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PAPER

Expert Assessment of the Quality of Remote Educational Resources

Andrii Guraliuk[1](✉), Iryna Varava[2], Svitlana Holovko[2], Liudmyla Shapenko[2], Veronika Oleshchenko[2]

[1]V O Sukhomlynskyi State Scientific and Pedagogical Library of Ukraine, Kyiv, Ukraine

[2]National Aviation University, Faculty of Law, Kyiv, Ukraine

ag.guraliuk@gmail.com

ABSTRACT

Analysis of scientific works in the field of education shows that one of the problems of the educational process is the assessment of its quality. Many authors consider the qualimetric approach to be the most effective approach to the practical implementation of such an assessment. While agreeing with scientists who study the application of qualimetry to assess the quality of education, the authors of this article focus on the use of the resource approach. The educational process itself can be considered as a set of these resources, united by defined interactions. This approach will allow individualization of learning at the student level. We consider the technology of constructing factor-criteria models with the involvement of specialists in their development. This approach is based on the numerical interpretation of the results obtained using the method of expert assessments. We also offer the tools we have developed (either a specialized program or a set of criteria for evaluation) to support the peer review of electronic resources. We show that this toolkit, with minor changes, is applicable to the evaluation (ranking by qualitative features) of arbitrary resources of the educational process that have quality as a characteristic. In addition, the use of the proposed approach makes it possible to use qualimetric monitoring as a tool for the educational process – in other words, to track the dynamics of changes in the state of the resources of the educational process and, using statistical methods, to establish their impact on the final result of education.

KEYWORDS

higher education, education quality assessment, qualimetry, resource approach in education

1 PROBLEM STATEMENT

The world events of the past years (COVID-19 pandemic) and that began in our country in 2022 (Russian aggression) have thrown an unprecedented challenge to the Ukrainian education system. The destruction of many educational institutions and the evacuation of the population, including applicants for education, from the war zone to safer regions and abroad led to the massive use of remote education in

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the educational process. Despite the existence of a fairly rich experience of correspondence education for various categories of its applicants, in general, the educational system was not quite ready for the introduction of remote learning. There has been some inevitable, albeit rather spontaneous, transformation of the educational process from a relatively rigid system to a system that is much more flexible, mobile, adaptive to life's realities.

Despite the negative reasons for the changes in the Ukrainian education system, in general, it was possible to maintain its huge potential, although a number of problems have significantly worsened. Among them are the psychological unpreparedness of many teachers to increase the share (sometimes up to 100%) of remote education relative to traditional forms of work, the fragmented development of remote learning methods, etc. Among other things, it was found that existing electronic educational resources do not fully cover curricula, in many ways they are outmoded (their modernization has not kept pace with the dynamics of the needs of the educational process), etc. In addition, many electronic textbooks and manuals are of dubious quality due to the use of outdated or unapproved terminology, the lack of methods for developing resources of this type, and a number of other reasons [1].

Understanding the current situation, as well as the analysis of scientific and pedagogical works, has shown that one of the problems of the educational process, especially the remote one, is the assessment of its quality. Many authors consider the qualimetric approach to be the most effective approach to the practical implementation of such an assessment. In these studies, the axiomatics and principles of assessing the quality of various pedagogical objects (the quality of the "processes" and "results" of training, education, upbringing, etc.) are considered. The researchers emphasize that the qualimetric approach involves the analysis and development of comprehensive assessments of the quality of the educational process using qualimetric methods. In particular, in the studies of many scientists, it is noted that pedagogical qualimetry widely uses expert methods to ensure the effectiveness of the training of future specialists.

Based on a systematic approach, quality criteria for various components of the educational process are developed. Based on the criteria obtained, a numerical function is constructed that performs an isomorphic mapping of the described empirical structure into an appropriately selected numerical structure.

At the same time, the authors note the lack of clear, regulated procedures for monitoring the quality of remote learning. We note that in remote education, the need for accurate and comparable data is felt most acutely, because students and teachers are separated by distance and interact indirectly in the information educational environment.

2 ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

Many authors have devoted their studies to the issue of assessing the quality of education (including remote learning). In the context of our work, we consider one of the most significant contributions by the team of authors Abderrahim El Mhouti, Mohamed Erradi and Azeddine Nasseh. Their work is to develop a scoring grid, taking into account academic, pedagogical, didactic and technical constraints. Their research also aims to evaluate digital educational resources by comparing

them with various criteria and grid questions to determine possible outcomes and analysis [2].

