function of "Z" and "Z" is a function of X, therefore:

$$\frac{\partial p}{\partial X} = \beta_1 p(p-1) \rightarrow (9)$$

$$\frac{\partial Z}{\partial X} = \beta_1 \rightarrow (10)$$

The mean and variance of "Z" are given by equations (11) and (12) as follow:

$$E(Z) = \beta_0 + \beta_1 X_i \rightarrow (11)$$

$$V(Z) = \frac{1}{n_i p_i (1-p_i)} = \delta_i^2 \rightarrow (12)$$

The Weighted Least Square Method (WLSM) should be used because the mean of "Z" is a function of β_1 *and* X_i, and its variance is a function of its mean, therefore the variance of "Z" is heteroscedasticity, i.e. $V(e_i / X_i) \neq \delta_i^2$.

According to (Kendall and Stuart; 1968) the weight "w_i" which in equation (13) was used to have homogeneity of variance.

$$w_i = \frac{1}{\delta_i^2} = n_i p_i (1-p_i) \rightarrow (13)$$

To estimate ß$_0$ and ß$_1$ the WLSM and partial derivative of ß$_0$ and ß$_1$ were used to equation (14)

$$SSe_i = \sum_{j=1}^{n_i} w_i (Z_i - \hat{Z}_i)^2 = \sum_{j=1}^{n_i} w_i (Z_i - \beta_0 - \beta_1 X_i)^2 \rightarrow (14)$$

At 1st by differentiating equation (14) with respect to ß$_0$ and equate the result by zero, at 2nd by differentiating the same equation with respect to ß$_1$ and equate the result by zero. Finally by solving the two previous equations that obtained by the differentiation we have:

$$\underset{\sim}{\hat{\beta}} = (X'WX)^{-1} X'WZ \rightarrow (15)$$

where: $\underset{\sim}{\hat{\beta}} = \begin{bmatrix} \hat{\beta}_0 \\ \hat{\beta}_1 \end{bmatrix}$, $X = \begin{bmatrix} 1 & X_{11} \\ 1 & X_{21} \\ 1 & X_{31} \\ . & . \\ . & . \\ 1 & X_{n1} \end{bmatrix}$, $Z = \begin{bmatrix} \ln(\frac{p_1}{q_1}) \\ \ln(\frac{p_2}{q_2}) \\ . \\ . \\ \ln(\frac{p_n}{q_n}) \end{bmatrix}$

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$$W = \begin{bmatrix} W_1 & 0 & ..... & 0 \\ 0 & W_2 & ..... & 0 \\ . & . & . & ... \\ . & . & . & \\ 0 & 0 & .... & W_n \end{bmatrix}, \quad X'WZ = \begin{bmatrix} \sum W_i Z_i \\ \sum W_i X_i Z_i \end{bmatrix} \quad X'WX = \begin{bmatrix} \sum W_i & \sum W_i X_i \\ \sum W_i X_i & \sum W_i X_i^2 \end{bmatrix}$$

From the previous equations the vector β can be written as in equation (16)::

$$\hat{\beta} = \begin{bmatrix} \hat{\beta}_0 \\ \hat{\beta}_1 \end{bmatrix} = \begin{bmatrix} \dfrac{\text{cov}(X,Z)}{v(X)} \\ \bar{Z} - \hat{\beta}_1 \bar{X} \end{bmatrix} \rightarrow (16)$$

The estimated value of "Z" can be written as in equation (17):

$$\hat{Z}_i = \hat{\beta}_0 + \hat{\beta}_1 X_i \rightarrow (17)$$

The Sum of Squares due to Regression (SSR) can be written as in equation (18):

$$SSR = S_{\hat{Z}\hat{Z}} = \hat{\beta}_1 \text{cov}(X,Z) = \hat{\beta}_1^2 S_{XX} \rightarrow (18)$$

The Sum of Squares due to Error term (SSE) can be written as in equation (19):

$$SSE = S_{ZZ} - S_{\hat{Z}\hat{Z}} = S_{ZZ} - \hat{\beta}_1^2 S_{XX} \rightarrow (19)$$

$$SST_0 = S_{ZZ} = \sum W_i Z_i^2 - \frac{(\sum W_i Z_i)^2}{\sum W_i} \rightarrow (20)$$

