CORRELATION-REGRESSION ANALYSIS - AS A MEANS OF IMPROVING THE QUALITY AND EFFICIENCY OF THE EDUCATION SYSTEM IN HIGHER EDUCATION INSTITUTION

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Article history:		Abstract:
Received:	1st April 2021	In order to improve the quality and effectiveness of education in this article, a correlation-regression analysis of the factors influencing it (specialization and supply sciences) is carried out and the relationship between them is studied. Based on the regression equations representing this relationship, a scientifically based proposal and recommendation for use in educational practice has been developed.
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INTRODUCTION.

One of the main goals of modernization of higher education is to improve the quality of education. This is due to the transition to mass higher education, the increase in the number of higher education institutions, the commercialization of education and the formation of a competitive environment in the market of educational services, the reduction of time for updating data (information). That is, its obsolescence before the end of the training cycle, the process of globalization due to social and geographical mobility, the shift of the labor market priority in the direction required not only the knowledge of the specialist, but also the set of competencies.

In addition to the internal benefits of higher education, this also requires the harmonization of the national education system with international standards. This coordination will not only improve the quality of teaching in higher education. Nevertheless, to ensure transparency, to eradicate corruption, to reveal the true knowledge of the student, for the student to study and work independently, to train high-quality personnel, diplomas of the Republic of Uzbekistan, including Doctor of Science, Candidate of Science, academic degrees allow for real recognition in the international educational services and the labor market.

Therefore, in recent years in our country at the level of public policy serious attention is paid to improving the quality of higher education and its further improvement, and extensive work is being done in this direction. Including:

— organization of training in accordance with the requirements of international standards;

— wider introduction of modern teaching methods and tools to further improve the quality and efficiency of the educational process;

— training of competitive, intellectually capable personnel, taking into account the needs of the labor market;

— provision of quality educational services; systematic study and analysis of knowledge, skills, abilities; development of improved assessment mechanisms to determine the level of professional readiness;

— creation of a system of clear, stable and promising procedures for evaluating the activities of higher education institutions; research of scientific bases of development of organizational and economic mechanisms and etc.

The above-mentioned reforms in the higher education system, if we pay attention to the large-scale work, we can see that they are based on the training of worthy, high quality, qualified and highly competitive personnel who can meet the requirements of international standards. This article is based on the study of research and scientific research of foreign higher education institutions on the training of high-potential, competitive personnel and taking into account the specific features of the higher education system of our country. We found it necessary to pay attention to some aspects of these educational institutions related to improving the quality of training of intellectually gifted personnel.

It is known that one of the constituent elements of determining the level of quality and ranking of higher education institutions is the achievements and quality of knowledge of students. Achievements of students and the quality of knowledge, in turn, are determined by monitoring, evaluation and diagnosis of their knowledge in the specialty (specialty) [5]. In particular, it should be noted that the study of specialties, humanities and socio-economic

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sciences, mathematics and natural sciences, general sciences, additional and elective sciences plays an important role in improving the quality of training high-potential personnel.

This is due to the fact that the mastery of general education subjects by students is the basis for their comprehensive development, the formation of knowledge, skills, abilities, levels and abilities, and the mastery of professional subjects promotes the acquisition of relevant professions and specialties. Also, the combination of the above-mentioned set of disciplines in the combination of theory and practice leads to positive results in terms of the quality of training. This, in turn, is an important factor in improving the quality of education in higher education institutions.

The subjects (modules) studied by students and the hours (credits) allocated to them, the number of allocated weeks and other necessary parameters are reflected in the curriculum. This is evidenced by Article 35 of Chapter 4 of the Law of the Republic of Uzbekistan "On Education" (Organization and control of educational activities) ("Curricula and study programs are developed on the basis of the goals and objectives of the relevant stages of education. The content of curricula and study programs in relevant state educational institutions and organizations, the order of their development and implementation The Ministry of Preschool Education, the Ministry of Public Education, the President under the Cabinet of Ministers, the Agency for Creative and Specialized Schools and the Ministry of Higher and Secondary Special Education. It is permissible to cite the information stated in). [1]

