Analysis of Factors Affecting the Efficiency of the Higher Education System in Ukraine

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The purpose of this article is to analysis the factors affecting the effectiveness of the education system in Ukraine. The article substantiates the need to determine the main criteria and tools for assessing quality for subsequent decision-making at the level of educational institutions, educational management, and added value. Results from DEAP Version 2.1 of technical efficiency contain information on CRS, VRS, and SEa models grouped by 24 regions of Ukraine. A set of control variables determined their impact on the effectiveness of the higher education system in Ukraine. Practical application of Data envelopment analysis (DEA) methods and regression analysis, graphical analysis, made it possible to form an idea of qualitative and quantitative indicators that affect the efficiency of the education system in Ukraine.

Keywords: education system, Institutions of Higher Education (IHE), added value, efficiency, regression, DEA, Ukraine

INTRODUCTION

The education system is directly dependent on social terms, conditioned by the needs, tasks, and capabilities of the state to ensure its organization, development, and competitiveness. Education at the microeconomic level contributes to socialization, economic self-sufficiency, social mobility, and at the macroeconomic level, through the gross domestic product, not only economic growth but also the protection of national interests. The study of factors affecting the efficiency of higher education will help determine

the prospects for the education system, train competitive specialists in domestic educational institutions, and increase the prestige of domestic education.

Lee (1994) notes in his study of Plato's philosophy of education that the Greek philosopher regards education as a means to achieve justice, both individual and social justice. One of the main purposes of the higher education system is the creation and dissemination of knowledge, as knowledge is the essential driver for future social and economic development in the knowledge economy and society (Oliinyk et al., 2021; Nagymzhanova et al., 2018). For this purpose, academic policy and decision-makers need an integrated view of the dimensions of a national higher education system, which is challenging. Resource allocation, technical efficiency, and managerial effectiveness are some of the significant objectives of government national higher education programs for developing countries, authors write, studying Iranian national higher education (Khatibi et al., 2020). Features of the socio-economic state depend on the basic characteristics of the country at the time of assessment, and the stage of its development. For Ukraine, the already existing asymmetry is an inhibiting factor, a characteristic feature of which is a different level of well-being, with the country's remoteness from assessment criteria, standards, world average values, hyperbolized by the post-crisis state of the country (Lesik et al., 2020). The author discusses the expansion and structural changes in Turkish higher education and analyses several economic consequences in terms of equity and returns across regions, outlining the institutional background of the expansion to identify various re-distributive dimensions of the policy (Polat, 2017).

The reform of Ukrainian high education follows slowly, inconsistently, without a clear strategic plan and roadmap. Universities are not provided autonomy, curricula require significant changes, and the system for making such changes is more flexible. The reform of the system of higher education in Ukraine is an indispensable condition for the country to exit the crisis (Shevchenko, 2019). The evaluation of university efficiency in Europe began timidly when the European Higher Education Area (EHEA) was created. However, this issue is currently becoming increasingly important in Southern European countries, where the limitation of public funding following the economic crisis in 2008 has put greater pressure on their public universities to achieve excellence and improve competitiveness, according to authors, who study the efficiency of Spanish public Higher Education Institutions (Martínez-Campillo and Fernández-Santos, 2020). Despite the progress made toward incorporating sustainability concerns into the curricula and management of higher education institutions around the world during the Decade of Education for Sustainable Development 2005–2014, progress has been sluggish in the former socialist states of Central Europe. A question has been raised in the article Dlouhá et al. (2017) about the specifics of this region where the situation in six of these countries (Czech Republic, Hungary, Poland, Serbia, Slovakia, Slovenia) was explored. With the rapid development of the economy, China's higher education has entered a new stage and made a series of extraordinary achievements. However, the uneven development of higher education has become a critical factor restricting China’s overall progress (Zhang et al., 2020). The improvement of technical efficiency is the main reason for the growth of HEIs, and the decline of technology has played a negative role. From a structural point of view, research by R. Yaohua et al. (2018) shows that the development of HEIs is uneven. This imbalance is reflected in two aspects. First, the difference in efficiency growth is huge. Second, the driving forces for efficiency growth are different. The system of centralized university governance is experiencing changes in its content, function, mechanisms, and approaches while maintaining its unity and a highly centralized structure. Thus, it is difficult to adapt and respond to free-market forces and challenges brought to the fore by the Euromaidan political turmoil and the war that followed. Such phenomena as corruption in education and internal pressures, marketization of educational services and financial integrity, changing organizational and managerial structures of universities present challenges to university governance and force it to change (Sapazhanov et al., 2020; Serdali et al., 2018). They may also facilitate the strengthening of university autonomy (Osipian, 2017).

The authors in their study argue that it is opportune to revisit profound questions about the purpose, nature, and value of higher education in society at a juncture where the context of higher education has been significantly influenced by the global sustainability agenda and responsible management education imperatives (Cicmil et al., 2017). In turn, it is difficult to disagree with the conclusion of Gao (2015), which, while studying the “Education for International Understanding” (EIU) program, has become popular in East

Asia found that the current curriculum of EIU needs to not only embed factual knowledge but also needs to present the roots and reasoning behind that knowledge for students (Tursynbayeva et al., 2020). We should also be aware that democracy encourages contributions from different voices. Seeking similarities between value systems does not mean putting down the difference of others. The advantages in the field of international education, each of the countries, first of all, considers from the point of view of obtaining their preferences (Slutskiy and Blanchard, 2021; Nagymzhanova et al., 2019). The outcome of Kim and Shin (2019) research shows reveal how the improvement in structural factors of the national higher education system could lead to better productivity of the whole system. Higher education is connected to the society and economy. We continue to understand little about how to best design and operate transnational collaborations between universities to advance research and education for sustainability. This article explores general practices in translational research and teaching that can provide information and inspiration for the sustainability field (Caniglia et al., 2017).

Assessment of the factors affecting the effectiveness of the higher education system in Ukraine should be considered as part of a comprehensive plan focused on the stability of the factors of the national higher education system and the national economy. For Ukraine, this issue remains relevant and unresolved, since insufficient attention is paid to it.

MATERIALS AND METHODS

Depending on the tasks, the amount of information, and several other factors, researchers choose the most appropriate technique and methodology for collecting and analyzing the information received. In the study of the effectiveness of the most competitive regions of Ukraine, the authors used correlation and regression analysis (Lesik et al., 2021). The authors analyzed the antecedents and consequences of trust in creating collaborative business relationships. To evaluate the performance and effectiveness of each considered trust factor for each party, a fuzzy data envelopment analysis (FDEA) based approach is proposed (Nematollahi, 2019). When studying the legal protection of consumers when using Internet sites, the authors used a comparative legal method in the study of legislative trends (Padalka et al., 2021).