The means of $\hat{\beta}_0$ and $\hat{\beta}_1$ are given by $E(\hat{\beta}_0) = \beta_0$ and $E(\hat{\beta}_1) = \beta_1$, and their variances are given by $S^2_{\hat{\beta}_0} = MSE(C_{00})$ and $S^2_{\hat{\beta}_1} = MSE(C_{11})$ .where C_{00} and C_{11} are the diagonal elements of the matrix $\begin{bmatrix} \sum W_i & \sum W_i X_i \\ \sum W_i X_i & \sum W_i X_i^2 \end{bmatrix}^{-1}$. Since $MSE = \hat{\delta}^2 = 1$, therefore $S^2_{\hat{\beta}_0} = C_{00} = \dfrac{1}{\sum W_i} + \bar{X}^2 S^2_{\hat{\beta}_1}$ and $S^2_{\hat{\beta}_1} = C_{11} = \dfrac{1}{S_{XX}}$.

The hypothesis should be tested is:

$H_0 : \beta_i = 0$ against $H_1 : \beta_i \neq 0 \quad \forall i = 0,1$

To test the above hypothesis the statistic "t" that in equation (21) was used.

$$t_c = \frac{\hat{\beta}_i - \beta_i}{s_{\hat{\beta}_i}} = \frac{\hat{\beta}_i}{s_{\hat{\beta}_i}} \rightarrow (21)$$

where under H_0 we have $\beta_i = 0$.

Since the sample size used in the research was very large, calculated value "t" is approach to Z, therefore it will be compared with the tabulated value "1.96", (because 95% confidence limits was used). If the absolute value of the calculated value in equation (21) is greater than 1.96, H_0 is rejected, otherwise it is accepted.

If we have more than one independent variable, the quantity $Ln(\frac{p}{q})$ can be written as in equation (22).

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$$Ln\left(\frac{p}{q}\right) = \hat{\beta}_0 + \sum_{j=1}^{P} \hat{\beta}_j X_{ij} \rightarrow (22)$$
$$i = 1, 2, \dots, n$$

$Ln\left(\frac{p}{q}\right)$ = Logit transformation

$\left(\frac{p}{q}\right) =$ Odds of success

The value of p is given by equation (23):

$$p = \frac{1}{1 + \exp[-(\hat{\beta}_0 + \sum_{j=1}^{P} \hat{\beta}_j X_{ij})]} \rightarrow (23)$$

Likelihood Function for Logistic Regression (LFLR):

Since Logistic Regression predicts probabilities, rather than just classes, therefore, we can fit it using likelihood. for each training data-point, we have a vector of features, x_i, and an observed class, y_i. The probability of that class was either p, if $y_i = 1$, or 1-p, if $y_i = 0$. The likelihood is then given by equation (24), (Cox; 1966).

$$L(\beta_0, \beta) = \prod_{i=1}^{n} (p(x_i))^{y_i} . (1 - p(x_i) \;\;)^{1-y_i} \rightarrow (24)$$

The log-likelihood turns products into sums as follow:

$$l(\beta_0, \beta) = \sum_{i=1}^{n} y_i . ln\,(p(x_i)) \quad + \sum_{i=1}^{n} (1 - y_i) \ln\big(1 - p(x_i)\big) \;\;) \rightarrow (25)$$

$$= \sum_{i=1}^{n} \ln\big(1 - p(x_i)\big) \;\;) + \sum_{i=1}^{n} y_i . ln \frac{p(x_i)}{(1 - p(x_i))} \rightarrow (26)$$

$$= \sum_{i=1}^{n} \ln\big(1 - p(x_i)\big) \;\;) + \sum_{i=1}^{n} y_i . (\beta_0 + \; x_i\, \beta) \rightarrow (27)$$

$$= \sum_{i=1}^{n} -\ln\big(1 + e^{\beta_0 + \, x_i\, \beta}\big) + \sum_{i=1}^{n} y_i . (\beta_0 + \; x_i\, \beta) \rightarrow (28)$$

Typically, to find the maximum likelihood estimates we differentiate the log likelihood with respect to the parameters, set the derivatives equal to zero, and solve. To start that, take the derivative with respect to one component of β, say β_j

$$\frac{\partial l}{\beta_j} = -\sum_{i=1}^{n} \left(\frac{e^{\beta_0 + \, x_i\, \beta}}{1 + e^{\beta_0 + \, x_i\, \beta}}\right) + \sum_{i=1}^{n} x_i . y_i . \rightarrow (29)$$

$$= \sum_{i=1}^{n} [y_i - \; p(x_i; \beta_{0;}\, \beta)] x_i \rightarrow (30)$$

Equations (29) and (30) are transcendental, and there is no closed form solution. Therefore they can be approximately solved numerically.