Thus, based on the above considerations, it can be said that the quality of teaching is a complex, complex problem as the preparation of students for further professional activity in higher education institutions depends on many factors. There are many types of mathematical models and approaches to solving this complex problem [6-15]. In the article, we focus on the approach to deriving regression equations and forecast estimates in order to analyze and manage the quality of teaching in academic subjects. That is, on the basis of the development of mathematical models, we will consider one of the directions of improving the quality of training on the account of forecasting the assimilation of students in certain disciplines of the educational process (mathematical and Natural-Scientific, general-educational, complementary and competitive Sciences). In particular, we will consider one of the directions of improving the quality of teaching by forecasting the mastery of students in the specialty subjects, which is taken as a necessary condition. In this case, a quantitative assessment of the quality criterion is carried out.

CRITERIA OF QUALITY

It is known that the effectiveness of education is characterized by qualitative and quantitative criteria. Quality criteria reveal the internal links between the concepts of "education, the purpose of teaching", "the cost of teaching" and "learning outcomes". The criteria in the second view show the quantitative relationship of these concepts. In this case, quantitative indicators can determine the qualitative criteria of efficiency, and qualitative indicators can supplement quantitative indicators.

The methodical determination of teaching effectiveness consists in assessing the role of teaching and learning in improving the effectiveness of manpower training through the use of appropriate criteria.

The objectivity of the solution of any mathematical model depends in many respects mainly on the reliability of the initial data. In the research work, the assessment of students (the results of mastering the subject) is used as this information. This is the most objective assessment, which is determined by the teacher. In all uncertainties, it is still a criterion and indicator (indicator) of the quality of teaching. The new generation of state education standards (SES) currently being developed is geared towards a competency-based approach and some adjustments may be made to the concept of "criterion of quality".

AN APPROACH TO DERIVING REGRESSION EQUATIONS

In the econometric assessment of the factors, influencing the quality and effectiveness of teaching in higher education institutions through economic-mathematical methods allows studying the strength of the interdependence of disciplines that provide specialization, to determine their laws and to observe them experimentally.

On the basis of the analysis of improving the quality and effectiveness of teaching using correlation-regression analysis methods to determine the strength of the relationship between factors and identify areas for correct organization and regulation of teaching in higher education institutions in interdisciplinary linkage.

It is known that correlation-regression analysis is the most widely used method in the study of correlations. Correlation analysis gives an idea of the bond density, but not its shape. Regression analysis is used to analyze the effect of one or more factors on the outcome indicator. If the correlations between the phenomena studied on the basis of correlation analysis are strong (that is, it is strong enough and statistically significant), it is expedient to find their mathematical expression in the form of a regression model and assess its adequacy.

Let us consider an approach to deriving regression equations and prognostic estimates in order to analyze and manage the quality of teaching in academic subjects. These equations can be obtained on the basis of processing real data on the mastery of students and using regression analysis.

The first step in solving this problem is to choose a specialty and some related disciplines (mathematical and natural sciences, general, additional and elective sciences). The chosen disciplines must be subject to the requirements of the structural-logical schemes and logical content of a particular field of study or specialty curriculum.

As a concrete example, in accordance with the curriculum of the 4th year of Termez State University 5130200 - "Applied Mathematics and Informatics", one specialty and four support subjects (mathematics and natural sciences, general, additional and elective subjects) taught in the 7th semester.

The following are their names and symbols:
- ✦ specialty: - "Mathematical modeling of practical problems" - y;
- ✦ providing sciences:
- Probability Theory and Mathematical Statistics (PT and MS) - x_1;
- Game Theory and Process Research (GT and PR) - x_2;
- System Programming (SP) - x_3;
- ch.s. Technology for creating electronic textbooks (TCET) - x_4;

As noted above, from the results of mastery in science (RMS) of the students of the two study groups were used as mentioned above (1-schedule). Levels of mastery in science are recorded in points.