Ferizat and Kuat (2021) in their study calculate the effectiveness of interactive methods during pre-service teacher training. Research method Yarmohammadian et al. (2011) is descriptive-analytic and the instrument of research is a questionnaire adopted from modified scales of AQIPin, two different versions for students and scientific members.

Both descriptive and inferential statistical techniques such as chi-square t-test and one-way ANOVA were used for analyzing the data (Yousefy and Baratali, 2011). Introducing the times of papers being cited to reflect the quality and international influence of scientific research, and the reputation to reflect the quality of teaching activity, the authors use Malmquist Index based on DEA to measure efficiency, technology, and productivity change (Yaohua et al., 2018). Efficiency scores in research J. Wolszczak-Derlacz (2017) are determined using nonparametric DEA with different input-output sets and considering different frontiers: global frontier (all HEIs pooled together), regional frontier (Europe and the U.S. having their frontiers), and country-specific ones. The external factors affecting the degree of HEI inefficiency are also investigated e.g., institutional settings (size and department composition), location and funding structure.

The use of the integral assessment method in identifying the qualitative indicators allows further detailed indicators and their modification influences the total level of the object development. The Six Sigma methodology of Define, Measure, Analyze, Improve, and Control (DMAIC) was used Arafeh et al. (2020), to improve student performance along with several improvement tools such as Fishbone diagram, Pareto charts, and Critical-To-Quality (CTQ) tree.

In the study Cunha and Miller (2014) develops a general methodology for measuring the value-added of institutions of higher education using commonly available administrative data. Their approach recognizes the data limitations and selection problems inherent in higher education and highlights the challenges these issues pose for education policy. Nearly every state evaluates teacher performance using multiple measures, but evidence has largely shown that only one such measure teachers' effects on student

achievement (i.e., value-added) – captures teachers' causal effects (Bacher-Hicks et al. 2019; Nagymzhanova, 2013). In their study, Kostakis (2020) address the challenge of evaluating the efficiency of HEIs taking into account different goals of the Colombian education system. To this aim, the author extends a cross-efficiency data envelopment analysis (DEA) approach to evaluate the efficiency of Colombian HEIs in the presence of flexible measures. To determine the weaknesses and identify the advantages of higher education in Ukraine in our work the method of DEA, analysis of variance, regression analysis, and other methods were practically applied.

The main purpose of this article is to analyze the factors affecting the effectiveness of the higher education system in Ukraine. The attainment of this goal determines the solution of following issues:

- justification of the need to determine the quality assessment criteria for subsequent decision-making at the level of educational institutions, educational management, and added value;
- defining a set of control variables to identify their impact on the effectiveness of the higher education system in Ukraine;
- practical application of the method of DEA, regression analysis in determining qualitative indicators to identify weaknesses and advantages of the higher education system in Ukraine and decision making.

RESULTS AND DISCUSSION

The factors affecting the higher education system are very multidimensional. These include various components that will not be able to fully exhaust the presence of all elements for a single student, educational institution, or system as a whole. Since the criteria, along with the fact that they have much in common, can be quite individual in terms of the personality of the student, the economic situation, political and religious beliefs, value orientations, and much more. From the institution's point of view, the higher education system in Ukraine does not have a single national educational concept that would ensure its efficiency and competitiveness. The difficulty lies in the fact that the holdover of the post-Soviet command-administrative system has had its influence until today (Yessenbayeva et al., 2020). A generation of managers, teachers, and parents, brought up and trained in different conditions and according to different programs, turned out to be largely incompetent in matters of training and control over it in modern conditions. Low wages, a significant degree of bureaucratic procedures, and economic instability are strongly reflected in the already complex education system, which also does not care about emotional burnout, making important functions of education formal (Mukhitov et al., 2022). The global pandemic caused by COVID-19 has exposed a huge problem of the education system not only in Ukraine but also in many other developed countries – the unavailability of work in remote conditions due to the lack of necessary technologies, programs, computer and mobile equipment, the presence of the Internet, not to mention the digital literacy of teachers and students (Yessengabylov et al., 2021).

The relevance of the issues raised by us is confirmed in the UNESCO Universal Declaration On Cultural Diversity, where among the main priorities you can see: "Promoting through education and awareness of the positive value of cultural diversity and improving to this end both curriculum design and teacher education; Incorporating, where appropriate, traditional pedagogies into the education process to preserve and make full use of culturally appropriate methods of communication and transmission of knowledge; Encouraging "digital literacy" and ensuring greater mastery of the new information and communication technologies, which should be seen both as an educational discipline and as pedagogical tools capable of enhancing the effectiveness of educational services" (UNESCO, 2001; Sydykhov et al., 2017).

Questions about bridging the gap between countries that are at different stages of development, including technological, digital, and informational, are raised very often. But it is impossible to close the gap since the level of developed countries is constantly improving, increasing the differences between developed and developing countries.

In our work, we are going to consider a small number of factors affecting the effectiveness of the education system in Ukraine. First of all, using regression analysis, we will assess the level of preliminary

training of applicants at schools by regions that hit the Top 200 ranking according to the EIE results in Ukraine in 2020. The added value will be considered as the level of preparation of applicants for the Score of External Independent Evaluation (EIE). From a total of 200 schools, we've chosen one from the region with the highest indicator (Table 1).

TABLE 1
RATING OF THE BEST EDUCATIONAL INSTITUTION (SCHOOL) AND ASSESSMENTS OF APPLICANTS AT THE END OF THE EIE 2020

Place TOP-200	**Regions**	**School rating point (x)**	**EIE rating (y)**	**Place TOP-200**	**Regions**	**School rating point (x)**	**EIE Rating (y)**
1	Lviv region	169.70	183.40	43	Rivne region	153.40	169.50
2	Kyiv region	166.10	189.40	44	Khmelnytsk region	153.30	162.80
10	Zhytomyr region	160.40	180.30	45	Chernihiv region	153.20	169.50
11	Dnipro region	159.20	184.70	49	Sumy region	152.10	168.70
19	Ivano-Frankivsk region	157.30	179.40	51	Kirovohrad region	152.00	169.10
20	Kharkiv region	157.20	179.30	54	Ternopil region	151.80	172.40
24	Cherkasy region	156.60	178.20	81	Volyn region	149.40	171.30
34	Vinnytsia region	154.30	170.40	93	Chernivtsi region	148.40	168.90
36	Kherson region	154.00	163.90	108	Mykolaiv region	147.20	167.00
37	Odesa region	153.80	170.50	147	Zakarpattia region	145.40	163.60
38	Poltava region	153.80	169.00	186	Donetsk region	143.80	166.40
40	Zaporizhzhia region	153.50	173.90		Luhansk region*	-	-

*Note: *Luhansk region – schools in this area are not included in the TOP-200 Rating of schools in Ukraine.*
Source: compiled by authors based on Secondary Education (2020), External Independent Evaluation (2020).

