

# Comparison of University Entrance Examination Scores with Graduate Students' GPA and Effects on Students' Success

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## Abstract

Choosing talented students is very essential and critical issue for each university. The International Black Sea University (IBSU) uses some measurements to choose and admit students like other universities. Before the National Unified Entrance Examination (NUEE), the Georgia Ministry of Education and Science, asks the IBSU for the coefficients of the Georgian Language, Logic, English Language and Mathematics which were written in this examination. The purpose of the present article is to decide an optimal distribution of these coefficients to accept students to the Faculty of Computer Technologies & Engineering (CT&E) and to the Faculty of Business & Management (B&M). This paper finds and compares correlation between the scores of NUEE and grade point average (GPA) of university diploma of the students of two faculties. Among prior academic achievement measures, University exam scores were examined to predict graduate students' GPA. The correlation and regression analysis indicates that there is low positive correlation between university entrance exam score and university GPA. Optimal weights were found for the given categories of NUEE.

**Keywords:** university entrance examination, GPA, multiple regression, correlation, engineering, business and management, matrix form.

## Introduction

We focused on the following questions to guide this investigation:

1. What percentage of variances in graduate students' GPA can be explained by the national unified university entrance examination?

2. What is the set of optimal weights of NUEE categories to choose best students for CT&E and B&M Faculties?

Because of the previous investigations about the academic success our hypothesis is prior academic achievements affects university GPA (Farahani A.,2001). There is positive correlation between university entrance exam and university GPA. We focused on this hypothesis and tried to proof it.

The Georgia National Examinations Center (NAEC) executes examinations on the large scale. This center is responsible for administering national university entrance examinations. 12th grade students writes this entrance examination in distinct categories. In this study we concentrate on the results of the Georgian Language , Logic, English Language and Mathematics scores. Their effects on the GPA and relation between the given weights of these scores and GPA were indicated.

Providing a basis for determining the adequacy of education is the reason for measuring the entrance behavior of the learners. If at the end of the instruction, the educational organization finds out that some of the learners have not acquired the final objectives, this will help it to decide

whether it is due to insufficient education or inadequacy of learners' preparedness (entrance behavior). (Farahani A., 2001). Here we used the scientific methods to clarify the situation.

## Methods

In this paper variety of methods and sources were used. The research was done for the (CT&E) and the (B&M) Faculties of IBSU. The Georgia NUEE (2007) results were used as input data. This data was taken from the <http://www.naec.ge/home.html?lang=en-GB>. This site was prepared by the Georgia Ministry of Education and Science.

The sample size of the data is 100 for the Engineering faculty. Since thirty students dropped out of university, information of 69 students was used in calculations. On the other hand the information of 96 students from the Faculty of B&M was used.

GPA scores were found from the IBSU student information system. Obtained data was analyzed using multiple regression method. All predictor variables were entered in the multiple regression analysis to find their effects on the GPA. To show the relation between weighted scores of NUEE and GPA correlation coefficients were calculated with MATLAB. Necessary calculations were done in Excel 2010.

Our problem was defined and represented in matrix form in the Notations and Definitions section.

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```

ResultXY resultXY = new ResultXY();
resultXY.setKey(Combination.combinations[i]);
resultXY.setSumOfCombinationsValues(sumOfCombinationsValuesSquare);
resultXY.setSumOfCombinationsValuesSquare(sumOfCombinationsValuesSquare);
resultXY.setSumOfGPAs(sumOfGPASquares);
resultXY.setSumOfGPASquares(sumOfGPASquares);
resultXY.setSumOfMultiplyOfCombinationsValuesAndGPA(sumOfMultiplyOfCombinationsValuesAndGPA);

double resultForRxy= ((sumOfMultiplyOfCombinationsValuesAndGPA)-((sumofGPAs *
sumOfCombinationsValues)/(studentList.size()))
/ Math.sqrt( ((sumOfCombinationsValuesSquare) - ( Math.pow(sumOfCombinationsValues,2) / (studentList.size()) ) )
* ((sumOfGPASquares) - ( Math.pow(sumOfGPAs,2) / (studentList.size()) ) ) );

resultsForCombinations.put(stringValOf(Combination.combinations[i]), resultForRxy);
resultXY.setResult(resultForRxy);
results.add(resultXY);
    