1-schedule
Results of mastering the subject by students of two study groups (in points)

№	MMPP	PT and MS	GT and PR	SP	ch.s. TCET	№	MMPP	PT and MS	GT and PR	SP	ch.s. TCET
-	y	x_1	x_2	x_3	x_4	-	y	x_1	x_2	x_3	x_4
1	69	65	69	65	61	25	73	73	72	72	62
2	80	71	74	67	62	26	72	71	75	60	69
3	80	72	80	82	67	27	60	57	59	63	17
4	77	71	81	71	73	28	76	72	72	65	57
5	75	64	56	69	60	29	75	60	68	61	17
6	77	72	63	72	61	30	62	71	64	78	17
7	88	86	86	90	90	31	72	72	69	65	60
8	79	72	83	77	75	32	59	71	66	73	59
9	76	71	84	68	78	33	68	72	61	64	67
10	76	75	78	78	61	34	66	72	63	67	21
11	79	80	82	80	71	35	57	60	57	63	67
12	73	72	81	68	65	36	72	58	75	65	73
13	72	71	75	78	60	37	64	60	56	59	57
14	71	72	78	69	71	38	71	71	71	63	66
15	78	81	82	76	76	39	62	56	61	63	60
16	76	72	80	65	71	40	77	72	84	74	71
17	68	68	76	66	60	41	75	87	84	61	68
18	74	78	81	67	73	42	59	57	59	40	17
19	67	63	83	68	69	43	71	62	63	64	21
20	89	87	91	86	86	44	72	72	65	67	65
21	76	72	81	69	73	45	89	87	90	89	87
22	73	68	67	67	72	46	72	71	87	82	75
23	79	74	83	66	75	47	62	57	65	68	56
24	59	72	56	68	17	48	59	71	66	65	17

It is possible to cite regulations on the rating system of control and assessment of students' knowledge in higher education institutions, approved by the order of the Minister of Higher and Secondary Special Education of the Republic of Uzbekistan dated June 11, 2009 No 204 and the "Procedure and criteria for assessment" in the appendix "On amendments and additions to the Regulations on the rating system of control and assessment of student knowledge in higher education institutions", approved by Order No. 333 of August 25, 2010 [2-3]. That is, according to these regulations, the formation of the degrees of students entering the 2017-2018 academic year, at the same time studying in the 4th year, in the scores on science.

It is advisable to compile regression equations for each study group separately or together if the study groups are taught on the basis of a single curriculum. Since the level of knowledge and skills of students in a specialty subject is influenced by several supporting disciplines, a linear or nonlinear multi-factor regression model can represent such a relationship.

Regression models with more than one independent variable are called plural regression models. An overview of a regression model record with several explanatory variables is as follows:

$$y = f(x_1, x_2, x_3, ..., x_k) + \varepsilon \tag{1}$$

Many of the concepts introduced for double-line regression also apply to plural regression. However, some new concepts are also emerging because more than one independent variable is used to predict the value of a dependent variable.

Linear regression model with several explanatory variables (classical linear model of plural regression (CLMPR) - the equation is written in the following form:

$$y = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + ... + a_k x_k + \varepsilon \, , \tag{2}$$

The object of econometric modeling is characterized by many features. The object symbols in the model are interconnected and participate either in the role of result (explanatory variable) or in the role of factor (explanatory variable).

Consider the multivariate linear regression model in our example:

$$y = a_0 + a_1 x_1 + a_2 x_2 + ... + a_k x_k \, , \tag{3}$$

where **y** – is the result of the students' mastery of the specialty; **$x_1, x_2, ..., x_k$** - the results of students' mastering in the subjects provided; **k** – is the number of supporting subjects; **$a_0, a_1, a_2, ..., a_k$** - coefficients of the regression model.

The econometric model was created using Excel, which belongs to the application software class. First, for the purpose of analytical study of the interdependence of certain academic disciplines, the correlation coefficients of the relationship between specialization and supporting disciplines were determined on the basis of data on the results of mastering the subject by students of two study groups. To do this, a matrix of double correlation coefficients was constructed using Excel program tools (by performing **Данные-Анализ данных-Корреляция**) (2-schedule).

2-schedule
A matrix of correlation coefficients of the relationship between a specialty subject and a supporting subject

	MMPP (y)	PT and MS (x_1)	GT and PR (x_2)	SP (x_3)	ch.s. TCET (x_4)
MMPP (y)	1				
EN and MC (x_1)	0,680627	1			
GT and PR (x_2)	0,750539	0,663879	1		
SP (x_3)	0,599299	0,629009	0,572001	1	
ch.s. TCET (x_4)	0,648866	0,481108	0,678848	0,466092	1

Source: Author's development on the basis of the data obtained from the fund sheet of the rating points of the Faculty of Information Technology.