Let us formulate an assumption about the existence of a relationship between the school's rating and the EIE rating. Using data analysis, we are going to determine the accuracy of our assumptions. Formally, our dependency model is going to look like this:

$$y = f(x) + u, \quad (1)$$

where y – applicant's EIE score; x – school rating point; f – a function describing the strength and shape of the influence of x на y; u – all other factors affecting y. When using a linear function, a simple linear regression equation is going to look like this:

$$Y = b_0 + b_1 x + u, \quad (2)$$

where b_0 , b_1– constants that determine the form of a linear equation. Calculation of the regression parameters by minimizing the sum of the squares of distances at the values of b0 and b1 are presented in the following formulas:

$$b_1 = \frac{cov(x.y)}{D_x}; \quad (3)$$

$$b_0 = \overline{y} - b_1 \overline{x} \quad (4)$$

where $cov(x, y)$ – covariance of x and y; D_x – variance of variable x; $\overline{x}$ and $\overline{y}$ – the average of these variables.

The covariance, which shows whether there is a relationship between two random variables, is calculated using the formula:

$$cov(x, y) = \frac{1}{n \sum_{i=1}^{n} (x_i - \overline{x})(y_i - \overline{y})} \quad (5)$$

where $\overline{x}$ and $\overline{y}$ – the average of these variables; $x_i \, and \, y_i$ – linear function indicators. One of the main indicators, which is a measure of a linear model and indicates its quality, is the R-square:

$$R^2 = \frac{\sum(\widehat{y_x} - \overline{y})^2}{\sum(y - \overline{y})^2} \quad (6)$$

We can find the variance by the formula:

$$\sum(y - \overline{y})^2 = \sum(\widehat{y_x} - \overline{y})^2 + \sum(y - \widehat{y_x})^2, \quad (7)$$

where $\sum(y - \overline{y})^2$ – the total sum of squares of deviations; $\sum(\widehat{y_x} - \overline{y})$ – sum of squares of deviations caused by regression; $\sum(y - \widehat{y_x})^2$ – residual sum of squares of deviations. In our case, the coefficient of determination R^2 by 68% explains the relationship between the studied parameters (Table 2).

TABLE 2
REGRESSION STATISTICS

Index	Value
Multiple R	0.823348
R-square	0.677902
Normalized R-square	0.662564
Standard error	4.173208
Observations	23

The coefficient 19.45 indicates what the values of Y are going to be, with all variables in this model equal to zero. That is, the influence of other factors that are not included in the described model is assumed. These factors include self-study and tutoring to improve the quality of preparation for the EIE. The coefficient 0.993 shows the effect of the variable x on y. In other words, the school's rating within this model affects the EIE rating with a weight of 0.993 (Table 3.4).

TABLE 3
ANALYSIS OF VARIANCE

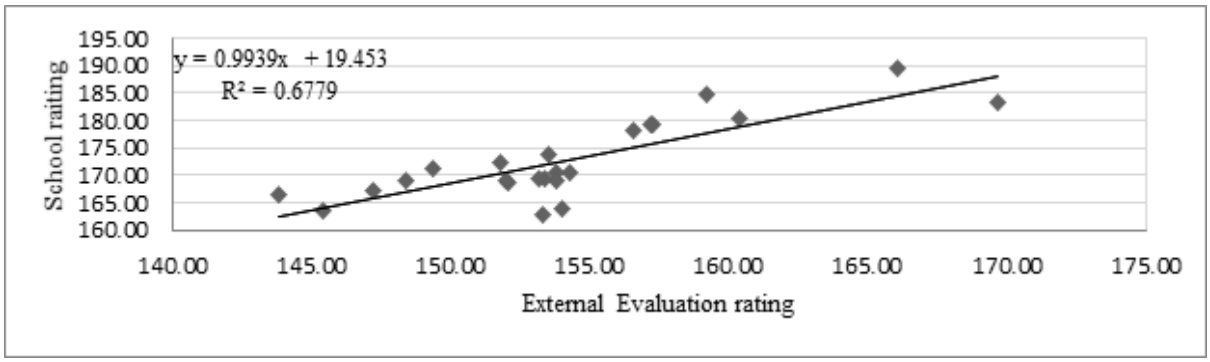
	Value				
Index	df	SS	MS	F	Significance F
Regression	1	683.8885	683.8885	41.27398	2.89E-06
Remainder	20	331.3897	16.56948		
Total	21	1015.278			

TABLE 4
LINEAR REGRESSION RESULTS

	Coefficients	Standard error	t-statistics
Y-intersection	19.45318501	23.06428402	0.843433292
Variable X 1	0.993873698	0.149496842	6.648125036

The final linear regression formula in our case is going to look like this (Fig. 1):

FIGURE 1
PARAMETERS OF THE STRAIGHT OF THE REGRESSION EQUATION



Therefore, we have good reason to conclude that the model reflects real-life patterns. The assumption about the influence of other factors that were not included in the described model can be explained by self-study and tutoring to improve the quality of preparation for the EIE. In the conditions of the pandemic, tutoring has increased significantly through various channels of remote communication. But due to financial instability during the pandemic in Ukraine, not every family could afford individual or group lessons with a tutor on EIE subjects.

We are going to carry out further analysis using the Data Envelopment Analysis (DEA) method which is a relatively new "data-oriented" approach for evaluating the performance of a set of peer entities called Decision Making Units (DMUs) which convert multiple inputs into multiple outputs. These DEA applications have used DMUs of various forms to evaluate the performance of entities, such as universities, cities, business firms, and others (Charnes et al., 1997; Cooper et al., 2011). For comparative analysis, we selected data from 24 regions of Ukraine (Table 5).

