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Directions and prospects of the development of educational services in conditions of energy transformation: the aspect of the coal industry

ABSTRACT: The purpose of the paper is to substantiate the expediency of diversifying educational services in the context of energy transformation and to highlight the modern approaches and teaching methods that contribute to the implementation of changes in the coal industry in the context of its reform to support the country's energy balance. The article investigates trends in the modern development of the coal industry, as well as the potential of this field based on the energy transformation, taking into consideration the directions and prospects of the development of educational services as the meanings of adaptation to the reforming changes. Examples of coal-industry reform in Ukraine, Poland and Kazakhstan are considered, highlighting the question of retraining retired workers. The results of the conducted survey of respondents' attitudes regarding the importance of training in the energy sector that can be used in the case of energy transformation, namely coal industry reform,

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are analyzed and discussed. The respondents were beginners who prioritize professional skills that are necessary for solving professional tasks. As for the respondents who already have practical experience, it is important to continue their education. Within the scope of this research, the opinion of the respondents was also evaluated regarding the priority of competencies that provide hard skills and soft skills for the energy industry. Directions and ways of development of educational services in the conditions of coal-industry reform are presented.

KEYWORDS: energy transformation, coal industry, education, development, hard and soft skills

Introduction

Today, the world is moving towards sustainable development, reducing the negative impact on the environment, conserving limited resources and increasing renewable sources. Despite the fact that the governments of developed countries have created a regulatory framework that allows managing the negative impact of the environment on energy supply issues, some countries, including Ukraine, are trying to optimize the structure of energy production, particularly by reforming the operation of coal mines in conditions of energy dependence. It should be noted that the European Union has defined strategic priorities for the complete closure of corner ports. However, in countries where traditional sources of energy, in particular coal, still occupy a significant share in the structure of the energy balance, new challenges have arisen: finding ways and selecting enterprises to optimize the functioning of the coal industry. Changes at work require changes in educational activities that ensure the development of employees with new knowledge, create opportunities for mastering competitive skills and formulate the best practices for solving energy problems by building new knowledge about energy transformation and new skills for sustainable energy development. Education is the dominant predictor of change and development, so the question of how education can help solve the problem of energy transition is relevant given the experience of countries in which corner industries are developing, and where this issue is relevant.

1. Analysis of publications on the issues studied

The works of scientists from different countries are devoted to the issue of the development of the coal industry. Ukrainian researchers [Amosha et al. \(2013\)](#) note that the reform of the coal industry creates complex social problems, primarily related to the threat of unemployment, in particular, “a certain reduction in personnel at abandoned mines. In this regard, taking into acco-

unt the experience of other countries (in particular, Great Britain, Poland, Russia), it is necessary to create a flexible system of social protection for workers who are released not only due to the closure of mines, but also due to the modernization and reorganization of enterprises” (Amosha et al. 2013). Pansir and Melnyk (2016), considering the problem of social consequences of the mass closure of mines, draw attention to the previous experience of the restructuring of the coal industry in Ukraine in 1995–2002. As the authors of the source (Pansir and Melnyk 2016) note, about a third of the workers retired after dismissal, about 40% went to work in the “shadow” economy (“spontaneous” markets, “pits”, etc.) and/or began to develop self-employment (crafts, work on the homestead, etc.), about 17% left to earn money in the Russian Federation, and only about 10% were employed with the assistance of the state. Referring to this data, it can be predicted that the ineffective policy of promoting the employment of released miners threatens the growth of the shadow sector of the economy and labor migration for about 20,000 mine workers (Pansir and Melnyk 2016). Oleksyuk and Samotiy (2019), researching the problems of the development of the coal industry in Western Ukraine, notes that “...a worrying factor is the decrease in the number of employees at the enterprises of the State Enterprise “Lvivvugillia”, which indicates, in particular, the general trend of the outflow of workers from the difficult and dangerous profession of a miner due to the unsatisfactory level of remuneration and late payments. It is necessary to pay attention to employment in coal regions and the possibility of filling jobs in the future in the case of the construction of new coal enterprises” (Oleksyuk and Samotiy 2019). It should be noted that the legal basis for the implementation of changes necessary for the reform of the coal industry, which are studied in the works of researchers, are program and regulatory documents that regulate the activities of coal enterprises and determine the policy of the development of the industry. In particular, the Government of Ukraine approved the concept of reforming and developing the coal industry for the period until 2020 and the plan of measures for its implementation (On the approval... 2020). However, significant results of the implementation of this concept have not been presented.

The research based on the results of focus groups with residents of seven mining towns of the Donetsk region in Ukraine proved a low level of knowledge of the European experience regarding the closure of mines and social support of the population. The respondents noted that they were not interested in this issue, and also believe that such a scenario is unrealistic in Ukrainian conditions. During the discussion of the issue of the employment of the working population after the closure of the mines, the audience emphasized the limited employment opportunities in the region. According to respondents, specialists will look for work in their specialty at private mines in the region or at mines abroad. The rest will try to use their skills in areas such as repair services or construction (welding, metalworking, woodworking, electrical). Young people are considering freelance and outsourcing options. It is worth noting the low orientation towards starting one’s own business. The reason may be the low consumption capabilities of the population.

Getting an education and retraining is an urgent issue, especially for young people and middle-aged people. They are interested in obtaining a profession that will be in demand on the labor market and will provide tools for self-realization. Regarding the availability of educational

institutions, where the population can quickly obtain additional qualifications, the respondents note that educational institutions in the region are oriented towards young people (universities, colleges). Therefore, the issue of the retraining of the population with work experience is not sufficiently communicated because most of the respondents are not informed about these opportunities and do not know where to apply for additional qualifications. Successful experiences were never mentioned during the focus groups.

In the fall of 2021, the draft law “On reforming the coal industry” developed by the Ministry of Energy was passed. This document defines a set of socio-economic measures aimed at solving debt issues and financial rehabilitation of state-owned coal mining enterprises, in particular with the involvement of private investments, in order to update the main material and technical funds and increase the economic feasibility of domestic coal production (The coal industry... 2021).

It should be noted that research performed by domestic scientists on the need to implement an energy conservation policy in Ukraine at the state level by changing the structure of national production, introducing energy-saving technologies (Golovchenko et al. 2020) and studying the scientific basis of technical improvement, particularly the influence of the voltage reserve on the parameters of parallel power active compensators in mining (Kolb et al. 2020), can also be used in the training of engineers in the electrical and mining industries (Shavarskyi et al. 2022).