One of the most interesting works from our point of view was the study by John C. Nesbit and Jerry Li [3], who reviewed modern approaches to the evaluation of educational objects and presented a set of web tools they developed for communities of teachers, students, instructional designers and developers. Compliant with current metadata standards, eLera provides a learning object validation tool and other features that support collaborative assessment. eLera is also designed to help researchers collect data on assessment processes and perceptions of the quality of learning objects. David Squires and Jenny Preece have proposed an approach that adapts the idea of usability heuristics, taking into account a social constructivist learning perspective. This led to the creation of a set of "learning with software" heuristics. A notable feature of these heuristics is that they take into account the integration of usability and learning considerations [4].

We also note the work of L. Dominique, J. M. Scapin, J. Christian Bastien, and M. Christian Bastien, "Ergonomic Criteria for Evaluating the Ergonomic Quality of Interactive Systems," [13] and a study by Hari Wibawanto, "E-Learning Quality Evaluation Instrument for SPADA Indonesia," [14] in which two types of tools were developed: (1) an instrument to measure the quality of learning objects and their placement and assembly in a Learning Management System, and (2) a checklist for determining the availability of elements forming the face validity of e-learning and many others. The authors analyzed various criteria that describe the characteristics of educational resources, the methodology for their use, the expediency of using them in the educational process, ergonomic properties, etc., with varying completeness and accuracy.

At present, there is a large number of studies on the use of qualimetric methods in education. So in the works of O. Kasyanova, the essence, algorithm, forms and methods of pedagogical examination of educational institutions and managerial and educational activities are defined using qualimetric modeling [5]. We note the work of V. Galina and Sergei V. Akimov, who presented the concept of using qualimetric models in e-learning systems. They managed to build a competently oriented qualimetric model of a student, taking into account the dynamics of educational achievements, as well as a qualimetric model for a comprehensive assessment of the quality of the electronic content of education [6]. Also of interest are the works of a large number of other authors, including G. Dmitrenko, H. Yelnykova, T. Borova, V. Stepashko, A. Salamatov, M. Baybaeva and E. Safargaliev.

It is noteworthy that the majority of authors have a rather narrow understanding of the term "educational resource," by which they usually mean either a certain computer program used in training or a set of personal qualities (the competence of an education seeker or teacher). The general picture, determined by the resource approach, remains uncovered.

In these studies, the axiomatics and principles of assessing the quality of various pedagogical objects (the quality of the "processes" and "results" of training, education, upbringing, etc.) are considered. The researchers emphasize that the qualimetric approach involves the analysis and development of comprehensive assessments of the quality of the educational process based on qualimetry. In particular, it is noted in the studies of many scientists that pedagogical qualimetry widely uses expert methods to ensure the effectiveness of the training of future specialists.

3 STATEMENT OF BASIC MATERIAL AND THE SUBSTANTIATION OF THE OBTAINED RESULTS

The system of Ukrainian education has traditionally been predominantly focused on full-time education. In this regard, the urgent transfer of training to a remote format revealed that not all educational institutions were ready for this radical restructuring of the educational process. The reasons for the difficulties were the objectively different levels of development of the information infrastructure of various institutions, the provision of disciplines with electronic educational resources and the readiness of teachers to use digital platforms and services in the educational process.

The mass introduction of remote (distance) education has led to the need to search for methods and technologies that provide an acceptable quality of education and allow this quality to be objectively assessed under the new conditions. There are many approaches to solving this problem, one of which is the resource approach. Using this approach allows the differentiation of the external and internal resources of students. External resources include material resources, information, social resources, etc.

External resources include socially significant resources – material values, information flows, the dynamism of an unstable environment, migration, the influence of external communications, etc. External resources of the educational process ensure the organization of professional training in comfortable conditions and optimal dynamics of working capacity, taking into account the level of well-being of students in the educational regime (teaching staff, material support, mass media, library collections, etc.). Internal resources are understood as abilities, individual characteristics of perception, knowledge, skills, competencies, personal goals, motivational system, etc. The system of internal individual resources of the personality of a future specialist takes into account biogenetic, physiological, psychological and professional resources [7, 8].