TABLE 5
OBJECTS FOR COMPARATIVE ANALYSES

No	Regions	No	Regions	No	Regions
R_1	Vinnytsia region	R_9	Kyiv region	R_{17}	Sumy region
R_2	Volyn region	R_{10}	Kirovohrad region	R_{18}	Ternopil region
R_3	Dnipro region	R_{11}	Luhansk region	R_{19}	Kharkiv region
R_4	Donetsk region	R_{12}	Lviv region	R_{20}	Kherson region
R_5	Zhytomyr region	R_{13}	Mykolaiv region	R_{21}	Khmelnytsk region
R_6	Zakarpattia region	R_{14}	Odesa region	R_{22}	Cherkasy region
R_7	Zaporizhzhia region	R_{15}	Poltava region	R_{23}	Chernivtsi region
R_8	Ivano-Frankivsk region	R_{16}	Rivne region	R_{24}	Chernihiv region

Let's form the indicators focused on CRS, consisting of five DMU's observations (Table 6).

TABLE 6
PERFORMANCE IMPACT INDICATORS 2019

Indicators	Comparative review, (’000s)
I_1	The number of students who joined IHE of Ukraine for the first time
I_2	The number of persons who received a certificate of completed general secondary
I_3	Number of persons who passed the EIE
I_4	Average costs of education in the IHE per year, hryvnia
I_5	The number of students studying for budgetary funds

The logical group indicators for using Data envelopment analysis are sorted by 24 regions of Ukraine. At the same time, for our analysis we have a single input measure – the number of students who joined the IHE of Ukraine for the first time, the remaining indicators will be the output measure (Table 7).

TABLE 7
THE SUMMARY OF INPUT/OUTPUT INDICATORS (’000S)

Regions	I_1	I_2	I_3	I_4	I_5	Regions	I_1	I_2	I_3	I_4	I_5
R_1	8	7	16	9	7	R_{13}	5	8	10	8	5
R_2	6	7	11	9	5	R_{14}	20	13	23	13	13
R_3	25	16	29	9	19	R_{15}	8	56	13	9	5
R_4	7	9	15	16	5	R_{16}	6	8	13	9	5
R_5	6	6	12	11	4	R_{17}	6	4	9	9	7
R_6	4	8	12	9	3	R_{18}	9	4	10	9	6
R_7	13	9	15	8	8	R_{19}	32	13	22	10	26
R_8	8	7	14	9	4	R_{20}	4	6	10	9	4
R_9	76	25	44	27	52	R_{21}	6	7	12	10	5
R_{10}	3	5	8	8	3	R_{22}	8	9	9	8	7
R_{11}	4	3	6	13	4	R_{23}	6	5	9	8	4
R_{12}	24	13	26	13	19	R_{24}	4	5	9	9	3

Source: compiled by authors based on Higher education in Ukraine in 2019 (2020), Directory of Educational Institutions (2019), External Independent Evaluation (2020).

Let’s evaluate the impact of indicators on the effectiveness of the education system using DEAP (Table 8-10).

TABLE 8
EFFICIENCY SUMMARY: FOR I_2

Technical Efficiency I_2									
DM	**CRS**	**VRS**	**SEa**	**RtS**	**DMU**	**CRS**	**VRS**	**SEa**	**RtS**
R_1	0.125	0.400	0.313	irs	R_{13}	0.229	0.659	0.347	irs
R_2	0.167	0.533	0.313	irs	R_{14}	0.093	0.189	0.491	irs
R_3	0.091	0.163	0.560	irs	R_{15}	1.000	1.000	1.000	-
R_4	0.184	0.485	0.379	irs	R_{16}	0.190	0.549	0.347	irs
R_5	0.143	0.516	0.277	irs	R_{17}	0.095	0.500	0.190	irs
R_6	0.286	0.824	0.347	irs	R_{18}	0.063	0.333	0.190	irs
R_7	0.099	0.261	0.379	irs	R_{19}	0.058	0.118	0.491	irs
R_8	0.125	0.400	0.313	irs	R_{20}	0.214	0.775	0.277	irs
R_9	0.047	0.065	0.720	irs	R_{21}	0.167	0.533	0.313	irs
R_{10}	0.238	1.000	0.238	irs	R_{22}	0.161	0.424	0.379	irs
R_{11}	0.107	0.750	0.143	irs	R_{23}	0.119	0.500	0.238	irs
R_{12}	0.077	0.158	0.491	irs	R_{24}	0.179	0.750	0.238	irs
					mean	0.177	0.495	0.374	x

TABLE 9
EFFICIENCY SUMMARY: FOR I_3

Technical Efficiency I_3									
DMU	**CRS**	**VRS**	**SEa**	**RtS**	**DMU**	**CRS**	**VRS**	**SEa**	**RtS**
R_1	0.667	1.000	0.667	drs	R_{13}	0.667	0.700	0.952	irs
R_2	0.611	0.625	0.978	irs	R_{14}	0.383	0.858	0.447	drs
R_3	0.387	1.000	0.387	drs	R_{15}	0.542	0.625	0.867	drs
R_4	0.714	1.000	0.714	drs	R_{16}	0.722	0.833	0.867	drs
R_5	0.667	0.667	1.000	-	R_{17}	0.500	0.542	0.923	irs
R_6	1.000	1.000	1.000	-	R_{18}	0.370	0.389	0.952	irs
R_7	0.385	0.538	0.714	drs	R_{19}	0.229	0.495	0.463	drs
R_8	0.583	0.750	0.778	drs	R_{20}	0.833	0.875	0.952	irs
R_9	0.193	1.000	0.193	drs	R_{21}	0.667	0.667	1.000	-
R_{10}	0.889	1000	0.889	irs	R_{22}	0.375	0.406	0.923	irs
R_{11}	0.500	0.750	0.667	irs	R_{23}	0.500	0.542	0.923	irs
R_{12}	0.361	0.878	0.411	drs	R_{24}	0.750	0.813	0.923	irs
					mean	0.562	0.748	0.775	x

Efficiency scores for I4, I5, are going to be grouped in Table 10.