The experience of reforming the coal industry in Poland (Vladyko et al. 2022) is also noteworthy, particularly the transition management in the coal sector of Silesia. Due to the great interest in training, additional funds from the European Union were launched in January 2001 for the implementation of a program of professional retraining of laid-off workers in the mining industry. In addition, training was provided to former miners who had not found a new job after leaving the mining industry. In total, more than 4,100 took advantage of retraining programs. Scientists from the University of Silesia conducted a study on the implementation of the program, the purpose of which was to support the government’s coal restructuring program by mitigating the social and regional consequences of a full or partial reduction in employment. The training was supposed to contribute to the release of workers of the coal industry profession (qualification), allowing them to find work outside the sector (Bara and Dobrowolska 2007). The study by Polish scientists of the effectiveness of the results of the restructuring process in the coal industry and its achievement of sufficient efficiency to sustainably compete on the open market covered all coal-mining enterprises included in official statistics over the long-term (1990–2020), starting from the beginning of the systemic transformation in Poland. The general conclusion of the study was that there is a lack of coherence (follow-up) between the forms and consequences of the restructuring of coal-mining companies in Poland on the one hand, and changes in the composition of the country’s energy balance as a result of energy transfer on the other. In particular, this means that such restructuring could not accelerate changes in the energy balance due to it being ineffective (Kaczmarek et al. 2022).

According to the results of the conducted research, it was concluded that the chances of finding and getting a new job increase with increases in the level of education. Graduates of training courses positively evaluated their choice and the training itself. However, the lack of practical

lessons and their quality during educational sessions caused the most reservations. It follows from this that the number of practical classes in the process of retraining should be increased.

In order to transition to a low-carbon development model, Kazakhstan is implementing measures to reform the domestic economy, which must be implemented at the expense of: attracting investments and new technologies; training and retraining specialists; updating the legislation. The Ministry of National Economy of the Republic of Kazakhstan is developing the strategy for achieving the carbon neutrality of Kazakhstan by 2060. A significant reduction in the share of generation is expected, up to the complete refusal to burn fossil fuels by 2060. Today, about 70% of electricity in the country is generated by coal-fired power plants. Deep processing of coal fuel in the regions requires support from the government as well as the training and retraining of specialists in the coal industry and scientific and research consultation on the introduction of new technologies.

Research by Kazakh scientists is also related to the issue of reforming the coal industry and solving the issue of miners' employment. In particular, (Igenova and Radostovets 2021) emphasized that instead of employing the released miners after the expected collapse of the coal industry, it is necessary to organize coal processing and introduce incentives for the creation of an economic zone around promising companies. It is necessary to find the means for acquiring new technologies for the development of coal generation. Furthermore, new types of products require new specialists with new competencies (Ishekenova 2017).

According to A. Kibarın, in order to eliminate the environmental consequences of the use of coal and thereby remove restrictions on the further increase in solid fuel consumption in Kazakhstan, technologies must be developed and implemented that ensure, along with preventing the release into the environment of "standard" and greenhouse loaders, a high degree of conversion of the chemical energy of coal into final forms of energy – heat and electricity, as well as converted chemical substances and energy carriers, such as motor fuel, methanol, hydrogen. Scientific research, experiential design work, large-scale research on coal gasification, the production of converted chemical substances and energy carriers are necessary (Igenova and Radostovets 2021). Kulekeev (2016) pointed out that the change in the employment structure of the population by industry characterizes the basis of state policy based on the rational use of the main productive forces of society – labor resources and how successful they are in terms of increasing the competitiveness of the national economy and in solving the social problems of society (Kulekeyev. 2016). Thus, determining the development trends of the coal industry with the allocation of potential natural reserves of coal, as well as the production and consumption of this energy resource in the world, is important in the context of the formation of foundations that support the long-term transition to a low-carbon and energy-saving economy and the direction of the process of change, in particular social caused by reform processes.

2. Unsolved questions and the purpose of the paper

Today, normative documents have been adopted in Europe and Ukraine which consider the conceptual foundations of reforming the coal industry, identify the most problematic issues, and consider options for solving existing problems. One of the problems associated with the reform of the coal industry in Ukraine is the low level of personnel potential among the production personnel of the coal industry: the decline in the prestige of mining work, the lack of an educational base and the mismatch in the level of the professional training of workers with the needs of the innovative development of coal production (Vondrova et al. 2019). The best solution can be achieved in conditions where specialists and experts in the field participate in solving the problem in cooperation with representatives of the community in whose territory coal mining takes place. Therefore, research is required with regard to what is being done on the ground to support energy transformation measures, what challenges are faced by the industry and the communities in which the energy companies are located, and what is appropriate to create the conditions to overcome the threats and weaken the weaknesses of their activities. Education is considered as the main condition for the implementation of changes.

The purpose of the paper is to substantiate the expediency of diversifying educational services in the context of energy transformation and highlighting modern approaches and teaching methods that contribute to the implementation of changes in the coal industry in the context of its reform to support the country's energy balance.

3. Research methodology

To achieve the purpose defined in the paper, the following research methods were used. The method of situational analysis for the conducting of development trends of the coal industry in the world and in individual countries was applied to determine the strengths, weaknesses, dangers and additional opportunities expected by enterprises of this industry as a result of changes in the energy sector caused by energy transformation. The result of the situational analysis is the selection of prerequisites, directions and methods of development of educational services in the conditions of reforming the coal industry. The method of situational analysis is supplemented by the method of comparative analysis. As based on the results of this, the expediency of considering the experience of countries such as Ukraine, Poland, and Kazakhstan will be substantiated in the issues of reforming the coal industry and the relevance for the issue of employment, training, career guidance, and other measures designed to resolve the issue of employment including the employment of released workers from coal enterprises of employees in the case of their closure and liquidation.

The research uses the questionnaire method to study the position of people whose activities are related to the energy sector in direct and indirect ways (as lecturers, consultants etc.). The questionnaire developed by the authors of the paper contains a list of questions determining the required competencies and skills for workers in the coal mining industry who are in a situation of unemployment or the risk of dismissal or layoff. Respondents whose field of activity is related to the energy sector will participate in the research. The purpose of the survey is to find out which skills are relevant to the respondents and which skills are prioritized and need additional attention.

