ОБ'ЄКТИВІЗАЦІЯ РЕЗУЛЬТАТІВ НАВЧАЛЬНО-ПІЗНАВАЛЬНОЇ ДІЯЛЬНОСТІ ЗДОБУВАЧІВ ОСВІТИ В УМОВАХ СЬОГОДЕННЯ

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DATA ANALYSIS IN THE EDUCATIONAL PROCESS BASED ON QUALIMETRIC MODELS

Annotation. The article is devoted to the study of approaches to data analysis in the educational process using qualimetric models. A systematic analysis of modern scientific research and publications devoted to the application of qualimetry in education, educational analytics, and assessment of the effectiveness of the educational process is carried out in the work. The main approaches to constructing qualimetric models are summarized and their advantages for processing and interpreting the results of educational measurements are determined.

The general algorithm for qualimetric models designing is considered. It includes the formation of research directions, the definition of their components, the selection of evaluation criteria, the establishment of weight coefficients and the calculation of integral quality indicators. For example, a simple qualimetric model "Organization of the educational process according to the educational and professional program" was developed and analyzed based on real empirical data from the survey of higher education students "Educational program through the eyes of a higher education student". For the constructed model, the main areas of research, their structural components and relevant evaluation criteria were determined, and the use of expert assessments and weight coefficients was justified. The results of calculating generalized quality indicators of the educational process organization were presented and their interpretation was carried out. The obtained results confirm the feasibility of using qualimetric models to support management decisions in the field of ensuring the quality of higher education and can be used to improve educational and professional programs and internal quality monitoring procedures.

Key words: qualimetric model, research directions, expert, weighting coefficients, evaluation criteria.

I. Introduction. Qualimetric measurements in education, according to [3], are procedures (operations) for presenting qualitative and quantitative characteristics, properties, quality features of objects or processes of education using special qualimetric tools. The specificity of qualimetric measurements in education is the absence of specific physical measures of quality. Factor-criteria (or qualimetric) models are used to carry out measurements in education, which are analytical models of a certain object (educational institution, department or department of education, teacher's activities, school head), which are based on the method of expert assessments using a qualimetric approach to determining the content and significance of each indicator of the assessment object quality [3].

The stages of conducting qualimetric measurements in education are: measuring various components (characteristics, properties, qualities) of the studied educational object; assessing the quality of the educational object by determining quality indicators calculated on the basis of the obtained results of measurements of the corresponding characteristics or properties [3]. The absolute indicators obtained during qualimetric measurements are interpreted into qualimetric estimates – relative indicators, which are determined by the ratio of the absolute indicator to the reference (base) indicator. Qualimetric measurements are carried out using qualimetric scales: nominal or name scale, ordinal (or ordinal, rank) and so-called metric scales – interval, ratio scale and absolute value scale. The choice of a scale for measuring quality or individual properties of objects, as well as its graduation depend on the nature of the object, on the goals and objectives of measurements, methods and means of measurement, accuracy requirements, etc. and other conditions of qualimetric measurement [3].

Qualimetry is the science of methods for quantitative assessment of quality, which makes it possible to measure any qualitative phenomena using factor-criteria models. That is, it is possible to provide a comprehensive assessment of quality through a set of indicators using an appropriate mathematical model. The factor-criterion model is most often used as a qualimetric model, since it involves dividing an object into structural elements. This approach allows us to consider an object as a system, evaluating it not as a whole, but as a set of interconnected components. The study of the universal qualimetric approach allowed its use for the development of factor-criterion models in a comprehensive assessment of education quality. The advantage of evaluative qualimetric technology is that its use

allows you to measure results that record the achievement of a goal at a certain point in time.

The selection of certain factors may be based on expert assessment by scientists and/or practicing teachers, and information processing may be carried out on the basis of express analysis using technologies of pairwise comparisons, ranking, as well as the use of statistical methods of mass observations, grouping of information and data, correlation analysis, etc. [9].

It is necessary to take into account not the obtained quantitative indicators, but their dynamics (increase or decrease) over time when comparing results given the peculiarity of the qualimetric approach, because this indicator is the indicator that characterizes the quality of education.