In the next step, a matrix of double correlation coefficients (2-schedule) was analyzed to determine the effect of factors (supply sciences) on the outcome factor (specialty science), their dependence, and whether there is a multicollinearity between the factors.

Multicollinearity is the gypsum relationship between the factors included in this model. Under the influence of multicollinearity, the following changes occur: distorting the amount of parameters that have a growth trend in the model; the economic interpretation of regression coefficients leads to a change in meaning; results in a weak conditioning of the system of normal equations; the most important factor complicates the process of character identification.

When the double correlation coefficient $r_{ij} \geq 0,70 \div 0,80$ there is a multicollinear correlation between the factors, taking into account that otherwise it does not exist, and when analyzing the data in 2-schedule, it was found that this inequality is not appropriate for all values of the double correlation coefficients. This, in turn, indicates that $r_{ij} \leq 0,70 \div 0,80$ inequality is appropriate for all values of the coefficients of the pair correlation and, based on this, there is no multicollinearity between the factors.

Also, when analyzing the dependence of factors (supply sciences) on the outcome factor (specialization science), the specialization science and "Probability Theory and Mathematical Statistics", "System Programming". It was found that there is a linear connection between the disciplines ch.s. "Technology of creating electronic textbooks", and a strong linear connection between the disciplines "Game Theory and Process Research".

Similarly, in the analysis of the interaction of factors (supporting disciplines), the discipline of "Probability Theory and Mathematical Statistics" with the disciplines of "Game Theory and Process Research", "System Programming", ch.s. "Technology of creating electronic textbooks". There is a weak connection between the disciplines of "Game Theory and Process Research" and the disciplines "System Programming", ch.s. "Technology of creating electronic textbooks", "Science of System Programming" and ch.s. (choice subject) "Technology of creating electronic textbooks" and there was a weak connection between science.

It should be noted that the values of the double correlation coefficients are determined on the basis of the following formula (4).

$$r_{xy} = \frac{\overline{x*y} - \bar{x}*\bar{y}}{\sigma(x)*\sigma(y)} \qquad (4)$$

The result of the above-mentioned factors (supporting subjects: "Probability Theory and Mathematical Statistics", "Game Theory and Process Research", "System Programming", ch.s. "Technology of creating electronic textbooks") (specialty: "Mathematical model of practical problems") allows us to exclude from the econometric model being constructed factors that are repetitive and have a weaker relationship with the outcome factor.

One of the important problems in constructing a multivariate regression equation is to correctly analyze and determine the factors to be included in the econometric model.

In the next step, using the tools of Excel (**Данные-Анализ данных-Регрессия**), Termez State University, Faculty of Information Technology, based on the data of the rating sheet, ie the results of mastering the subject in two subjects, the following regression and variance analysis results obtained (3-5-schedule).

Based on the results of correlation and regression analysis of Excel, the relationship between the disciplines provided in Table 5 and the mastery of the specialty "Mathematical Modeling of Practical Problems" can be written as the regression equation:

$$Y = 20{,}651739 + 0{,}255090 \times X_1 + 0{,}273640 \times X_2 + 0{,}119450 \times X_3 + 0{,}085986 \times X_4 \qquad (5)$$

We write the regression equation in the following form using conditional definitions.

$$Y = 20{,}651739 + 0{,}255090 \times ЭНваМС + 0{,}273640 \times ЎНваЖТ + 0{,}119450 \times ТД +$$
$$+ 0{,}085986 \times ЭДЯТ \qquad (6)$$

Results of regression and variance analysis

3-schedule

Regression statistics	
Plural R	0,814631614
R-square	0,663624666
Normalized R-square	0,632333938
Standart error	4,720063435
Observation	48

4-schedule

Dispersion analysis					
Indicator	*df*	*SS*	*MS*	*F*	*importance F*
Regression	4	1890,00305	472,5007625	21,2083481	1,02447E-09
Residue	43	957,9969498	22,27899883		
Total	47	2848			