A well-known method of surveying experts was chosen to analyse the results of the survey and form conclusions regarding the prospects for the development of educational services, according to the results of which, it will be sufficient to rank the answers received in the survey process according to the degree of their significance (Feshchur 2013).

The concordance coefficient W serves as a measure of the consistency of the conclusions drawn by experts, which in the case of strict ranking (the assessment is made within the established criteria) is calculated using the following formula, which has wide usage for resolving the issue of the coordination of the opinions of different experts (Hrabovetskyi 2010):

$$W = \frac{12 \sum_{j=1}^m (R_j - \bar{R})^2}{n^2 (m^3 - m)}, W \in [0; 1] \quad (1)$$

The task of assessing the dominant characteristics of the competencies required for the energy sector is to match the system of m obtained in the process of obtaining expert assessments with the permutation of numbers from 1 to m . Denoting with R_{ij} the score given to the j^{th} criterion by the i^{th} respondent, the obtained survey results will be presented in the corresponding table, and further calculations of the obtained data will be carried out using formulae:

$$R_j = \sum_{i=1}^n R_{ij}, (j = \overline{1, m}) \quad (2)$$

$$\bar{R} = \frac{n(m+1)}{2} = 24 \quad (3)$$

where:

R_j – the total score of each question,

R_{ij} – the assessment of each of the considered questions by the i^{th} respondent,

\bar{R} – the average sum of ranks,

m – the number of researched assessment questions,

n – number of respondents.

We will use the χ^2 criterion with $(m-1)$ degrees of freedom to check the significance of the concordance coefficient. At the same time, we will compare the calculated value of the criterion statistics $\chi^2 = W \cdot n \cdot (m - 1)$ with the table value for the selected probability level. If the calculated value exceeds the table value, the consistency of the respondents' answers is confirmed.

4. Analysis of trends in the development of the coal industry

In modern conditions, the activities of the energy sector of the economy are aimed at providing industry and the population with energy resources on the basis of sustainable development. This is related to the extraction and generation of energy resources without harming the surrounding environment. The biggest environmental consequences of the irresponsible handling of natural resources are global warming, environmental pollution and disruption of the ecological balance, which negatively affects the natural and business ecosystems. Awareness and maintenance of activities in the energy sector should be accompanied by the training and retraining of personnel involved in the energy sector. Rapid changes in the environment, along with new requirements and technologies for their implementation, are accompanied by new knowledge; they require experience and personnel retraining processes in connection with energy transformations. It should be noted here that by 2050, Europe has chosen the path of abandoning industries that lead to the growth of carbon emissions into the environment and the transition to zero-net technology making the development of renewable energy sources a priority.

Thus, today's period is defined as the period of energy transformation, which means the transition of the world's energy sector from a system of energy production and consumption based on fossil fuels, in particular oil, natural gas and carbon, to renewable energy sources such as wind and solar sources, as well as using lithium-ion batteries. Completely abandoning natural fossil resources is not possible, especially in conditions of dependence on traditional energy sources. However, it is necessary to use the transformation period to prepare and implement relevant changes. In the context of sustainable development, this requires additional measures related to the reform of the industry and the transition to ecological principles of energy supply. The energy transition is the transition of the world's energy sector from fossil-based energy production and consumption systems, including oil, natural gas and coal, to renewable energy sources such as wind and solar sources, as well as the utilization of lithium-ion batteries ([A look at the old development... 2021](#)). The global decrease in coal production and consumption will be accompanied by the reduction of coal enterprises and the release of workers, which will create social tension and worsen the socio-economic development of the territories in which coal enterprises are located.

The growing demand for renewable energy sources and the subsequent share of renewable energy sources in the total energy production places new demands on the development of the energy sector, in particular the coal industry. In 2020, Carbon Tracker found that 46% of coal-fired

power plants would be unprofitable, and by 2030, this percentage is set to reach 53% (A look at the old development... 2021) and the total world consumption of coal, according to forecasts, will decrease by 8% (Coal – Global energy... 2020). Energy firm McKinsey's Global Energy Outlook 2021 report says that while the demand for coal has already peaked, demand for oil and gas were not far behind, peaking in 2029 and 2037, respectively. It is expected that the growth of the energy sector will be driven by the growth of electrification, a significant part of which will be carried out at the expense of renewable sources (Global Energy Perspective 2022).

Reductions in coal production and consumption will lead to changes in the activities of coal enterprises and a reduction in the number of employees. Instead, green energy has already created four million jobs in Europe. Another 492,000 will be created globally to combat climate change. By 2050, as a result of the transition to energy use, the number of jobs is set to increase by 0.3%. Reducing global emissions could create 0.9% of new jobs (A look at the old development... 2021).

The experiences of Ukraine, Poland and Kazakhstan proves that the problem of reforming the coal industry is timely, and the governments of the countries are making efforts to increase the efficiency of the functioning of coal enterprises and create conditions for solving the existing problems. In order to highlight the directions and prospects for the development of educational services in the conditions of the energy transformation of the coal industry, we conducted a survey by covering respondents of Ukraine, Poland and Kazakhstan.

4.1. The results of the survey of respondents

People whose activities are related to the energy sector (65% from respondents' amount of forty-five people) took part in the survey. Below we present the metadata of the conducted survey.

The purpose of the survey is to assess the attitude of the respondents regarding the importance of training in the energy sector and determine the priorities of such training. Competencies regarding professional knowledge, universal competencies that ensure the success of professional tasks and competencies that are necessary for work in the conditions of energy transformation and modern development challenges are taken into consideration. The list of questions includes:

Q1: Assess the level of importance of having special (hard) competencies in the field of energy;

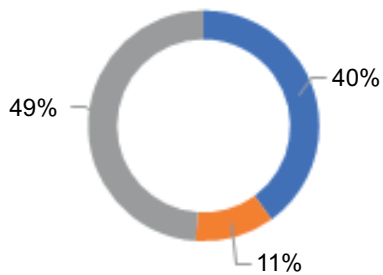
Q2: Assess the level of importance of having universal (soft) competencies in the field of energy;

Q3: Assess the importance of digital competencies in the energy sector;

Q4: Assess the importance of sustainable development skills in the energy sector;

Q5: Assess the need for additional training in modern competencies in the field of energy.