One of the basic principles of qualimetry, namely, taking into account the relationship between complex and simple properties of an object by creating a standard, is implemented when using the qualimetric approach. This standard corresponds to the ideal state (quality) object model through the decomposition of this object properties, which occurs by providing the main parameters of development, factors and criteria for reflecting these factors.

II. Review of Recent Research and Publications. The topical problem of the effectiveness of monitoring the quality of education in a higher education is considered in [1]. The effectiveness of monitoring the quality of education in higher education is seen as the degree of achievement of the goals of monitoring the quality of education, quality performance and ensuring the interaction of all its functions, taking into account sociopsychological factors in monitoring procedures. On the basis of the qualimetric approach the factor-criterion model of efficiency of monitoring of education quality is developed by the authors, the weights for each parameter, factor and criterion are calculated. The peculiarity of theirs model is the ability to adapt to the specifics of the system of internal monitoring of the quality of education in the institution of higher education, which ensures its variability. Tracking changes in the level of effectiveness of monitoring the quality of education in a higher education institution based on the factor-criterion model developed by the authors allows us to track the dynamics of monitoring effectiveness indicators and make management decisions based on the results obtained that will contribute to the improvement of monitoring procedures [1].

The integration of qualimetric approaches into modern information and measurement technologies is investigated in the article [2]. The possibilities of using qualimetric methods to increase the accuracy and objectivity of assessing the quality of educational processes and products are considered. The authors [2] provide examples of the implementation of qualimetric methods, which confirm their effectiveness and prospects. The results of their study demonstrate that the integration of qualimetric approaches contributes to a significant improvement in the accuracy, reliability, and objectivity of the assessment of various parameters. Qualimetry is considered as a science of quantitative quality assessment, offering effective tools for analyzing the quality of educational processes and products. The authors explore the methods and approaches of qualimetry, their technical implementation and integration into modern information and measurement technologies. Also in [2], a table presents a systematization of qualimetric assessment methods and a structural diagram of the classification of qualimetric assessment methods.

The essence of the qualimetric approach and its role in the procedures for assessing the quality of specialist training in institutions of professional pre-higher education are disclosed in [4]. The authors consider the concepts of "qualimetry", "pedagogical qualimetry", as well as its types, methods, components, principles of the qualimetric approach, qualimetric quality indicators that are directly related to the process of assessing the quality of education; characterize the complex of principles of the qualimetric approach to the system of assessing the quality of training of specialists in construction colleges (principles of decomposition, priority, reference, inequality, normalization, variety of diagnostic methods). Also in [4] there is a schematic presentation of the principles of the qualimetric approach.

A practical qualimetric study "Qualimetric assessment of the quality of teaching mathematical disciplines in the Computer Science specialty" is presented in [7]. For the study, the authors used the responses of higher education applicants to the questions of the questionnaire "Teacher through the eyes of students." The research was conducted in the following areas of activity: the level of formation of methodological competence and information culture of the teacher, the level of formation of subject competence, the level of formation of moral and communicative competence and, accordingly, the indicators were grouped. In this study, to determine the expert assessments and fill in the relevant tables, the calculated average grades in mathematical disciplines, given by higher education applicants from different groups of the Computer Science specialty, were used. The analysis of real data using the relevant criteria resulted in an overall assessment of a sufficient level [7].

The article [8] is devoted to the organization of monitoring the quality of students' learning using qualimetric models. A general approach to the design of qualimetric models is considered. Also, to monitor the quality of student learning, a qualimetric model for evaluating this quality was compiled, for which the corresponding directions of research and their components were determined. This research was conducted with a certain time interval for students of different courses and specialties. The article presents qualimetric model "The level of evaluating quality in students` learning", the research results and appropriate conclusions.

III. The main part. Let's use the general algorithm (*Fig. 1*) for applying the qualimetric approach to data analysis in the educational process and building a qualimetric model "Organization of the educational process according to the Educational and Professional Program" [5; 6; 8].