5-schedule

Indicators	Y-intersection MMPP (y)	PT and MS (x_1), score	GTand PR (x_2), score	SP (x_3), score	ch.s. TCET (x_4), score
Coefficients	a_0	a_1	a_2	a_3	a_4
Answers	20,651739	0,255090	0,273640	0,119450	0,085986

Analysis of the regression equation

(5) or (6) the results of mastering the specialty "Mathematical modeling of practical problems" in "Probability Theory and Mathematical Statistics", "Game Theory and Process Research", "System Programming" and ch.s. "Technology of creating electronic textbooks" shows that it will be further improved with the increase of mastering indicators in the disciplines.

They provide a quantitative measure of the impact of the disciplines that provide a specialty subject, and at the same time allow the prediction of the mastery of that discipline when the final learning outcomes of other disciplines change. For example, when the mastering result in the subject "Probability Theory and Mathematical Statistics" is increased by 1 point, the mastery index in the specialty is increased by an average of 0.2551 points; When the result of mastering in "Game Theory and Process Research" is increased by 1 point, the mastering index in the specialty is 0,2736 points on average; When the result of mastering in "System Programming" is increased by 1

point, the mastering index in the specialty is 0,1195 points on average, ch.s. When the result of mastering the ch.s. "Technology of creating electronic textbooks" is increased by 1 point, the mastering of the specialty will improve by an average of 0,08599 points. In this way, it is possible to manage the quality of teaching.

The significance of the regression equation is evaluated by the following formula according to Fisher's criteria (7):

$$F = \frac{\sigma_{\hat{y}}^2}{\sigma_{\varepsilon}^2} \qquad (7)$$

There $\sigma_{\hat{y}}^2$ – is the factorial variance; σ_{ε}^2 – is the residual variance.

Significance assessment is based on statistical assumptions: in this case, the main hypothesis is considered to be $H_0: \sigma_{\hat{y}}^2 = \sigma_{\varepsilon}^2$, and the alternative hypothesis is considered to be $H_a: \sigma_{\hat{y}}^2 \neq \sigma_{\varepsilon}^2$.

To test the null hypothesis, it is necessary to find the calculated and tabular values of the Fisher criterion. The table value of the Fisher criterion is $F(a, f_1, f_2)$, where a is the significance factor; $f1$ is the number of subjects provided $f_1=k$, $f_2=n-1-k$; n – is the number of observations (number of choices) (number of students in the group), determined by the Fisher-Snedekor table [10].

If $F>F(a, f_1, f_2)$, then this means that the zero hypothesis must be rejected and an alternative hypothesis must be accepted. If the null hypothesis is not rejected, then it is concluded that the influence of the supporting sciences (factors x_1, x_2, x_3, x_4) on the science of specialization (the result indicator - y) is insignificant, the overall quality of the regression equation is low. If $F<F(a, f_1, f_2)$, then this means that the null hypothesis must be accepted.

In our example, the calculated value ($F_{calculation}$) is equal to 21,2083481.

$$F = \frac{472,5007625}{22,27899883} = 21,2083481 \approx 21,208$$

We compare the calculated values with the values in the schedule. a - when the significance factor corresponds to a probability of 0,05, when the number of degrees of speed freedom (f_1 - the number of supporting disciplines) is $f_1 = 4$ and the number of degrees of freedom of denominator is $f_2=n-1-k=48-1-4=43$ (where n is the number of observations (number of students in the group), $n = 48$) the value in the schedule is – 2,59. This, in turn, indicates that the calculated value of the Fisher F-criterion ($F_{calculation} = 21,208$) is greater than the value in the table ($F_{schedule} = 2,59$). Since Fisher is $F_{calculation} > F_{schedule}$ on the F-criterion, the constructed multivariate regression equation can be recognized as valid.

It is known that in multi-factor models, if the outcome factor is affected by several factors, then the correlation between the factors should be considered as the multiplicity factor. In our example, the R correlation plurality coefficient is $-0,814631614 \approx 0,81$. This, in turn, indicates that there is a correct correlation between the factors, if the correlation coefficient is $0 < r < 1$, and that there is a close correlation between factors with a correlation coefficient R of 0,81.