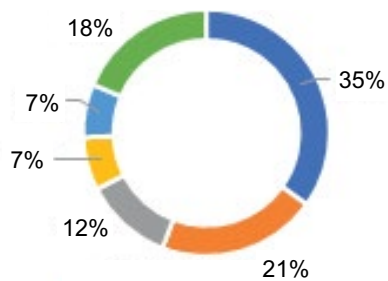
The proposed list of questions is addressed to people who are in roles related to the energy sector and/or work in its service areas. Therefore, the proposed questions reflect modern deve-



■ 18–27 years ■ 28–37 years ■ 38–57 years

Fig. 1. Age of respondents

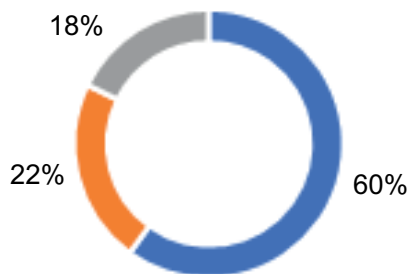
Rys. 1. Wiek respondentów



■ no experience
 ■ experience more than 20 years
 ■ experience 1–5 years
 ■ experience 5–10 years

Fig. 2. Work experience in the energy sector

Rys. 2. Doświadczenie zawodowe w sektorze energetycznym



■ Ukraine ■ Kazakhstan ■ Poland

Fig. 3. Nationality of respondents

Rys. 3. Narodowość respondentów

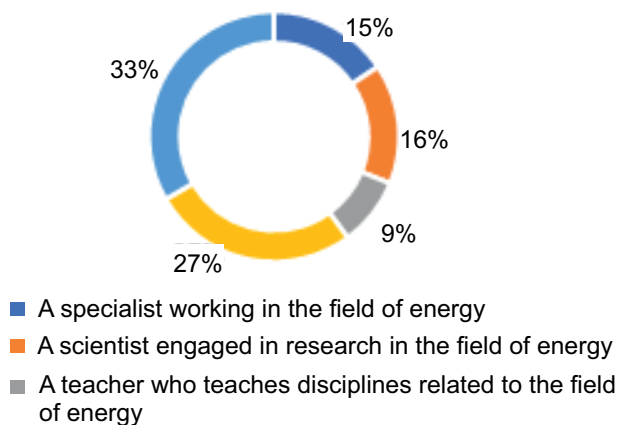


Fig. 4. Field of activity of the respondents

Rys. 4. Pole aktywności respondentów

lopment trends and the needs of modern knowledge in the field of energy, as well as competencies within the framework of sustainable development. This applies to professionals who have previous work experience, specifically in mines or related activities, as well as those who wish to improve their professional skills in the search for new opportunities and retraining professional experience.

The results of the survey are divided into two groups according to the criterion of work experience. Note that 65% of respondents have work experience, so their assessment has the applied value (Table 1).

To summarize the values of the survey results obtained in the table related to the assessment of the priority of competencies for work in the energy sector, we will determine the concordance coefficient that is the consistency of the assessment results of the considered example, which requires intermediate calculations, in particular:

$$\bar{R} = \frac{n(m+1)}{2} = \frac{30(5+1)}{2} = 90; \quad (4)$$

$$\sum_{j=1}^5 (R_j - \bar{R})^2 = 1444 + 1444 + 1936 + 1764 + 2025 = 8613; \quad (5)$$

$$W = \frac{12 \cdot 8613}{30^2 (125 - 5)} = \frac{103356}{108000} = 0.957 \quad (6)$$

As a result, we note that a higher level of consistency of the obtained estimates corresponds to a larger value of the coefficient, which approaches 1.

TABLE 1. Results of a survey of respondents with practical experience in the energy sector

TABELA 1. Wyniki badania respondentów z praktycznym doświadczeniem w sektorze energetycznym

No.	No. of respondent	Questions				
		Q1	Q2	Q3	Q4	Q5
1	1	5	5	5	4	3
2	2	5	5	5	5	5
3	3	5	4	5	5	5
4	4	3	4	3	4	4
5	5	2	3	3	5	5
6	6	3	3	4	3	3
7	8	4	4	5	5	5
8	9	5	5	5	5	5
9	10	4	5	5	4	5
10	11	5	5	5	5	5
11	12	5	4	4	4	5
12	13	5	4	5	4	5
13	18	4	5	4	5	5
14	20	5	5	5	5	5
15	21	4	3	4	2	4
16	23	5	5	4	5	5
17	25	5	4	5	5	4
18	26	4	5	4	4	4
19	27	4	4	4	4	4
20	29	4	4	4	4	4
21	30	5	5	5	4	5
22	31	3	3	3	3	3
23	33	5	5	5	4	5
24	37	5	4	5	5	5
25	38	4	4	5	5	4
26	40	5	4	4	4	5
27	42	5	4	5	5	5
28	43	3	5	5	5	4
29	44	3	3	5	5	5
30	45	4	5	4	5	4
R_j	–	128	128	134	132	135
$R_j - \bar{R}$	–	38	38	44	42	45
$(R_j - \bar{R})^2$	–	1,444	1,444	1,936	1,764	2,025

Using the data in Table 1, we find the total score of each of the criteria for evaluating the characteristics of a manager R_j according to expression (1). We use the x^2 criterion with $(m - 1)$ degrees of freedom to check the significance of the concordance coefficient. The estimated value of the criterion statistics $x^2 = W \cdot n \cdot (m - 1)$ is compared with the table value for the selected probability level. If the estimated value exceeds the table value, the consistency of the respondents' answers is confirmed.

For the considered example, the estimated value of criterion statistics is:

$$x_{calculated}^2 = 0.957 \cdot 30 \cdot 4 = 114.84 \quad (7)$$

From the x^2 distribution tables for a significance level of 0.05 and 4 degrees of freedom, we find $x_{critical}^2 = 9.5$.

Since the estimated value of the statistics is greater than the table value, we can consider the obtained ranking results to be statistically significant. We make similar calculations for respondents who do not have work experience. This group includes students and those interested in modern energy development (Table 2).