```

Frame 1

The program was written with Java programming language to find the set of optimal coefficients for the larger data. This program has the ability to connect data directly with a .csv file (comma separated values). We were thus able to calculate the optimum coefficients for the other faculties too.

**Notations and Definitions**

In this section necessary notations and definitions were given. To find correlation between the weighted four input variables of the NUEE in 2007-2008 academic years and GPA of the final students of the two faculties of IBSU in 2010-2011 academic years, first mathematical illustration was done.

Correlation Analysis is to measure the strength or degree of linear association between two variables. You cannot say that one of them “causes” the other. Correlation tells you that as one variable changes, the other seems to change in a predictable way. A single summary number that gives you a good idea about how closely one variable is related to another variable (Higgins J., 2005).

This number is important to explain the situation between the GPA and the column vector of the weighted averages which are suggested below. In our sample to find the optimum distribution of the coefficients, the following matrices were used.

$$A = [a_{ik}] \quad (1 \leq i \leq 69 \text{ and } 1 \leq k \leq 4),$$

$$B = [b_{kj}], \quad (1 \leq k \leq 4 \text{ and } 1 \leq j \leq 24)$$

Matrix A defined by the scalars  $a_{ij}$  is called matrix representation of entry scores of our sample. In the matrix  $A=[a_{ij}]$  the first column  $a_{i1}$  shows grades of Georgian Language, second column  $a_{i2}$  represents Logic grades,  $a_{i3}$  shows English Language marks and the last column  $a_{i4}$  indicates grades of Mathematics of the students after the NUEE in Georgia (2007).

Matrix  $B=[b_{kj}]$  is called matrix of coefficients which is denoted as permutations of the set  $\{1,2,3,4\}$ .  $P(4,4)=4!(4-4)!=24$  is the number of the column of matrix B and we use 24 different permutations of set  $\{1,2,3,4\}$  as elements of matrix B.

The product of A and B, denoted AB is the  $69 \times 24$  matrix such that

$$X = [x_{ij}] = (AB)_{ij} = \sum_{k=1}^4 A_{ik}B_{kj} \quad \text{for } 1 \leq i \leq 69, 1 \leq j \leq 24$$

The values of GPA is represented as column vector

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_i \\ \vdots \\ y_{69} \end{bmatrix} \quad 1 \leq i \leq 69 \quad \text{and new product matrix } X=[x_{ij}]$$

is represented as :

$$X = \begin{bmatrix} x_{11} & \dots & x_{1j} \\ x_{21} & \dots & x_{2j} \\ \vdots & \dots & \vdots \\ \vdots & \dots & \vdots \\ x_{i1} & \dots & x_{ij} \\ \vdots & \dots & \vdots \\ \vdots & \dots & \vdots \\ x_{691} & \dots & x_{69j} \end{bmatrix} \quad 1 \leq i \leq 69, 1 \leq j \leq 24$$

To indicate linear dependence between each column of  $X=(AB)_{ij}$  matrix and vector Y, first each column of matrix X is rearranged with the following way:

$$X=[X_1 X_2 \dots X_{24}]$$

The first column is rewritten as below:

$$X_1 = \begin{bmatrix} x_{11} \\ x_{21} \\ \vdots \\ x_{i1} \end{bmatrix} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_i \end{bmatrix}, \quad i = 69$$

We used the same way respectively for the  $X_2, X_3, \dots, X_{24}$  to assign  $x_{ij}$  values to  $x_i$ . In the last step we obtain the last column vector

$$X_{24} = \begin{bmatrix} x_{1j} \\ x_{2j} \\ \vdots \\ x_{ij} \end{bmatrix} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_i \end{bmatrix} \quad i = 69, j = 24$$

Using vector  $X_1$  the first correlation coefficient is calculated by the general Pearsons’ correlation coefficient formula. For the Faculty of CT&E the formula is applied

```

public static void main(String[] args) {
    // TODO Auto-generated method stub
    //File inFile = new File("C:\\input.csv");

    try {
        // args[0] -> "E:\\Dev\\allWorkspaces\\GPACalculator\\data.csv"
        if (args.length<=0)
            throw new Exception();
        BufferedReader reader = new BufferedReader(new FileReader(args[0]));
        List<Student> studentList = new ArrayList<Student>();
    }
}
    