TABLE 10
EFFICIENCY SUMMARY: FOR I_4, I_5

DMU	**Technical Efficiency**							
	I_4				I_5			
	CRS	**VRS**	**SEa**	**RtS**	**CRS**	**VRS**	**SEa**	**RtS**
R1	0.346	0.400	0.865	irs	0.750	0.750	1.000	-
R2	0.462	0.533	0.865	irs	0.714	0.750	0.952	irs
R3	0.111	0.128	0.865	irs	0.651	0.897	0.726	drs
R4	0.703	1.000	0.703	drs	0.612	0.643	0.952	irs
R5	0.564	0.600	0.940	irs	0.571	0.625	0.914	irs
R6	0.692	0.800	0.865	irs	0.643	0.750	0.857	irs
R7	0.189	0.231	0.821	irs	0.527	0.567	0.931	drs

R8	0.346	0.400	0.865	irs	0.429	0.469	0.914	irs
R9	0.109	1.000	0.109	drs	0.586	1.000	0.586	drs
R10	0.821	1.000	0.821	irs	0.857	1.000	0.857	irs
R11	1.000	1.000	1.000	-	0.857	0.937	0.914	irs
R12	0.167	0.167	1.000	-	0.679	0.934	0.726	drs
R13	0.492	0.600	0.821	irs	0.857	0.900	0.952	irs
R14	0.200	0.200	1.000	-	0.557	0.711	0.784	drs
R15	0.346	0.400	0.865	irs	0.536	0.562	0.952	irs
R16	0.462	0.533	0.865	irs	0.714	0.750	0.952	irs
R17	0.462	0.533	0.865	irs	1.000	1.000	1.000	-
R18	0.308	0.356	0.865	irs	0.571	0.583	0.980	irs
R19	0.096	0.106	0.905	irs	0.696	1.000	0.696	drs
R20	0.692	0.800	0.865	irs	0.857	0.937	0.914	irs
R21	0.513	0.567	0.905	irs	0.714	0.750	0.952	irs
R22	0.308	0.375	0.821	irs	0.75	0.750	1.000	-
R23	0.410	0.500	0.821	irs	0.571	0.625	0.914	irs
R24	0.692	0.800	0.865	irs	0.643	0.750	0.857	irs
mean	0.437	0.543	0.841	x	0.681	0.777	0.887	x

Source: Authors' estimation from DEAP.

Our calculated Technical Efficiency data contains information on the models CRS, VRS, and SEa. If we consider the results of data analysis SEa = 1, it can be argued that within the framework of this model, the Poltava region is the most effective on I_2 "The number of persons who received a certificate of completed general secondary education", since this indicator coincides for both the CRS model and the VRS model. The worst indicators for I_2 in the CRS model belong to the Kyiv, Kharkiv, and Ternopil regions, which corresponds to 27.0%, 33.0%, and 36.0% of the national average. Analyzing the data indicators for I_3 "The number of individuals who passed the EIE", we can note the Zakarpattia region, for which all indicators are effective in the DEA model. Among the most ineffective are the Kyiv region and the Kharkiv region, whose indicators are less than the national average by 66.0% and 59.0, respectively. Investigating the "Average cost of studying in the IHE per year" (I_4), it should be noted that among all the regions under consideration, the Luhansk region turned out to be the most effective, with the best efficiency indicator (SEa = 1) and the Kharkiv, Dnipro, and Kyiv regions, the least effective, with indicators 22-25% of the average.

As the last indicator (I_5), we studied "The number of students studying for budgetary funds". Sumy region turned out to be the most effective out of 24 studied regions of Ukraine, and the Kyiv region, with an indicator of 63.0% of the average in Ukraine, can be called the least effective. In general, for all studied indicators, only 4 have 100% of the effective regions in the SEa = 1 model, which indicates that 83.0 of the samples have variable returns to scale.

Taking into account the fact that the Kyiv region is mentioned among the ineffective ones, it should be noted that the city of Kyiv, which is the capital of Ukraine and a huge metropolis, has the largest number of IHE in the state, where students from different regions go to study. This, in turn, influenced the quality indicators of the Kyiv region (Fig. 2, 3).

FIGURE 2
INDICATORS OF THE EFFECTIVENESS OF THE EDUCATION SYSTEM OF THE REGIONS OF UKRAINE FOR I2, I3

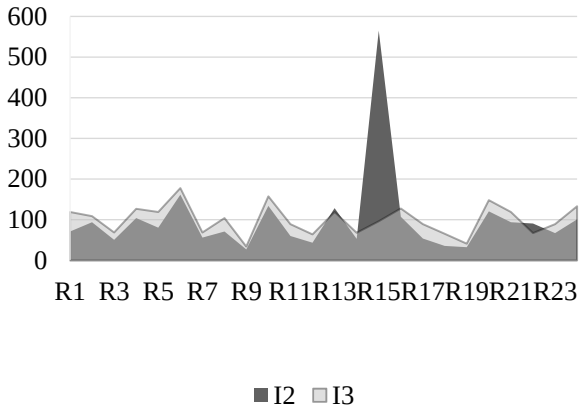
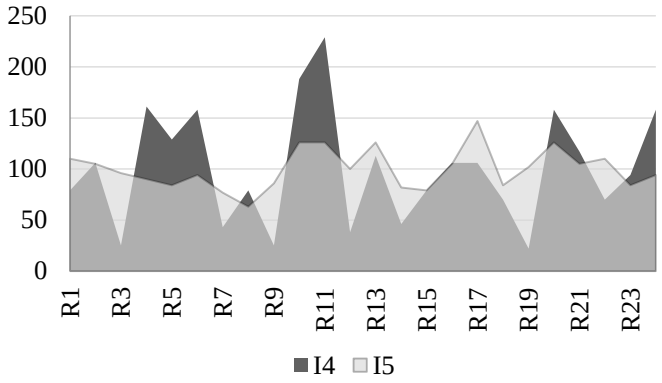


FIGURE 3
INDICATORS OF THE EFFECTIVENESS OF THE EDUCATION SYSTEM OF THE REGIONS OF UKRAINE FOR I4, I5



The graphical display of performance indicators I2 – Poltava region (R15), I3 – Zakarpattia region (R6), I4 – Luhansk region (R11), I5 – Sumy region (R17) demonstrates their advantages, but at the same time makes it possible to assess the dispersion of indicators, demonstrating compared to these areas, large-scale ineffective regions with diminishing returns.

Let us formulate the following assumption about the existence of dependence between “assessment of the quality of scientific and pedagogical potential” and “assessment of the quality of education” (Table 11).