TABLE 2. Results of the survey of respondents who do not have practical experience in the energy sector

TABELA 2. Wyniki badania respondentów nieposiadających praktycznego doświadczenia w energetyce

No.	No. of respondent	Questions				
		Q1	Q2	Q3	Q4	Q5
1	7	5	5	5	4	3
2	14	5	5	5	5	5
3	15	5	5	5	5	5
4	16	3	4	3	4	4
5	17	2	3	3	5	5
6	19	3	3	4	3	3
7	22	4	3	4	4	3
8	24	4	4	5	5	5
9	28	5	5	5	5	5
10	32	4	5	5	5	5
11	34	5	5	5	5	5
12	35	5	4	4	4	5
13	36	5	4	5	4	5
14	39	5	4	5	4	4
15	41	5	5	5	5	5
R_j	–	68	61	68	66	65
$R_j - \bar{R}$	–	23	16	23	21	20
$(R_j - \bar{R})^2$	–	529	256	529	441	400

To summarize the values obtained in Table 3 of the survey results of the managers of divisions related in the performance of the sales function, we determine the concordance coefficient that is the consistency of the assessment results of the considered example, which requires intermediate calculations, in particular:

$$\bar{R} = \frac{15 \times (m+1)}{2} = 45, \quad (8)$$

$$\sum_{j=1}^5 (R_j - \bar{R})^2 = 529 + 526 + 529 + 441 + 400 = 2155; \quad (9)$$

$$W = \frac{12 \cdot 2155}{15^2 (125 - 5)} = \frac{25860}{27000} = 0.958 \quad (10)$$

As a result, we note that a higher level of consistency of the obtained estimates corresponds to a larger value of the coefficient, which approaches 1.

Using the data in Table 1, we find the total score of each of the criteria for evaluating the characteristics of a manager R_j according to expression (1).

We use the x^2 criterion with $(m - 1)$ degrees of freedom to check the significance of the concordance coefficient. The estimated value of the criterion statistics $x^2 = W \cdot n \cdot (m - 1)$ is compared with the table value for the selected probability level. If the estimated value exceeds the table value, the consistency of the respondents' answers is confirmed. For the considered example, the estimated value of criterion statistics is:

$$x_{calculated}^2 = 0.958 \cdot 15 \cdot 4 = 57.48 \quad (11)$$

From the distribution tables for a significance level of 0.05 and 4 degrees of freedom, we find $x_{critical}^2 = 9.5$.

Since the estimated value of the statistics is greater than the table value, we can consider the obtained ranking results to be statistically significant. The calculations performed using expressions (1), (2) and (3) and the obtained results of expert evaluation of characteristics by thirty respondents for questions Q1–Q5 are presented in Table 3.

TABLE 3. Priority of questions determined by respondents

TABELA 3. Priorytet pytań określony przez respondentów

Category of respondents	Priority of questions				
Respondents with practical experience	Q5	Q	Q4	Q1	Q2
Respondents without practical experience	Q1	Q3	Q4	Q5	Q2

As we can see from Table 3, respondents without practical experience prioritize professional skills, in other words, we can generalize that the competences necessary for solving professional tasks are decisive for beginners. As for the respondents who already have practical experience, it is important for them to continue their education.

Within the scope of this research, the opinion of the respondents was also evaluated regarding the priority of competencies that provide hard skills and the priority of competencies that provide soft skills. The results obtained during the survey allow us to characterize the structure of hard and soft skills, which is presented in Figures 5–6.

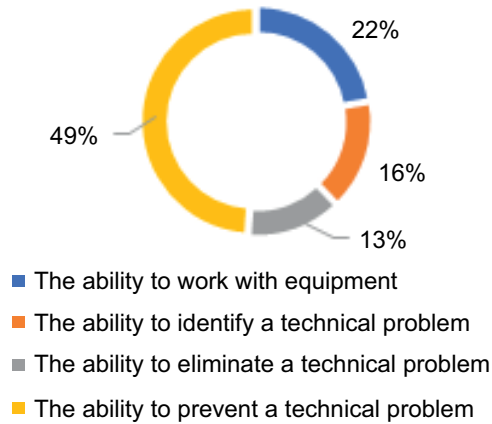


Fig. 5. Structure of hard skills

Rys. 5. Struktura umiejętności twardych

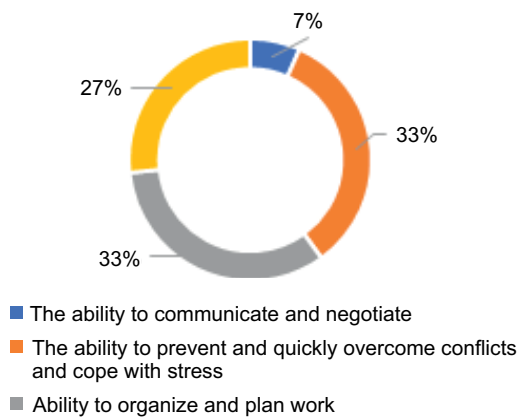


Fig. 6. Structure of soft skills

Rys. 6. Struktura umiejętności miękkich

In terms of hard skills, the priority is the ability to anticipate a technical problem and the ability to work with equipment. In other words, it can be argued that the knowledge and ability to accept and carry out technical annual reports allow the prevention of the occurrence of technical problems and the need to eliminate them. With regard to soft skills, the ability to organize and plan work together with the ability to prevent and resolve conflicts and cope with stress are prioritized.

4.2. Directions and ways of the development of educational services in the conditions of coal industry reform

The implementation of any changes requires additional knowledge and information, the acquisition of which is possible with the help of educational services. It should be noted that the improvement of the educational base of the region has become one of the main success factors on the way to abandoning coal use in Germany (*Experience of... 2020*). From the experience of reforming Germany, it is important not only to solve the problems of unemployment, the functioning of the economy and the energy system but also to introduce measures to improve the infrastructure of former coal regions, develop universities and research institutions, as well as consider intangible factors, such as the development of culture and the state of the environment.

In the Law of Ukraine “On Education”, educational services are considered as a set of “actions defined by legislation, an educational program and/or a contract of the subject of educational activity, which have a defined cost and are aimed at achieving the expected learning outcomes by the student” (*Law of Ukraine... 2017*). Therefore, the training and retraining of specialists in the energy sector, in particular the coal industry, also requires the functioning of a systemically adjusted field of activity that would provide educational services demanded by business entities and specialists who intend to change or improve their profession. As was noted in the paper, Poland has experience in the retraining of mine workers, and the conducted research on the results of retraining shows that more than half of the participants in the retraining program are satisfied with the training.