For testing goodness of fit, the log likelihood ratio, which distributed as chi – square is used, as in equation (31).

$$X^2 = \; 2[\ln L_0 - \ln L_1] \ldots\ldots (31)$$

L_1 = Likelihood function that contains "i" variables.

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L_0 = Likelihood function that contains "i-1" variables.

To test the significance between observed "h_{ik}" and expected " $h^{\wedge}_{ik}$ " frequencies, the following null hypothesis H_0 is tested according to equation (32).

H_0: $h^{\wedge}_{ik} = h_{ik}$ against H_1: $h^{\wedge}_{ik} \neq h_{ik}$

$$\text{H-Statistics} = \Sigma\Sigma \left(h_{ik} - h^{\wedge}_{ik} \right)^2 / h^{\wedge}_{ik} \quad \ldots\ldots\ldots\ldots..(32)$$

Where H is distributed as chi-square with (m-2) degrees of freedom, where "m" is number of iterations.

According to Hosmer, et al (1988), after coding, data by using SPSS, choosing analyze, Regression, and Binary logistic. By putting the dependent variable in the dialogue box (dependent) and the independent variables in (Covariates). From option, choose 1st classification plots, 2nd Hosmer-Lemeshow goodness of fit, 3rd casewise listing of residual, 4th correlation of estimates, 5th iteration history, 6th CL for exp(ß), 7th Display: (At each step), and Removal: (0.10), 8th Include constant in model.

By using SPSS the data that collected by the questionnaire which in Appendix (1), was analyzed and obtained the summary of the data, containing the selected sample size, as in table (1).

Table (1): Case Processing Summary of Data.

Case Processing Summary			
Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	384	100.0
	Missing Cases	0	.0
	Total	384	100.0
Unselected Cases		0	.0
Total		384	100.0
a. If weight is in effect, see classification table for the total number of cases.			

Table (2) shows coding data of the dependent variable.

Table (2): Dependent Variable Encoding

Original Value	Internal Value
less than 4	0
4 and above	1

Appendix (2) includes step1 iteration history of the studied data, contains 8 iterations. -2 Log likelihood = 169.489 (at this point the function at least limit). Because there was no changing in coefficients at iteration 8, therefore, the iteration stopped at this point. Appendix (3) includes Wald statistics for each parameter of the estimated model, degrees of freedom (df), significance of the parameters, the expected values of the dependent variable (Exp(B)) and their 95% confidence interval. Appendix (3) is also contains coefficients of the estimated model.

From table (3), R^2 is equal to 0.578, which means that nearly 58% of the change of the student's academic rate depends upon the change of the studied independent variables.

Table (3): Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	169.489[a]	.329	.578
a. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.			

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According to the result that in table (4), chi-square was equal to 153.063, with 15 degrees of freedom and level of significance 0.000 (less than 0.001), therefore, the fitted model is significant.

Table (4): Omnibus Tests of Model Coefficients

		Chi-Square	df	Sig.
Step 1	Step	153.063	15	.000
	Block	153.063	15	.000
	Model	153.063	15	.000

From table (5), H-Stat (Chi-Square) = 8.649, with df=8 and level of significance "Sig.=0.373", therefore, H_0: is accepted. This means that the fitted model passed the test of the goodness of fitting.

Table (5): Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	8.649	8	.373

Table (6) describes Contingency Table for Hosmer and Lemeshow Test that use non-parametric chi-square test for testing goodness of fitting logistic regression.

Table (6): Contingency Table for Hosmer and Lemeshow Test

		Students' Academic Rate = less than 4		Students' Academic Rate = 4 and above		Total
		Observed	Expected	Observed	Expected	
Step 1	1	38	37.943	0	.057	38
	2	38	37.883	0	.117	38
	3	38	37.817	0	.183	38
	4	38	37.739	0	.261	38
	5	37	37.544	1	.456	38
	6	35	37.095	3	.905	38
	7	37	36.119	1	1.881	38
	8	35	32.220	3	5.780	38
	9	18	19.905	20	18.095	38
	10	13	12.736	29	29.264	42

From table (7), the overall percentage correct is equal to 90.1%, therefore the probability of incorrect classification is 9.9%.

Appendix (4) shows the correlation matrix of the studied variables.