The overall quality of the model is evaluated by the coefficient of determination plurality. The coefficient of determination set is equal to the square of the coefficient (index) of the correlation set. The coefficient of determination is determined by the following formula (8):

$$R^2 = \frac{\sigma_{\hat{y}}^2}{\sigma_y^2} \qquad (8)$$

There $\sigma_{\hat{y}}^2$ – is factorial variance; σ_y^2 – is the total variance.

It shows which fraction of the variable under study is explained by the variation of the remaining variables.

In our example, the coefficient of determination plurality R^2 (given in 3-schedule) is 0,664.

$$R^2 = \frac{1890,00305}{2848} = 0,663624666 \approx 0,664$$

The amount (value) of this coefficient confirms that the mastery of the specialty subject depends on the mastery of the supply subjects under consideration by 66%.

In addition to the determinant plurality coefficient, the normalized coefficient of determination is also determined [11-12]:

$$R_{norm}^2 = \frac{R^2(n-1)-k}{n-1-k} \qquad (9)$$

There R^2 – is the coefficient of determination plurality; n – is the number of observations (number of students in the group); k – is the number of factors (number of supporting sciences).

$$R_{norm}^2 = \frac{0,663624666 \times (48-1)-4}{48-1-4} = \frac{27,190359302}{43} = 0,632333938$$

Its application is due to the fact that the coefficient of determination is constantly increasing as the number of factors increases. For example, the coefficient of determination is constantly increasing as the number of disciplines increases. However, this does not always correspond to the logical nature of the process change under study.

Therefore, a normalized coefficient of determination, which can be reduced in the wrong choice of factors, is determined, that is, it is an indicator of the correctness of the choice of subjects it provides.

The accuracy of the model is evaluated using the standard error - σ_{ε} or the approximation error value – ε. The standard error of the model is determined by the following formula:

$$\sigma_\varepsilon = \sqrt{\frac{\sum\limits_{i=1}^{n} \varepsilon_i^2}{n-1-k}} \qquad (10)$$

Here: $\varepsilon_i = y_i - \widehat{y}_i$; y_i - the actual i - value of the indicator (semester grade of the student in the specialty);

- The forecast value of the i - value of the indicator, obtained by the model- $\widehat{y}_i$.

Based on the value of this error, the research model is selected. A model with a minimum error value is acceptable. The value of the approximation error is calculated on a correlation basis.

$$\varepsilon = \frac{1}{n} \sum_{i=1}^{n} \left| \frac{y_i - \widehat{y}_i}{y_i} \right| \cdot 100\% \qquad (11)$$

If the approximation error is less than 5%, then the model can be used for practical purposes.

The standard error of the model is 4,7201 according to formula (10).

$$\sigma_\varepsilon = \sqrt{22,27899} = 4,720063435 \approx 4,7201$$

Conclusions and suggestions. The general conclusion is drawn depending on the characteristics of the model. The model features are: R = 0,81 (correlation multiplicity coefficient); R^2 = 0,664 (determination multiplicity coefficient); σ_ε = 4,72 (model standard error); $R^2_{\text{норм}}$ = 0,63 (normalized coefficient of determination); F = 21,208 (calculated value of the criterion F). Based on this information, it can be concluded that the model is significant and can be used for more purposes that are practical.

It can be obtained because of a model of correlation with a sufficiently complete list of disciplines that provide the most accurate forecast of the results of students' mastery of the specialty. Improving the quality of teaching is achieved by predicting the mastery of students. As noted above, in this study, only one specialty and four support subjects (mathematical and natural-scientific, general, additional, and elective subjects) taught in the 7th semester were obtained.

It is recommended that this type of regression model be developed and used for practical purposes to predict the grades of state exams (final state certifications) of graduate students in the field of "Applied Mathematics and Informatics".

The results obtained are in line with the results of our subsequent research on the mastery of students in other specialties and supporting disciplines; points (grades) in specialty subjects with the results of the defense of course work. The results of the state exam and the defense of the final qualifying work can be focused on the creation of models of correlation with the results of the semester grades (mastering results) in mathematics and science, general, additional and elective and specialty subjects. This will serve to further improve the quality of training high potential, competitive personnel.

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