In Ukraine, the situation of reforming the coal industry along with the implementation of measures to retrain workers of mines that were closed or are planned to close due to unprofitability is complicated by the war with Russia. However, the developed global experience and trends in the development of educational services are important for the formation of program measures for the implementation of the concept of reforming the coal industry planned for 2020–2024.

The relevance and importance of considering education services to reform the coal industry is supported by the fact that the size of the global education services market is expected to grow from US\$ 2,882.52 billion in 2021 to US\$ 3,191.79 billion in 2022 at a compound annual growth rate (CAGR) of 10.7%. The growth of the education services market is mainly due to the reorganization of companies and the recovery from the effects of COVID-19, which previously led

to restrictive measures, including social distancing, remote work and the closure of commercial activities, which led to operational challenges. The education services market is expected to reach \$4,623.90 billion in 2026 at a CAGR of 9.7% (Educational services... 2022).

In the formation of the system of educational services for the retraining of employees, specialized educational institutions occupy an important place. However, as we can see from Figures 7–8 the demand on mining specialty decreases.

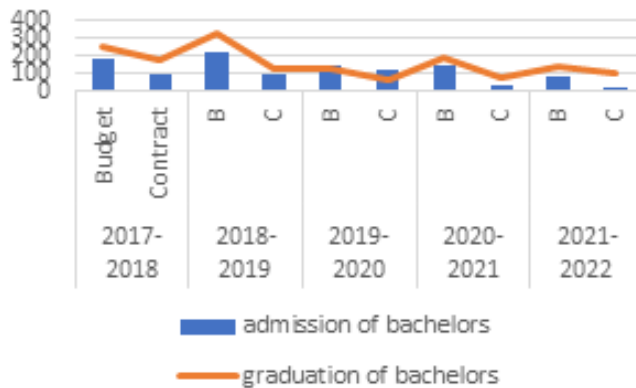


Fig. 7. Dynamics of admission and graduation of Bachelors in Mining [number of people]

Source: Report of the Educational Department of the Dnipro University of Technology on the form 2-3n-k regarding the movement of the student contingent (as of October 1, 2017–2021)

Rys. 7. Dynamika przyjęć i ukończenia studiów licencjackich na kierunku górnictwo [liczba osób]

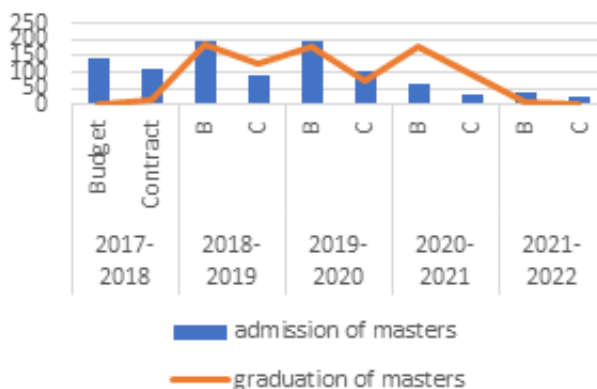


Fig. 8. Dynamics of admission and graduation of Masters in Mining [number of people]

Source: Report of the Educational Department of the Dnipro University of Technology on the form 2-3n-k regarding the movement of the student contingent (as of October 1, 2017–2021)

Rys. 8. Dynamika przyjęć i ukończenia studiów magisterskich na kierunku górnictwo [liczba osób]

One of the areas of encouragement to study is the implementation of measures to improve the quality of education, particularly through the digitalization of educational services. We should note that in modern conditions, educational services that use gamification methods to improve the educational experience of students are becoming very popular. Gamification is the concept of applying game design to various classroom tasks to make them more fun and engaging and is the creation of a holistic learning environment in educational services that increases student's engagement, motivation and core skills.

In Ukraine, gamification technologies used in educational services are episodic in nature and depend mainly on the professional level of the lecturer or trainer and the availability of a favorable digital environment for such training. Of particular interest is a study that was conducted on the attitude of Ukrainian respondents to gamification technology in their workplaces (Polańska et al. 2022). The vast majority of respondents (61%) represent the age category from 18 to 30 years, 19.5% of the respondents are from the age category from 31 to 43 years, 12.2% are from the age category from 44 to 59 years, and the fewest number of respondents (namely 7.3%) belong to the category of 60 years and older.

When considering the issue of the development of educational services in conditions of reforming the coal industry, attention should be paid to such a direction of education as the acquisition of sustainable development competencies, in particular, participation in solving issues related to the impact of mine operations on the environment and mastering the latest technologies capable of minimizing the negative impact on the environment. As noted by Prof. I. Kulchytska "... the progress of technologies, especially ecological ones, ... will contribute to minimizing the pressure of the mining industry on the environment. Until then, the existing mining industry will eliminate environmental damage using knowledge and modern experience. Increasing awareness of communities from mining regions regarding the role of mining for the economy will allow reaching a compromise on the topic of the future of mining" (Pietrzyk-Sokulska et al. 2015). Kazakhstan's experience in the implementation of national programs for the transformation of professions, in particular Atlas, deserves attention. Its implementation will make it possible to prepare new professions based on forecasting the needs for various competencies in strategically important sectors of the economy, which will have a positive impact on the future strategic programs of the country's development. In addition, it will be reflected in the understanding and interest of the population in advanced qualifications, involvement in learning relevant skills or professions that will be restored. Increased attention to industry education will allow an intensification of innovative activity and bring the field of education closer to the practical field of the application of the acquired knowledge. For example, in 2022, the universities of the Republic of Kazakhstan developed ninety-one innovative programs, and by 2025, it is planned to increase this number to 200. In addition, the share of state orders for technical areas of training has been increased to 60%. Additionally, in the current year 2022, 406 industrial enterprises of Kazakhstan hold patronage over 406 colleges. In 2021, there were only fifty-one such examples (Atlas of... 2022).