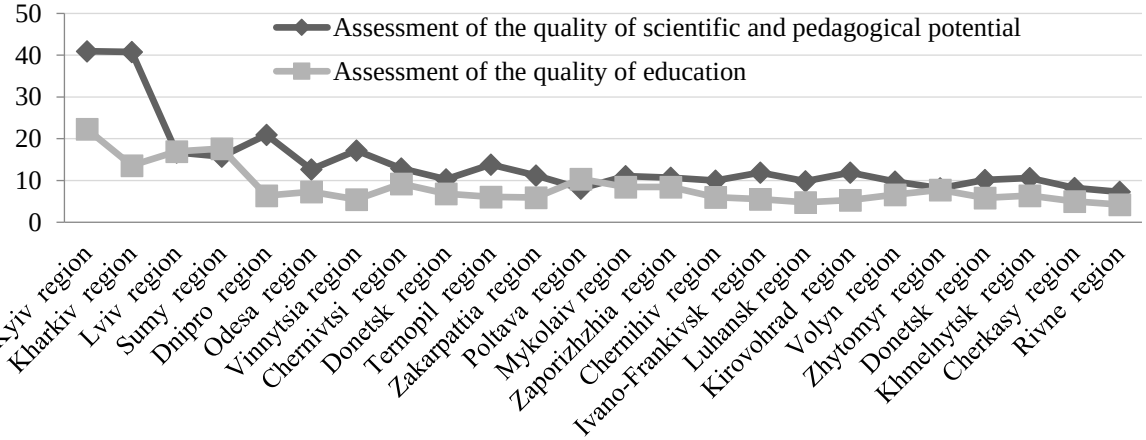
TABLE 11
RANGING OF REGIONS ACCORDING TO THE BEST OF THE UNIVERSITIES IN THE RANKING "TOP-200 UKRAINE", 2019

Place TOP-200	Region for the best IHE in TOP-200	*Assessment of the quality of scientific and pedagogical potential*	Assessment of the quality of education	Place TOP-200	Region for the best IHE in TOP-200	*Assessment of the quality of scientific and pedagogical*	Assessment of the quality of
1	Kyiv region	40.95	22.32	46	Mykolaiv region	11.09	8.45
3	Kharkiv region	40.76	13.55	48	Zaporizhzhia region	10.71	8.42
4	Lviv region	16.72	16.94	59	Chernihiv region	10.00	6.03
6	Sumy region	15.71	17.68	62	Ivano-Frankivsk region	11.89	5.53
8	Dnipro region	20.96	6.40	69	Luhansk region	9.86	4.78
16	Odesa region	12.64	7.29	71	Kirovohrad region	11.92	5.28
22	Vinnytsia region	17.20	5.47	75	Volyn region	9.74	6.64
24	Chernivtsi region	12.87	9.22	76	Zhytomyr region	8.16	7.78
31	Donetsk region	10.27	6.85	79	Donetsk region	10.14	5.85
34	Ternopil region	13.82	6.09	82	Khmelnytsk region	10.63	6.39
35	Zakarpattia region	11.21	5.95	101	Cherkasy region	8.24	5.02
38	Poltava region	8.09	10.38	169	Rivne region	7.27	4.24

Source: compiled by authors based on University Rating. TOP-200 Ukraine (2019).

Using graphical data analysis, let us determine the accuracy of our assumptions (Fig. 4).

FIGURE 4
THE RELATIONSHIP BETWEEN THE INDICATOR "ASSESSMENT OF THE QUALITY OF SCIENTIFIC AND PEDAGOGICAL POTENTIAL" AND THE INDICATOR "ASSESSMENT OF THE QUALITY OF EDUCATION"



The analysis of the given data for 24 regions of Ukraine "Assessment of the quality of scientific and pedagogical potential" and "Assessment of the quality of education" clearly demonstrates the lack of relationship between these two indicators. This, in turn, can be explained by the presence of a significant number of factors influencing each of the considered indicators more than they influence each other. For example, "Assessment of the quality of scientific and pedagogical potential" can contain both publication activity in databases and the international rating of the university, as well as many other factors. If there was a relationship, we would observe an interdependent trend of growth or decline.

As the next example of the impact on the efficiency of the higher education system in Ukraine, we will consider two indicators “The number of doctors of philosophy” and “The number of graduates of the educational degree (ED) Master” (Table 14).

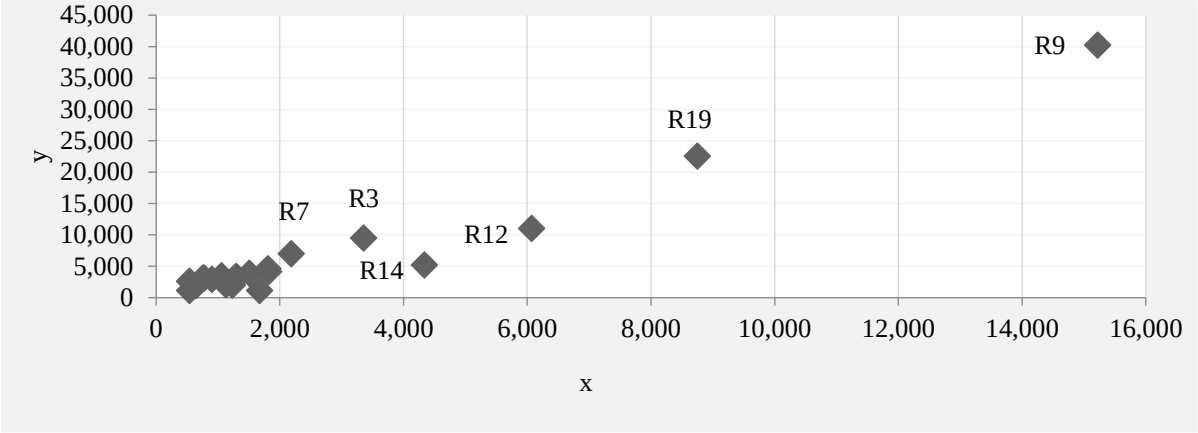
TABLE 14
NUMBER, AT THE BEGINNING OF THE 2019-2020 ACADEMIC YEAR AT IHE

No	Graduates ED Master (y)	Doctors of Philosophy (x)	No	Graduates ED Master (y)	Doctors of Philosophy (x)
R1	4 159	1 817	R13	2 915	902
R2	2 565	1 084	R14	5 248	4 339
R3	9 514	3 356	R15	3 922	1 508
R4	2 532	1 116	R16	3 500	1 058
R5	3 127	758	R17	3 392	1 294
R6	2 062	1 129	R18	4 594	1 809
R7	6 982	2 184	R19	22 548	8 748
R8	1 147	1 671	R20	3 110	776
R9	40 224	15 223	R21	3 139	1 273
R10	1 132	541	R22	3 143	1 288
R11	2 624	537	R23	2 002	1 233
R12	11 039	6 071	R24	1 982	649
mean				6108	2515

Source: compiled by authors based on Higher education in Ukraine in 2019 (2020)

According to the regression analysis data, the obtained determination coefficient $R^2$was 0.96, which in turn explains the dependency between the studied parameters by 96%. Such a connection between the parameters can be considered high. For a visual representation of the connection between the studied indicators of the effectiveness of the education system, in the coordinate system, we are going to map the individual values of the productive attribute y - "The number of doctors of philosophy" and the factor attribute x - "The number of doctors of philosophy". The set of points of effective and factorial signs - the correlation field makes it possible to put forward a hypothesis that the relationship between all possible values of x and y is linear (Fig. 5).