```

Frame 2

in the following way:

$$r_k = \frac{\sum_{i=1}^{69} x_i y_i - \frac{\sum_{i=1}^{69} x_i \sum_{i=1}^{69} y_i}{n}}{\sqrt{\left(\sum_{i=1}^{69} x_i^2 - \frac{(\sum_{i=1}^{69} x_i)^2}{n_x}\right) \left(\sum_{i=1}^{69} y_i^2 - \frac{(\sum_{i=1}^{69} y_i)^2}{n_y}\right)}} ; \quad 1 \leq k \leq 24$$

It is easy to use the same formula for the B&M Faculty too. We gave the mathematical view of our sample in the previous descriptions. Using the above formula we wrote Java code to calculate the correlation for the larger data. A part of that code which calculates the correlation coefficient is given in (frame1)

In the following frame 2 we connected data.csv files with Java code to insert input data. This application is fast enough to have the results and compare them for the other faculties too.

MATLAB calculations and the above Java code showed that the set of optimal weights is [4, 1, 3, 2] since r2=0.56 is the largest correlation between weighted input entry scores and output GPA for the Faculty of B&M. Also [1, 2, 4, 3] gives the best correlation r1=0.39 between weighted input entry scores and output GPA in Faculty of Engineering. r1=0.39 is the best choice between 24 correlation coefficients in engineering faculty. Unfortunately this result suggests that there is low correlation among weighted entry exam values and GPA scores of students of Engineering faculty. On the other hand r2= 0.56 is the largest correlation coefficient in Faculty of Business and Management. In two cases it is clear that there is positive correlation between input values and GPA.

Both input and output are not independent .Because If X and Y are statistically independent , the correlation coefficient between them is zero, but if r=0 , it does not mean that two variables are independent. In other words zero correlation does not necessarily imply independence [Gujarati D.N., 2005].

In our case study r1 is closer to zero than r2 but not zero. The closer a correlation coefficient is, the weaker the relationship is and the less you are able to tell exactly what happens to one variable based on knowledge of the other. Regression Analysis gives us detailed information for both faculties.

Results of regression analysis for the Faculty of Computer Technologies and Engineering are suggested in Table 1a, 1b and Table 2a, 2b.

### Regression Analysis Results and Its Interpretation

The multiple regression method was used to extract ideal relation between the NUEE scores and final university GPA. In the regression analysis  $\alpha$  level was chosen 0.05 and our model, as a whole, is a significant fit to the data since in both table1b and table 2b significance was lower than 0.05.

In table 1a, R square=0.15 which implies that only 15% of the GPA scores can be explained by variables of NUEE. From table 2a, R square=0.37 and it is clear that 37% of the GPA scores can be explained by the independent variables of NUEE.

In our multiple linear regression method, there are 4 Explanatory variables. These were Georgian Language (GL), Logic (L), English Language (EL) and Mathematics(M).

The theoretical model was given in equation1 (Orlow M.L.,1996):

$$GPA = \beta_0 + GL * \beta_1 + L * \beta_2 + EL * \beta_3 + M * \beta_4 \quad (eq.1)$$

According to the matrix of entry marks  $A = [a_{ik}] (1 \leq i \leq 69, 1 \leq k \leq 4)$  estimated equation for the CT&E Faculty is given in equation2:

$$\hat{Y}_i = 31.1 + 0.009 * a_{i1} + 0.15 * a_{i2} + 0.22 * a_{i3} + 0.15 * a_{i4} ; (1 \leq i \leq 69) \quad (eq.2)$$

For the B&M Faculty our estimated equation was given in equation3:

$$\hat{Y}_i = -45.15 + 1.15 * a_{i1} - 0.32 * a_{i2} + 0.23 * a_{i3} + 0.43 * a_{i4} ; (1 \leq i \leq 91) \quad (eq.3)$$

Table 1A: Regression statistics results of CT&E Faculty

Regression Statistics-CT&E Faculty	
Multiple R	0.39
R Square	0.15
Adjusted R Square	0.10
Standard Error	11.80
Observations	69

**Table 1B: ANOVA**

Engineering	df	SS	MS	F	Significance F
Regression	4	1657.79	414.44	2.97	0.026
Residual	64	8916.66	139.322		
Total	68	10574.4			

Dependent variable: GPA

Independent variables (Predictors): Georgian Language, Logic, English Language, Mathematics

**Table 2A: Regression statistics outputs for the B&M Faculty**

Regression Statistics- B&M Faculty	
Multiple R	0.60
R Square	0.37
Adjusted R Square	0.34
Standard Error	14.78
Observations	92

**Table 2B: ANOVA**

Business	df	SS	MS	F	Significance F
Regression	4	10967.7	2741.926	12.54283	4.23E-08
Residual	87	19018.64	218.605		
Total	91	29986.34			

Dependent variable: GPA

Independent variables (Predictors): Georgian Language, Logic, English Language, Mathematics

It was found that in the table 1a  $r_3=0.39$  and in the table 2a  $r_4=0.60$ .  $r_3$  and  $r_4$  shows the correlation coefficient between entry scores (not weighted) and graduated students university GPA.

**Table 3: Descriptive Statistics of Data**

The Faculty of Business and Management								