Conclusion

The research carried out in the paper on the situation of the global development of the coal industry has made it possible to justify the expediency of the diversification of educational services in the conditions of reforming the coal industry, which meets the challenges of global energy transformation. Against the background of the global decline in coal production and consumption, the features of reforming the coal industry of Ukraine, Poland and Kazakhstan are characterized. The comparative analysis made it possible to conclude that the global energy transformation caused changes in the development of the coal industry of the studied countries, albeit with different experiences and achievements. In the case of the availability of natural coal deposits, an important issue is the reform of the coal industry while ensuring the profitable operation of mines and the elimination of man-made and ecologically dangerous units with minimal negative consequences for the social component of the reform. The development and diversification of educational services is an important source of knowledge and information on how to implement measures to transform old, dangerous and unprofitable coal enterprises into economically and ecologically attractive business entities. Furthermore, the development of educational services should take into account the real state of educational activity and the challenges and needs that are supposed to be solved at their expense. Conducting research among respondents whose activities are related to the energy sector made it possible to identify priorities for acquiring competences in the energy sector. This made it possible to emphasize modern approaches and training methods that allow the acquisition of the necessary competencies and contribute to the implementation of changes in the coal industry in the context of its reformation to support the country's energy balance. The development of new energy sources and its implementation requires new approaches to the training of specialists and, as the article indicated, gamification methods as well as other digital methods are appropriate for this.

The directions and practical ways of diversifying educational services are characterized on the basis of results of conducted research and surveys.

References

- A look at the old development – energy transformation, Volume 1 (*Ohlyad staloho rozvytku — enerhetychna transformatsiya, Tom 1*) 2021, December 3. International auditing company BDO. [Online] <https://www.bdo.ua/uk-ua/insights-2/information-materials/2021/sustainability-snapshots-energy-transition-vol-1> [Accessed: 2021-02-12] (*in Ukrainian*).
- AMOSHA et al. 2013 – AMOSHA, O.I., STARYCHENKO, L.L. and CHEREVATSKYI, D.Yu. 2013. Status, main problems and prospects of the coal industry of Ukraine (*Stan, osnovni problemy i perspektyvy vuhil'noyi promyslovosti Ukrayiny*). Scientific report of the National Academy of Sciences of Ukraine. Institute of Industrial Economics. Donetsk.[Online] <http://surl.li/ctbhr> [Accessed: 2023-10-15] (*in Ukrainian*).

- Atlas of professions will be introduced into curricula (*Atlas professiy budet vnedren v uchebnyye programy*) 2022. Kazakhstan Today. Information agency. [Online] https://www.kt.kz/rus/education/atlas_professiy_budet_vnedren_v_uchebnye_programmy_1377931484.htm [Accessed: 2021-02-12] (*in Russian*).
- BARA, I. and DOBROWOLSKA, M. 2007. The effectiveness of qualification training as a method of professional activation and gender: on the example of graduates of retraining training of the European Union aid programs PHARE Initiative I (PL 9811) and PHARE Initiative II (*Skuteczność szkoleń kwalifikacyjnych jako metody aktywizacji zawodowej a płeć: na przykładzie absolwentów szkoleń przekwalifikujących programów pomocowych Unii Europejskiej PHARE Inicjatywa I (PL 9811) i PHARE Inicjatywa II*). *Chowanna*, 1, pp. 63–78. [Online] <https://www.sbc.org.pl/dlibra/publication/5137/edition/4748/content?> [Accessed: 2023-01-24] (*in Polish*).
- Coal – Global energy review 2020 – Analysis 2020. IEA. [Online] <https://www.iea.org/reports/global-energy-review-2020/coal> [Accessed: 2021-02-12].
- Educational services market analysis, size and trends global forecast to 2022–2030*. 2022. Global Market Research Reports & Consulting | The Business Research Company. [Online] <https://www.thebusinessresearchcompany.com/report/educational-services-global-market-report> [Accessed: 2021-02-12].
- Experience of transformation of mining regions: recommendations for Ukraine (*Dosvid transformatsiyi shakhtars'kykh rehioniv: Rekomendatsiyi dlya Ukrayiny*) 2020, June 17. Ecodiia. [Online] <https://ecodiiia.org.ua/aftercoal-ua.html> [Accessed: 2021-02-12] (*in Ukrainian*).
- FESHCHUR, R.V. 2013. *Making project decisions*. Lviv: Publishing House of the Lviv Polytechnic, 220 pp.
- Global Energy Perspective 2022. Executive Summary*. 2022. Global management consulting. McKinsey & Company. [Online] <http://surl.li/ctbhn> [Accessed: 2021-02-12].
- GOLOVCHENKO et al. 2020 – GOLOVCHENKO, A., DYCHKOVSKYI, R., PAZYNICH, Y., EDGAR, C.C., HOWANIEC, N., JURA, B. and SMOLINSKI, A. 2020. Some Aspects of the Control for the Radial Distribution of Burden Material and Gas Flow in the Blast Furnace. *Energies* 13(4), DOI: 10.3390/en13040923.
- HRABOVETSKYI, B. 2010. Methods of expert evaluations: theory, methodology, directions of use: monograph. Vinnytsia: VNTU. 171 pp.
- IGENOVA, Z. and RADOSTOVETS, N. 2021. Coal industry: not to curtail, but to modernize (*Ugol'naya otrasl': ne svorachivat', a modernizirovat'*). AGMP News. [Online] <https://agmpnews.kz/ugolnaya-otrasl-ne-svorachivat-a-modernizirovat/> [Accessed: 2021-02-12] (*in Russian*).
- ISHEKENOVA, B. 2017. Rumors about the development of renewable energy in Kazakhstan are somewhat exaggerated – expert (*Slukhi o razvitii VIE v Kazakhstane neskol'ko preuvelicheny – ekspert*). [Online] <https://lsm.kz/sluhi-o-razvitii-vie-v-kazakhstane-neskol-ko-preuvelicheny-eksperty> [Accessed: 2023-01-24] (*in Russian*).
- KACZMAREK et al. 2022 – KACZMAREK, J., KOLEGOWICZ, K. and SZYMLA, W. 2022. Restructuring of the Coal Mining Industry and the Challenges of Energy Transition in Poland (1990–2020). *Energies* 15(10), DOI: 10.3390/en15103518.
- KOLB et al. 2020 – KOLB, A., PAZYNICH, Y., MIREK, A. and PETINOVA, O. 2020. Influence of voltage reserve on the parameters of parallel power active compensators in mining. *E3S Web of Conferences* 201, DOI: 10.1051/e3sconf/202020101024.
- KULEKEYEV, Z. 2016. What can the structure of sectoral employment in Kazakhstan indicate? (*O chem mozhet svidetel'stvovat' struktura otraslevoy zanyatosti v Kazakhstane?*). [Online] <https://aerc.org.kz/news/o-chem-mozhet-svidetel'stvovat-struktura-otraslevoj-zanyatosti-v-kazakhstane?lang=ru> [Accessed: 2023-01-24] (*in Russian*).
- Law of Ukraine “On Education”* (No. 2145-VIII) (*Zakon Ukrayiny «Pro osvitu» (№ 2145-VIII)*) 2017. Verkhovna Rada of Ukraine. [Online] <https://zakon.rada.gov.ua/laws/show/2145-19#Text> [Accessed: 2021-02-12] (*in Ukrainian*).