Internal resources are understood as psychological resources – abilities, individual characteristics of perception, acquired knowledge, skills, formed competencies, personal goals, motivational state, etc.

Traditionally, despite the fact that external resources directly affect the manifestation and development of internal resources, they are not the object of psychological diagnostics and are more often the field of study of other disciplines (e.g., economics, sociology). At the same time, remote education, like no other type of education, is directly dependent on the quality of external resources.

It should be noted that the assessment of resources that affect the educational process is not a panacea, since they are just a tool to enable applicants for education to develop professional (and not only) competencies. But high quality of the resources of the educational process is one of the important conditions for the implementation of its effectiveness.

In remote education, the need for accurate and comparable data is felt most acutely as students and teachers are separated by distance and interact indirectly in the information educational environment. Today, despite the scientific research conducted, there is a lack of clear regulated procedures for quality control of remote learning. Based on the analysis of scientific papers devoted to the evaluation of various objects of the pedagogical process, its tools and results, we came to the conclusion that the qualimetric approach is the most universal and its use allows to see

the dynamics of changes in the quality of this process and promptly correct it. The essence of the qualimetric approach lies in the fact that, based on the needs of the educational process, criteria for the quality of its various resources are developed. Based on the obtained criteria, a numerical function is constructed that performs an isomorphic mapping of the described empirical structure into an appropriately selected numerical structure.

Note that qualimetry as a science of quantitative measurement of qualitative phenomena is being developed in factor-criteria modeling, including social processes that have not previously been quantified. This approach is based on the numerical interpretation of the results obtained using the method of expert assessments. Quantity and quality act as something separate only in abstraction; in reality, they exist in an indissoluble unity, within which this quality is modified, varies due to changes in quantity and individual nonessential properties, while maintaining its essential characteristics [7].

Consider the construction of a qualimetric model in the general case. Let's represent the set of resources involved in a certain educational institution in the form of a certain ontology $O = <X, R, F>$, where X is a finite set of concepts (in our case, resources, both internal and external) of a given subject area – the pedagogical process of an educational institution. R is a finite set of relations between these concepts, F is a finite set of interpretation functions defined by concepts and relations. Without detailing the mathematical apparatus, we note that $X \neq \emptyset$, $F \neq \emptyset$, with a certain degree of error, and we will take "part_of" ("part – whole") as basic relations. Thus, there is a set of relations $R = \{r_1, ..., r_m\}$ that establish binary incidence between some concepts from the set X, so that this set can be represented as a tree, where $X = \{X_1, ..., X_m\}$, where each of concepts of the first order X_i can be (optionally) represented by a set of concepts of the second order:

$$X_1 = \{X_{1\text{-}1}, ..., X_{1\text{-}k}\}, X_2 = \{X_{2\text{-}1}, ..., X_{2\text{-}p}\}, ... X_m = ... \quad (1)$$

In turn, each of the concepts of the second order can consist of concepts of the third order, etc.

To simplify mathematical calculations, we assume that each of the subsets of concepts coincides with the parent set $X = \cup \boldsymbol{X_i}$; moreover, if the "part_of" relationship is not established between the concepts (groups of concepts), then they have a very weak correlation between themselves, which can be neglected:

$$X_k \cap X_p \rightarrow \emptyset, k \neq p \quad (2)$$

Let us introduce a certain function $\boldsymbol{F}$, calling it the rule of interpretation. This function will determine the significance of each of the concepts in the overall structure of the ontology. In the simplest case, it is linear:

$$\boldsymbol{F}(X_j) = m_j \cdot X_j, \ \Sigma m_j = 1 \quad (3)$$

As already mentioned, the set of concepts is finite. Thus, there is a need for a mechanism that limits the partitioning of a set into subsets. In fact, there are two such mechanisms. The first is natural. Since the concept in our scheme is a certain resource, its division details its components and causes the appearance of smaller resources in the structure under consideration. So if by "resource" we mean some kind of competence of the applicant for education, then resources of a lower order

will be his personal characteristics, such as knowledge, skills and personal qualities. Skills can be divided, for example, into special (hard skills) and general (soft skills). Those, in turn, are divided into smaller components; for example, one of the components of soft skills will be communication, and communication will have several more components. And so on until the limit is reached in the form that each of the components will be a simple object that does not have component parts that are independent resources. Or another example – exploring the resource "student canteen" after several details, we come to a resource of a lower order – "coffee spoon," which becomes impossible to be divided into subsets.