FIGURE 5
SCATTER DIAGRAM BETWEEN THE INDICATORS "NUMBER OF DOCTORS OF PHILOSOPHY" AND "NUMBER OF GRADUATES OF THE EDUCATIONAL DEGREE (ED) MASTER"



The scatter diagram demonstrates a significant gap in indicators between the studied 24 regions of Ukraine. According to the results of the assessment, the Kyiv region (R9) is 7 times, the Kharkiv region (R19) is 4 times, Lviv region (R12) is 2 times higher than the national average. This, in turn, indicates the presence of metropolitan cities with a significant concentration of IHE.

The consequences of such an uneven distribution negatively affect the economic situation of the regions, if we consider IHE - as the availability of jobs, as filling the local budget, as a labor market for future specialists. The issues of imbalance in demand and supply of labor, low qualifications of workers, and the shadow labor market remain unresolved (Lesik, 2018).

CONCLUSIONS

The factor analysis affecting the effectiveness of the education system in Ukraine allowed us to substantiate the main criteria and tools for assessing quality for subsequent decision-making at the level of educational institutions, educational management, and added value. Literature review introduced us to the problems of other countries, through the research of the authors, and the possibilities of solving them in the field of education. Using regression analysis in assessing added value, we examined the level of preparation of applicants for the Score of External Independent Evaluation (EIE). Within the considered model, we concluded that the model reflects real-life patterns. Although it does not completely exclude the influence of other factors that were not included in the described model, among which self-study, classes with tutors, and several others can be considered. Results from DEAP Version 2.1 of technical efficiency, containing information on CRS, VRS, and SEa models, grouped by 24 regions of Ukraine, made it possible to assess the degree of dispersion of indicators, demonstrating the leading regions as well as largely ineffective regions. As a search for a solution, a condition was proposed under which the relative efficiency is achieved for the minimum and maximum indicators of regions to the national average in the VRS TE model for two out of 4 indicators.

The result of this decision was to balance the overall performance against the average and close the significant gap between regions. Using the methods of Data Envelopment Analysis (DEA) and regression analysis, graphical analysis, decision tree, an idea was formed about the influence of the factors understudy on the effectiveness of the higher education system in Ukraine. As a result, attention is focused on the problematic aspects that require a competent complex solution from the educational management. Remaining centralized, the education system in Ukraine largely depends on the choice of alternative actions by the administrative authorities, and in difficult conditions of the pandemic, those actions would be able

to maintain and increase the qualitative indicators of the effectiveness of the education system. In our study, we examined a far from the complete range of factors that affect the effectiveness of the education system in Ukraine, which indicates the relevance of this topic and the need for further research.

REFERENCES

Arafeh, M., Khader, M., & Desouky, T. (2020). Six sigma application for raising student academic achievement. *Management Science Letters*, *11*(3), 699–710.

Bacher-Hicks, A., Chin, M.J., Kane, T.J., & Staiger, D.O. (2019). An experimental evaluation of three teacher quality measures: Value-added, classroom observations, and student surveys. *Economics of Education Review*, *73*, 101919.

Caniglia, G., Luederitz, C., Groß, M., Muhr, M., John, B., Keeler, L.W., & Lang, D. (2017). Transnational collaboration for sustainability in higher education: Lessons from a systematic review. *Journal of Cleaner Production*, *168*, 764–779.

Charnes, A., Cooper, W., Lewin, A.Y., & Seiford, L.M. (1997). Data envelopment analysis theory, methodology and applications. *Journal of the Operational Research Society*, *48*(3), 332–333.

Cicmil, S., Gough, G., & Hills, S. (2017). Insights into responsible education for sustainable development: The case of UWE, Bristol. *The International Journal of Management Education*, *15*(2), 293–305.

Cooper, W.W., Seiford, L.M., & Zhu, J. (2011). *Data Envelopment Analysis: History, Models, and Interpretations*. Retrieved February 4, 2022, from https://link.springer.com/chapter/10.1007%2F978-1-4419-6151-8_1

Cunha, J.M., & Miller, T. (2014). Measuring value-added in higher education: Possibilities and limitations in the use of administrative data. *Economics of Education Review*, *42*, 64–77.

Directory of Educational Institutions. (2019). Retrieved January 18, 2022, from https://abiturients.info/ru/university

Dlouhá, J., Glavič, P., & Barton, A. (2017). Higher education in Central European countries–Critical factors for sustainability transition. *Journal of Cleaner Production, 151*, 670–684.

External Independent Evaluation. (2020). *Statistics and analytics: Regional Data of the External Evaluation*. Retrieved February 17, 2022, from https://zno.testportal.com.ua/

Ferizat, M., & Kuat, B. (2021). The effectiveness of interactive teaching methods in the professional training of pre-service geography teachers. *Cypriot Journal of Educational Sciences*, *16*(4), 1976–1996.

Gao, Y. (2015). Confucius and Plato on Virtue and its Implementation in Education for International Understanding: A Comparative Study. *American Journal of Educational Research*, *3*(1), 25–30.

Higher education in Ukraine. (2019). Retrieved January 23, 2022, from http://www.ukrstat.gov.ua/

Khatibi, V., Keramati, A., & Shirazi, F. (2020). Deployment of a business intelligence model to evaluate Iranian national higher education. *Social Sciences & Humanities Open*, *2*(1), 100056.

Kim, C., & Shin, W.S. (2019). Does information from the higher education and R&D institutes improve the innovation efficiency of logistic firms? *The Asian Journal of Shipping and Logistics*, *35*(1), 70–76.

Kostakis, I. (2020). Socio-demographic determinants of household electricity consumption: Evidence from Greece using quantile regression analysis. *Current Research in Environmental Sustainability, 1*, 23–30.