- OLEKSYUK, H. and SAMOTIY, N. 2019. Trends and problems of coal industry development in Ukraine (on the example of state enterprise «Lvivvuhillya») (*Tendentsiyi ta problemy rozvytku vuhil'noyi promyslovosti Ukrayiny (na prykladi derzhavnoho pidpryyemstva «L'vivvuhillya»*)). [In:] *Sotsial'no-ekonomichni problemy suchasnoho periodu Ukrayiny* 135(1), pp. 3–9, DOI: 10.36818/2071-4653-2019-1-1 (*in Ukrainian*).
- On the approval of the Concept of reforming and developing the coal industry for the period until 2020* 2020. Cabinet of Ministers of Ukraine. [Online] <https://www.kmu.gov> [Accessed: 2023-02-20].
- PANTSUR, S.I. and MELNYK, S.V. 2016. What should be the state policy of Ukraine regarding miners under conditions of mass closure of coal mining enterprises? (*Yakoyu maye buty derzhavna polityka Ukrayiny shchodo shakhtariv za umov masovoho zakryttya vuhledobuvnykh pidpryyemstv?*). European Information and Educational Center. [Online] https://pdf.usaid.gov/pdf_docs/PA00XC8J.pdf [Accessed: 2022-02-17] (*in Ukrainian*).
- PIETRZYK-SOKULSKA et al. 2015 – PIETRZYK-SOKULSKA, E., UBERMAN, R. and KULCZYCKA, J. 2015. The impact of mining on the environment in Poland – myths and reality. *Gospodarka Surowcami Mineralnymi – Mineral Resources Management* 31(1), pp. 45–64, DOI: 10.1515/gospo-2015-0009.
- POLAŃSKA et al. 2022 – POLAŃSKA, A., ANDRIIOVYCH, M., GENEROWICZ, N., KULCZYCKA, J. and PSYUK, V. 2022. Gamification as an Improvement Tool for HR Management in the Energy Industry – A Case Study of the Ukrainian Market. *Energies* 15(4), DOI: 10.3390/en15041344.
- SHAVARSKYI et al. 2022 – SHAVARSKYI, I., FALSHTYNSKYI, V., DYCHKOVSKYI, R., AKIMOV, O., SALA, D. and BUKETOV, V. 2022. Management of the longwall face advance on the stress-strain state of rock mass. *Mining of Mineral Deposits* 16(3), pp. 78–85, DOI: 10.33271/mining16.03.078.
- The coal industry reform law will ensure miners' rights to social protection* 2021. Ministry of Energy of Ukraine. [Online] https://mpe.kmu.gov.ua/minugol/control/publish/article?art_id=245567098 [Accessed: 2023-01-24].
- VLADYKO et al. 2022 – VLADYKO, O., MALTSEV, D., SALA, D., CICHÓŃ, D., BUKETOV, V. and DYCHKOVSKYI, R. 2022. Simulation of leaching processes of polymetallic ores using the similarity theorem. *Rudarsko-Geološko-Naftni Zbornik* 37(5), pp. 169–180, DOI: 10.17794/rgn.2022.5.14.
- VONDRROVA et al. 2019 – VONDRROVA, Z., WENERT, T., GINYA, G., DUDEU, R., KRIZHANIVSKY, V., KRYNITSKY, K., OEY, P-YU., SUTLOVICHOVA, K. and SHON-CHANISHVILI, M. 2019. *Achievements of the transformation of mining regions: recommendations for Ukraine (summary of the study)*. Center for environmental initiatives “Ecodiya”. K: ALT Company.

Kierunki i perspektywy rozwoju usług edukacyjnych w warunkach transformacji energetycznej: aspekt przemysłu węglowego

Streszczenie

Celem artykułu jest uzasadnienie celowości dywersyfikacji usług edukacyjnych w kontekście transformacji energetycznej oraz zwrócenie uwagi na nowoczesne podejścia i metody nauczania, które przyczyniają się do wdrażania zmian w przemyśle węglowym w kontekście jego reformy wspierającej bilans energetyczny kraju. Artykuł bada trendy we współczesnym rozwoju przemysłu węglowego, a także potencjał tej dziedziny w oparciu o transformację energetyczną, biorąc pod uwagę kierunki i perspektywy rozwoju usług edukacyjnych jako znaczeń przystosowania się do zmian reformatorskich. Rozważono przykłady reform przemysłu węglowego na Ukrainie, w Polsce i w Kazachstanie, zwracając uwagę na kwestię przekwalifikowania emerytowanych pracowników. Analizie i dyskusji poddano wyniki przeprowadzonego badania postaw respondentów dotyczącego znaczenia szkoleń w sektorze energetycznym, które mogą być wykorzystane w przypadku transformacji energetycznej, czyli reformy przemysłu węglowego. Respondentami były osoby początkujące, dla których priorytetem są umiejętności zawodowe niezbędne do rozwiązywania zadań zawodowych. W przypadku respondentów, którzy mają już doświadczenie praktyczne, ważne jest, aby kontynuować naukę. W ramach niniejszego badania oceniono również opinię respondentów na temat priorytetu kompetencji dostarczających umiejętności twarde i miękkie dla branży energetycznej. Przedstawiono kierunki i sposoby rozwoju usług edukacyjnych w warunkach reformy górnictwa.

SŁOWA KLUCZOWE: transformacja energetyczna, przemysł węglowy, edukacja, rozwój, umiejętności twarde i miękkie