In addition to natural constraints, expediency constraints apply. So, when evaluating the performance of applicants for education, it makes no sense to consider each grade received for the entire period of study. For this, there are some integrative assessments – exams, final tests, etc.

In other words, the limiter that determines the finiteness of the division of concepts into subsets is a certain third-party condition that sets the semantic restriction. Within the framework of qualimetry, since the goal is to assess quality, such a limitation is the possibility of an unambiguous numerical interpretation of the degree of conformity of the final concept to some conditional standard. The totality of all finite concepts is called a taxonomy, and finite sets are called qualitaxa. Some authors argue that qualitaxon, being a set of qualities (properties) of objects or processes that are identical (similar, homogeneous) according to certain characteristics (base of comparison), form groups with the following properties: within the group, quality indicators have a high correlation; quality indicators of different groups are weakly correlated [9]. From our point of view, such a statement, at least from the point of view of the pedagogical process, is not true, since the qualimetric approach implies the division of the entire process into independent factors, described by independent criteria, on the basis of which it is possible to create the so-called qualimetric (factor-criteria) models. The factor-criteria model of the pedagogical process is understood as a structured set of concepts that describes this process (its part). As a rule, a partition (construction of subsets) is used no deeper than the third order; otherwise, the construction turns out to be unnecessarily cumbersome. So G. V. Elnikova [10] proposes a qualimetric model for assessing the progress of applicants. The model she built consists of nine parameters: motivation, goal, learning, control, self-control, correction, self-correction, evaluation, self-esteem. Each of these parameters is explained by factors, which in turn are revealed by the criteria. In total, the author identified 18 factors and 37 criteria. At the same time, the author emphasizes that it is necessary to determine the significance of parameters, factors and criteria in creating a qualimetric model of educational activity of applicants. In other words, it is necessary for the function $\boldsymbol{F}(X_j) = m_j \cdot X_j$ to determine the values of the weight coefficients m_j.

Other Ukrainian researchers, G. Polyakova and S. Achkasova, evaluating the quality of the educational program, identified 8 parameters, 13 factors and 37 criteria [11]. T. Khlebnikova, evaluating the quality of university education at Kharkiv National Pedagogical University named after G. S. Skovoroda, identifies 9, 27 and 95 concepts of different levels, respectively [12].

For ease of perception, it is convenient to present the qualimetric model in the form of a table. For example, we give a description of the first parameter out of 9 in the model built by T. Khlebnikova.

Table 1. Qualimetric model for assessing the quality of university education at Kharkiv National Pedagogical University G. S. Skovoroda (fragment, weight s changed for clarity) [12]

Parameter	Weight p	Factor	Weight s	Criterion	Weight m
1. Regulatory support and management system for the training of specialists	0.1	**1.** Conceptual support for the functioning and development of faculties (institutes)	0.6	**1.** Charter, information package of the university. Regulations on faculties	0.17
				2. The concept and provisions on the training of bachelors, masters	0.17
				3. The concept of cultural and educational work with students	0.18
				4. Normative documents regulating the activities of student unions and student self-government bodies	0.15
				5. University development concept	0.18
				6. Regulations on the individual plans of students and the organization of its development and implementation	0.15
		2. Development of a management system for the training of specialists	0.4	**7.** The results of licensing and accreditation of specialties and the university as a whole	0.4
				8. Availability of resource support for the student training management system	0.3
				9. Development of information support for management in the system of Educational Department – Dean's Office – Departments of the University	0.3
2. … **9.**	The complete table contains 9 parameters, 27 factors and 95 criteria				

The construction of such a model-table is rather complicated, since it is necessary to take into account all the concepts that are significant for evaluation, avoiding semantic duplication (the condition of weak correlation, or better, its absence). In addition, significance (weight) must be given to each concept. Then each of the final concepts must be evaluated, being based on certain evaluation rules. For example, it can be a score from 0 to 10, where 0 corresponds to the absence of a criterion, and 10 corresponds to its ideal implementation.