Lee, M. (1994). Plato's philosophy of education: Its implication for current education. *Dissertations*. Retrieved February 12, 2022, from https://www.eajournals.org/wp-content/uploads/Plato%E2%80%99s-Philosophy-of-Education-and-Its-Implications-to-Counselling.pdf

Lesik, I., Bobrovska, N., Bilichenko, O., Dranus, L., Lykhach, V., Dranus, V., . . . Nazarenko, I. (2020). *Assessment of management efficiency and infrastructure development of Ukraine.* Retrieved January 20, 2022, from http://www.growingscience.com/msl/Vol10/msl_2020_152.pdf

Lesik, I., Lesik, M., Tishechkina, K., Ushkarenko, I., Soloviov, A., & Lahoiskyi, A. (2021). Analytical evaluation of the prospects for sustainable development of environmentally oriented tourism business. *Business: Theory and Practice*, *22*(2), 318–329.

Lesik, I.M. (2018). Socio-economic aspects of society development. *Ukrainian Black Sea Region Agrarian Science*, *4*, 11–17.

Martínez-Campillo, A., & Fernández-Santos, Y. (2020). The impact of the economic crisis on the (in) efficiency of public Higher Education institutions in Southern Europe: The case of Spanish universities. *Socio-Economic Planning Sciences*, *71*, 100771.

Mukhitov, O.M., Shaukenova, Z.K., Kabul, O.K., Yeshniyazova, A.C., & Baigabylov, N.O. (2022). Structural measures to prevent radicalism among youth. *Journal of Community Psychology*, *50*(2), 1123–1134.

Nagymzhanova, K. (2013). Formation of creative thinking of teachers in educational environment of higher education institute. *Life Science Journal*, *10*(Spl. Issue 12), 439–443.

Nagymzhanova, K., Bapaeva, M.K., Koksheeva, Z.T., Kystaubayeva, Z., & Shakhmetova, D.S. (2019). Psychological peculiarities of occupational choice by high school students. *Education in the Knowledge Society*, *20*, 1–10.

Nagymzhanova, K.M., Aikenova, R., Dzhanbubekova, M.Z., Magavin, S.S., & Irgebaeva, N.M. (2018). The importance of educational quality management in improving student's capital. *Espacios*, *39*(30), 1–8.

Nematollahi, I. (2019). Empirical investigation of trust antecedents and consequences in decentralized supply chain: The case of cosmetics market in Iran. *Decision Science Letters*, *8*(4), 483–504.

Oliinyk, V.V., Malets, O.O., & Kukharchuk, O.S. (2021). Problems and perspectives of implementation of modern methods of teaching philosophy in higher education in Ukraine. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, *2*, 130–134.

Osipian, A.L. (2017). University autonomy in Ukraine: Higher education corruption and the state. *Communist and Post-Communist Studies*, *50*(3), 233–243.

Padalka, A.M., Gribincea, A., Lesik, I.M., Semenda, O.V., & Barabash, O.O. (2021). Consumer protection when purchasing goods on the Internet. *Journal of the National Academy of Legal Sciences of Ukraine*, *28*(2), 189–197.

Polat, S. (2017). The expansion of higher education in turkey: Access, equality and regional returns to education. *Structural Change and Economic Dynamics*, *43*, 1–14.

Sapazhanov, Y., Orynbassar, A., Kadyrov, S., & Sydykhov, B. (2020). Factors affecting mathematics achievement in Central Asian specialized universities. *International Journal of Emerging Technologies in Learning*, *15*(19), 143–153.

Secondary Education. (2020). Retrieved January 18, 2022, from https://osvita.ua/school/rating/

Serdali, B.K., Beldibekova, A.T., Zhaxylykbaeva, R.S., Uzbekova, G., & Tursyn, K. (2018). Democratic principles of education in media environment. *Espacios*, *39*(30), 1–16.

Shevchenko, V.V. (2019). The reform of the higher education of Ukraine in the conditions of the military-political crisis. *International Journal of Educational Development*, *65*, 237–253.

Slutskiy, Ya.S., & Blanchard, C. (2021). Programmes for remote counselling of international students in the higher education institutions of the United States of America. *Scientific Bulletin of Mukachevo State University. Series "Pedagogy and Psychology"*, *7*(3), 18–28.

Sydykhov, B., Daiyrbekov, S., Muratbekova, M., Issayeva, Z., Burkitbayeva, M., Kavakli, M., & Rizayeva, L. (2017). Methodology for the development of search and research skills of prospective math teachers in a course on mathematical physics equations. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(11), 7223–7236.

Tursynbayeva, B.Z., Mukhambetkaliyeva, G.M., Auyesbay, K.A., & Baigabylov, N.O. (2020). National policy and the media in the formation of environmental awareness among students of Kazakhstan. *Media Watch*, *11*(3), 428–438.

UNESCO. (2001). Retrieved February 16, 2022, from http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CLT/pdf/5_Cultural_Diversity_EN.pdf

University Rating. (2019). *TOP-200 Ukraine*. Retrieved February 22, 2022, from http://ru.osvita.ua/vnz/rating/64884/

Wolszczak-Derlacz, J. (2017). An evaluation and explanation of (in) efficiency in higher education institutions in Europe and the US with the application of two-stage semi-parametric DEA. *Research Policy, 46*(9), 1595–1605.

Yaohua, R., Muyu, L., Weihu, C., & Xianyu, C. (2018). Efficiency, Technology and Productivity Change of Higher Educational Institutions Directly under the Ministry of Education of China in 2007-2012. *Procedia Computer Science, 139*, 598–604.

Yarmohammadian, M.H., Mozaffary, M., & Esfahani, S.S. (2011). Evaluation of quality of education in higher education based on Academic Quality Improvement Program (AQIP) Model. *Procedia-Social and Behavioral Sciences, 15*, 2917–2922.

Yessenbayeva, A.M., Yelikbayev, B.K., Abdrahman, G.K., Makulova, L.T., & Serdali, B.K. (2020). Investigating the communicative functions of interrogative sentences in dialogue texts. *Media Watch, 11*(3), 488–501.

Yessengabylov, I., Nurgozhayev, S., Aldabergenova, A., Smagulov, Y., & Krivankova, L. (2021). Factors in the productive use of information and communication technologies by mathematics teachers. *World Transactions on Engineering and Technology Education, 19*(4), 392–397.

Yousefy, A., & Baratali, M. (2011). Women, Employment and Higher education schoolings. *Procedia-Social and Behavioral Sciences, 15*, 3861–3869.

Zhang, G., Wu, J., & Zhu, Q. (2020). *Performance evaluation and enrollment quota allocation for Higher Education Institutions in China*. Retrieved January 28, 2022, from https://www.sciencedirect.com/science/article/abs/pii/S0149718920301257