The fitted model can be written from appendix (3) as follow:

$$\ln\left(\frac{p}{1-p}\right) = -12.084 + 0.847X_1 + 1.067X_2 - 0.519X_3 + 1.299X_4 - 0.532X_5 + 2.366X_6 - 0.455X_7 - 0.576X_8 + 0.698X_9 + 0.336X_{10} + 0.129X_{11} + 1.666X_{12} + 0.014X_{13} + 0.074X_{14} - 0.414X_{15}$$

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RESULTS

There is relationship exists between the academic rate of the students and the studied variable.

The academic rate of the students depends upon the studied variables by probability nearly equal to 90%.

About 58% of the changing that occurs to the academic achievement of the student in Faculty of Sciences and Humanities (Thadiq), due to the studied factors.

From appendix 3, 95% confidence limit for Exp(B) does not contain zero, therefore the fitted model is significant.

DISCUSSIONS

In consequence of the above mentioned results, the following points discussed:
To conduct similar studies in other colleges.
To conduct similar studies to variables that not included in the studied model.
To take the advantages of this study in the planning and improvement of student's academic achievement.

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APPENDICES

Appendix (1): Questionnaire

No	Variable	**Symbol**	Classification	**Code**
1-	Students' Academic Rate (Dependent Variable)	Y	Less than 4 ( )	0
			4 and above ( )	1
2-	Sex	X_1	Female ( )	0
			Male ( )	1
3-	Father's Educational Status	X_2	Less than Higher Secondary School ( )	0
			Higher Secondary School and above ( )	1
4-	Mather's Educational Status	X_3	Less than Higher Secondary School ( )	0
			Higher Secondary School and above ( )	1
5-	Existence of big brother(Sister) helps in study	X_4	No ( )	0
			Yes ( )	1
6-	Existence of desire in the specialty	X_5	No ( )	0
			Yes ( )	1
7-	Average number of hours of revision	X_6	Less than 3 hours ( )	0
			3 hours and above ( )	1
8-	Revision with colleagues in groups	X_7	No ( )	0
			Yes ( )	1
9-	Can the majority of the students understand the Professors or Lecturers who teach courses?	X_8	No ( )	0
			Yes ( )	1
10-	Does the classrooms equipped for teaching.	X_9	No ( )	0
			Yes ( )	1
11-	Far of college from your residence.	X_{10}	No ( )	0
			Yes ( )	1
12-	Adequacy of the expenses	X_{11}	Not Enough ( )	0
			Enough ( )	1
13-	Availability of courses	X_{12}	No ( )	0
			Yes ( )	1
14	Taking advantage of Academic Advising	X_{13}	No ( )	0
			Yes ( )	1
15-	Contribution to sports activities of the college	X_{14}	No ( )	0
			Yes ( )	1
16-	Participation to cultural activities of the college	X_{15}	No ( )	0
			Yes ( )	1

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Appendix (2): Iteration Historya,b,c,d

		Coefficients																
		-2log likelihood	Constant	x1	x2	x3	x4	x5	X6	x7	X8	X9	X10	x11	X12	X13	x14	x15
Step1	1	227.548	-4.081-	.225	.212	.143	.558	-.103-	.418	-.128-	-.193-	.204	.182	-.037-	.837	-.118-	.093	-.357-
	2	183.948	-6.749-	.485	.431	.043	.888	-.257-	.834	-.257-	-.362-	.402	.298	.010	1.226	-.127-	.133	-.481-
	3	172.300	-9.181-	.723	.743	-.240-	1.130	-.427-	1.368	-.382-	-.501-	.593	.354	.080	1.494	-.081-	.136	-.483-
	4	169.817	-10.955-	.830	.986	-.461-	1.259	-.515-	1.911	-.445-	-.565-	.684	.349	.119	1.628	-.020-	.104	-.444-
	5	169.501	-11.854-	.847	1.059	-.515-	1.295	-.532-	2.263	-.455-	-.575-	.698	.338	.128	1.662	.010	.078	-.418-
	6	169.489	-12.073-	.847	1.066	-.519-	1.298	-.532-	2.360	-.455-	-.576-	.698	.336	.129	1.666	.014	.075	-.414-
	7	169.489	-12.084-	.847	1.067	-.519-	1.299	-.532-	2.366	-.455-	-.576-	.698	.336	.129	1.666	.014	.074	-.414-
	8	169.489	-12.084-	.847	1.067	-.519-	1.299	-.532-	2.366	-.455-	-.576-	.698	.336	.129	1.666	.014	.074	-.414-

a. Method: Enter
b. Constant is included in the model.
c. Initial -2 Log Likelihood: 322.552
d. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