Based on the above, the integral estimate E can be obtained as the sum of estimates for each of the n parameters $E_i^p, i = \overline{1,n}$, normalized by their weight coefficients.

$$E = \sum_{i=1}^{n} E_i^p \cdot p_i \tag{4}$$

Similarly, calculations are presented for estimating the parameter

$$E_i^p = \sum_{j=1}^{k_i} E_j^s \cdot s_j, \tag{5}$$

where k_i is the number of factors corresponding to the i-th parameter. The j-th factor E_j^s will be calculated according to the same scheme:

$$E_j^s = \sum_{l=1}^{t_j} E_l^m \cdot m_l, \tag{6}$$

where t_j is the number of criteria describing the j-th factor, E_l^m is the assessment of the l-th criterion, which is determined empirically.

Thus, if we substitute (6) → (5) → (4), we get a simple function in which arguments are the concepts of ontology O:

$$E = F(O) = \sum_{i=1}^{n} \left(\sum_{j=1}^{k_i} \left(\sum_{l=1}^{t_j} E_l^m \cdot m_l \right) \cdot s_j \right) \cdot p_i \tag{7}$$

By the simplicity of a function, here we mean the possibility of its simple automation, for example, using MS Excel.

Consider the implementation of this function for Table 1. Suppose that the criteria $E_l^m, i = 1,9$ received estimates $E_1^m = 1, E_2^m = 2, \ldots E_9^m = 9$. Expanding (7), we get that the integral estimate consists of the sum of normalized parameter estimates:

$$E = p_1 \cdot E_1^p + p_1 \cdot E_2^p + \ldots + p_9 \cdot E_9^p \tag{8}$$

Using the data in the table, we can calculate the normalized estimate of the first parameter:

$$p_1 \cdot E_1^p = p_1 \cdot (s_1 \cdot (E_1^m + E_2^m + E_3^m + E_4^m + E_5^m + E_6^m) + s_2 \cdot (E_7^m + E_8^m + E_9^m)) \tag{9}$$

Substituting numerical values into (9), we obtain:

$$p_1 \cdot E_1^p = 0.1 \cdot (0,6 \cdot (1+2+3+4+5+6) + 0,4 \cdot (7+8+9)) = 2,22 \tag{10}$$

The complexity of building a model and the subjectivity of evaluation determines the widespread use of expert methods in qualimetry, and the cumbersomeness of calculations requires the creation of various automation tools. Another important aspect is the universality of qualimetric methods in the sense of the possibility of evaluating pedagogical resources, regardless of their nature.

It is important to note that when using qualimetric models, the task of conducting pedagogical monitoring is simplified. The dynamics of changes obtained in the numerical equivalents of the quality of resources can be easily used for analysis, evaluation, interpretation, forecasting of further development and development of measures of correction for the educational process.

A logical continuation of the theoretical study was the web-based peer-review support system developed by the authors, located at http://expert.eor.in.ua/.

The system is designed to automate expert evaluation using qualimetric quality assessment models. For this, two types of cabinets are provided: an administrator's cabinet, in which an arbitrary qualimetric model can be set, and an expert's cabinet (see Figure 1).

The administrator determines the list of resources to be evaluated by experts and provides access to experts in their personal account, which describes the evaluation criteria and specifies the evaluation rules.