Categories of NUEE	Georgian Language	Logic	English	Math	Total	Dm.	Not finish.	IBSU GPA (2007-2011)
Mean	81	77.41	91.31	74.38	1752.14	9	7	75.01
The Faculty of Computer Technologies and Engineering								
Categories of National Entry Exam	Georgian Language	Logic	English	Math	Total	Dm.	Not finish.	IBSU GPA (2007-2011)
Mean	66.16	64.93	81.1	66.75	1660.7	30	13	70.01

**Table 4: Correlation Analysis results for two faculties:**

Correlation Analysis (NUEE) Scores	B&M F.	CT&E F.		B&M F.	CT&E F.
	IBSU GPA	IBSU GPA		IBSU GPA	IBSU GPA
TOTAL	0.40	0.39	For first 20 students	0.45	0.60
ENGLISH L.	0.19	0.25		0.19	0.28
MATH	0.33	0.33		0.39	0.55
LOGIC	0.18	0.31		0.46	0.33
GEORGIAN L.	0.53	0.12		0.27	0.27

## Conclusion

The correlation analysis result shows that when we compare weighted entry inputs with GPA  $r_1=0.39$  and  $r_2=0.56$  for the CT&E and B&M faculties respectively. This study suggested that there is positive low correlation between the NUEE scores and the university GPA of the faculty of CT&E. This relation increases for the B&M Faculty of the IBSU. There is 43.5% differences between  $r_1=0.39$  and  $r_2=0.56$ . The total average of NUEE of B&M.F is 5.5% higher and average university GPA is 7% higher than CT&E faculty. The multiple regression analysis results implies that  $r_3=0.39$  and  $r_4=0.60$  for the CT&E and B&M faculties. We can say that higher entry results increases the success of the students. This situation shows the importance of the entrance behavior (scientific background). Entrance behavior is consisted of the abilities that a learner should have acquired before starting an educational level. What the learner has learned before which is considered as prerequisite for learning the new materials and also all of the positive and negative experiences resulted from previous taught which are effective in instructing new materials are called as entrance behavior. Though it may be assumed as an evident, the preparedness of the learner is very important. In many cases, the learner cannot behave in the way that the teacher expects. It should be recalled that if the learner is not prepared for learning the materials, the instructor will not succeed in teaching them. (Farahani A., 2001).

As we explained there is not high positive correlation between university entrance scores and GPA. The correlation between weighted entry averages and GPA is also low. Selecting students with the help of coefficients does not affect significantly on GPA scores. But to choose best group of students set of optimal coefficients should be considered with other factors too. The relationship/interactions between the factors cannot be ignored.

This study indicates that, in the engineering faculty 30% of 100 students dropped out of university. A bulk of literature on the prediction of academic success and retention among first year university students showed that most students, despite the academic, social, emotional and other challenges, successfully complete the transition period and achieve academic success (e.g. DeBerad, Julka & Spielmans, 2004). Others do not manage these challenges and are forced to leave their study at its early stage. According to Tinto (1993), the majority of students (75%) leave college during the first years (57%) of them do so without graduation. And first year first semester GPA is one of the major responsible factors for early drop-out from college (McGrath & Braunstein, 2007). In our sample, the university entrance scores of these kind of students indeed are not low. But first year university GPA is very low. The difficulties of the lectures in the engineering faculty show the

need for prior academic preparedness. The reasons for the dropouts should be searched in another study. On the other hand the problem is less in the B&M Faculty. We can say that at the beginning of the university education the level of B&M students are 5.5% better than the CT&E students. The quantitative thinking is the most significant predictor for the CT&E. This important point should be considered mainly when we choose students of CT&E Faculty.

Eventually the results of the first twenty students indicate that the students are able to have higher GPA when they start with high entrance scores. The correlation between these students' entrance scores and GPA is higher than other students (see table 4).

Finally according to Olani A. (2009) for the higher academic success in institutions, prior academic achievement measures (preparatory school grade average point(GPA), aptitude test scores, university entrance scores) and psychological variables (achievement motivation and academic self-efficacy) should be examine together. The NUEE scores only, are not enough to explain background education deposit and to show real picture. This study should be developed to have better education success.

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