Appendix (3): Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	x1	.847	.444	3.648	1	.056	2.334	.978	5.568
	x2	1.067	.973	1.202	1	.273	2.905	.431	19.563
	x3	-.519-	.931	.311	1	.577	.595	.096	3.688
	x4	1.299	.607	4.574	1	.032	3.664	1.115	12.043
	x5	-.532-	.411	1.677	1	.195	.587	.262	1.314
	X6	2.366	1.203	3.869	1	.049	10.654	1.009	112.536
	x7	-.455-	.479	.901	1	.343	.635	.248	1.624
	X8	-.576-	.452	1.620	1	.203	.562	.232	1.365
	X9	.698	.504	1.918	1	.166	2.009	.748	5.393
	X10	.336	.519	.419	1	.518	1.400	.506	3.873
	x11	.129	.474	.074	1	.786	1.137	.449	2.878
	X12	1.666	.666	6.264	1	.012	5.290	1.435	19.496
	X13	.014	1.880	.000	1	.994	1.014	.025	40.402
	x14	.074	1.864	.002	1	.968	1.077	.028	41.604
	x15	-.414-	.587	.497	1	.481	.661	.209	2.089
	Constant	-12.084-	3.006	16.163	1	.000	.000		

a. Variable(s) entered on step 1: x1, x2, x3, x4, x5, X6, x7, X8, X9, X10, x11, X12, X13, x14, x15.

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Appendix (4): Correlation Matrix

		Constant	x1	x2	x3	x4	x5	X6	x7	X8	X9	X10	x11	X12	X13	x14	x15
Step 1	Constant	1.000	-.344-	-.133-	.017	-.110-	-.109-	-.440-	-.185-	-.060-	-.183-	-.261-	-.254-	-.119-	-.007-	-.038-	-.383-
	x1	-.344-	1.000	.230	-.212-	.107	.044	.001	-.114-	-.116-	.000	.107	.123	-.022-	.033	-.015-	.115
	x2	-.133-	.230	1.000	-.710-	.009	-.111-	-.148-	.002	-.042-	-.076-	-.103-	-.024-	.048	.176	-.155-	.154
	x3	.017	-.212-	-.710-	1.000	-.167-	.119	.020	-.079-	.176	.024	.036	.041	-.297-	-.145-	.150	-.035-
	x4	-.110-	.107	.009	-.167-	1.000	-.074-	-.275-	-.009-	-.038-	-.162-	-.029-	.079	.053	.013	.005	.199
	x5	-.109-	.044	-.111-	.119	-.074-	1.000	-.020-	.008	.050	-.093-	-.036-	-.067-	-.001-	-.028-	.031	-.054-
	X6	-.440-	.001	-.148-	.020	-.275-	-.020-	1.000	.010	-.130-	.184	.030	-.077-	-.275-	-.019-	-.006-	-.188-
	x7	-.185-	-.114-	.002	-.079-	-.009-	.008	.010	1.000	-.208-	-.133-	.035	.030	-.029-	.062	-.052-	.266
	X8	-.060-	-.116-	-.042-	.176	-.038-	.050	-.130-	-.208-	1.000	.010	-.185-	-.067-	-.001-	-.025-	.026	-.037-
	X9	-.183-	.000	-.076-	.024	-.162-	-.093-	.184	-.133-	.010	1.000	-.195-	-.018-	-.110-	-.109-	.094	.036
	X10	-.261-	.107	-.103-	.036	-.029-	-.036-	.030	.035	-.185-	-.195-	1.000	.084	.025	-.005-	.020	.061
	x11	-.254-	.123	-.024-	.041	.079	-.067-	-.077-	.030	-.067-	-.018-	.084	1.000	.208	.039	-.045-	-.165-
	X12	-.119-	-.022-	.048	-.297-	.053	-.001-	-.275-	-.029-	-.001-	-.110-	.025	.208	1.000	-.003-	-.006-	.216
	X13	-.007-	.033	.176	-.145-	.013	-.028-	-.019-	.062	-.025-	-.109-	-.005-	.039	-.003-	1.000	-.974-	-.096-
	x14	-.038-	-.015-	-.155-	.150	.005	.031	-.006-	-.052-	.026	.094	.020	-.045-	-.006-	-.974-	1.000	.070
	x15	-.383-	.115	.154	-.035-	.199	-.054-	-.188-	.266	-.037-	.036	.061	-.165-	.216	-.096-	.070	1.000