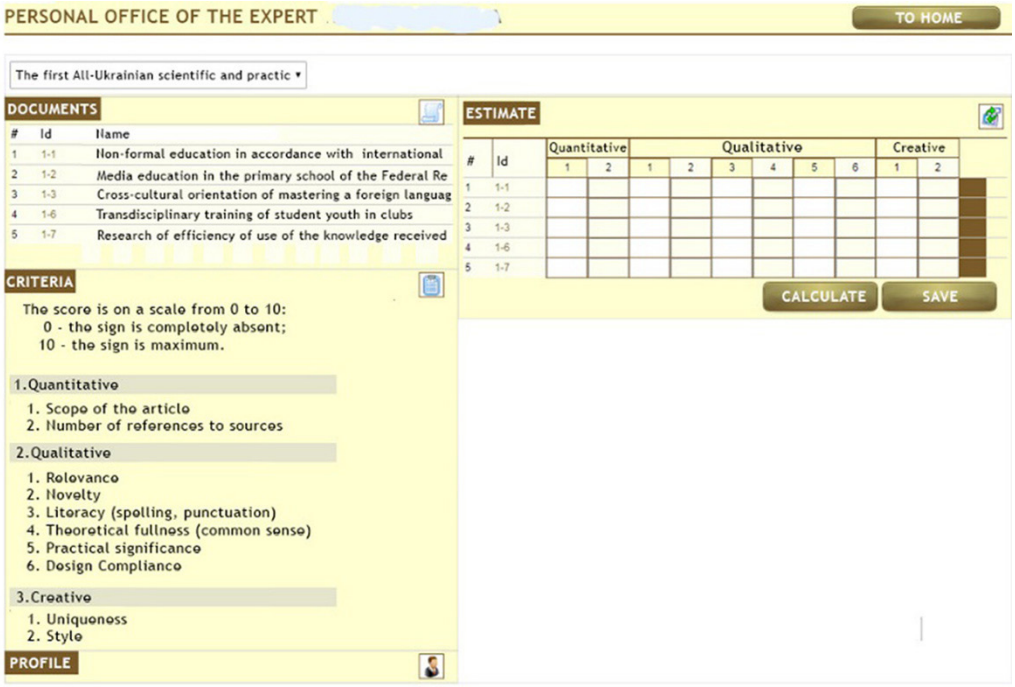

Fig. 1. Expert's Office

Figure 1 shows the personal account of an expert with a pre-installed qualimetric model (developed by the authors) for evaluating student scientific work. The model shown in the example is a two-level one (Table 2).

Table 2. Factors and criteria of the model for assessing the quality of student scientific work

Factor	Criteria
Quantitative	Scope of the article Number of references to sources
Qualitative	Relevance Novelty Literacy (spelling, punctuation) Theoretical fullness (common sense) Practical significance Design Compliance
Creative	Uniqueness Style

According to the results of expert evaluation, resources can be ranked, which can be used, for example, to automate competitive evaluation.

The Expert Cabinet allows using the qualimetric models entered by the administrator in a convenient form, setting estimates, carrying out automatic calculations, etc.

The web resource developed by us can be used both in the activities of educational institutions and in assessing the quality of objects of any nature, where qualimetric methods are applicable.

4 CONCLUSIONS

We consider the technology of constructing factor-criteria models with the involvement of specialized specialists in their development. This approach is based on the numerical interpretation of the results obtained using the method of expert assessments. We also offer the tools we have developed (either a specialized program or a set of criteria for evaluation) to support the peer review of electronic resources, which can be easily used to determine their quality during certain competitions, selections, etc. We show that this toolkit, with minor changes, is applicable to the evaluation (ranking by qualitative features) of arbitrary resources of the educational process (and not only remote ones) that have such a characteristic as quality.

As a result of the study, the authors come to the conclusion that the use of qualimetric methods based on the resource approach when designing tools for evaluating a remote educational process is justified. Such an approach turns out to be quite convenient, and in emergency situations, one of the most effective, if it is adapted to the current realities.

The proposed approach in the study makes it possible to scientifically substantiate the structure and content of the factors and criteria for evaluating both the educational process itself and its results – the level of development of the competence of applicants for education. In addition, the methods of qualimetric analysis make it possible to algorithmize the procedures necessary for the assessment, and the result of this assessment to be as close to the objective as possible.

In addition, the use of the proposed approach makes it possible to use qualimetric monitoring as a tool for the educational process – in other words, to track the dynamics of changes in the state of the resources of the educational process and, using statistical methods, to establish their impact on the final result of education.

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6 AUTHORS

Andrii Guraliuk, V O Sukhomlynskyi State Scientific and Pedagogical Library of Ukraine, Kyiv, Ukraine. https://orcid.org/0000-0002-7497-5746

Iryna Varava, National Aviation University, Faculty of Law, Kyiv, Ukraine. E-mail: varavairina8@gmail.com, https://orcid.org/0000-0001-5168-2775

Svitlana Holovko, National Aviation University, Faculty of Law, Kyiv, Ukraine. E-mail: GolovkoS@ukr.net, https://orcid.org/0000-0003-0795-7166

Liudmyla Shapenko, National Aviation University, Faculty of Law, Kyiv, Ukraine. E-mail: shapenkol@ukr.net, https://orcid.org/0000-0001-7351-641X

Veronika Oleshchenko, National Aviation University, Faculty of Law, Kyiv, Ukraine. E-mail: verona21.ua@gmail.com, https://orcid.org/0000-0002-1490-8875