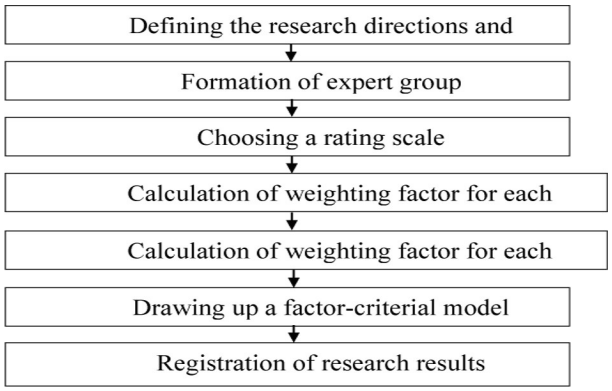

Fig. 1. *Algorithm for constructing a qualimetric model*

Let's define for the simplicity of the experiment two research directions based on the questions of the questionnaire "Educational program through the eyes of a higher education student":

1. Quality of educational, methodological and information support for the educational process;
2. Content and features of training according to the Educational and Professional Program.

Let us also define, for example, the components of each direction.

Components of direction 1:

- availability of work programs/syllabuses of educational components;
- availability of educational and teaching-methodical literature;
- availability of electronic courses in moodle;
- availability of software tools for learning.

Components of direction 2:

- sufficient content of the list of mandatory educational components;
- possibility of forming an individual educational trajectory;
- organization and implementation of independent work;
- sufficient time allocated for practical training.

Regarding the formation of expert groups, let's define the experts as higher education students of different years of study.

Factor-criterion model, as a rule, is drawn up in the form of a table. For the convenience of tables design and implementation of all the calculations it is recommended to use the Microsoft Excel software (version does not matter).

To evaluate the research directions by experts and calculate the weighting factors for each direction, the corresponding tables are filled in [8].

Let's say we've chosen a point scale for grading. Each expert (member of the expert group) fills in appropriate column the number of points corresponding to the importance of research direction. The lowest point is 1. The highest point is equal to the number of research directions. Also, such condition must be satisfied: it is not possible to assign the same number of points to two different directions. The expert gives the highest number of points to the most significant direction. Points in other directions are put down in decreasing order of their importance.

The algorithm for expert evaluation and calculation of the weighting coefficients for each direction of research, as well as the weighting coefficients for the components of these directions, is presented in [8].

A general presentation of the qualimetric factor-criterion model is also made in [8].

The names of research directions, names of components within each direction, weighting factors of directions, as well as weighting factors of components within each direction are transferred from corresponding tables.

For our study, *Fig. 2* presents auxiliary tables.

Fig. 3 shows the compiled qualimetric factor-criterion model.

In column "Degree of component manifestation" in the compiled qualimetric factor-criterion model, one of the estimates must be put down for each indicator:

0 – if the relevant activity was not carried out;

0,25 – if the relevant activity was carried out at a low level;

0,5 – if the relevant activity was carried out at a middle level;

0,75 – if the relevant activity was carried out at a sufficient level;

1 – if the relevant activity was carried out at a high level.

The algorithm for calculating the overall final comprehensive assessment using the qualimetric model is presented in [8].

Then the overall rating (g) is analyzed. Let`s use the following criteria:

1) the overall rating $g < 0{,}55$ – level direction of implementing activities is low;
2) the overall rating $0{,}55 \le g < 0{,}65$ – level direction of implementing activities is middle;
3) the overall rating $0{,}65 \le g < 0{,}75$ – level direction of implementing activities is sufficient;

Qualimetric model "Organization of the educational process according to the Educational and Professional Program"

Calculation of weighting coefficients for research directions

	Research directions	Weighting factor	Experts 1	2	3	4	Σ
1	Quality of educational, methodological and information support for the educational process	0,50	1	2	2	1	6
2	Content and features of training according to the Educational and Professional Program	0,50	2	1	1	2	6
		1,00					12

Calculation of weight coefficients for the components of direction 1 "Quality of educational, methodological and information support for the educational process"

	Components	Weighting factor	Experts 1	2	3	4	Σ
1	Availability of work programs/syllabuses of educational components	0,38	4	4	3	4	15
2	Availability of educational and teaching-methodical literature	0,15	1	2	2	1	6
3	Availability of electronic courses in moodle	0,33	3	3	4	3	13
4	Availability of software tools for learning	0,15	2	1	1	2	6
		1,00					40

Calculation of weight coefficients for the components of direction 2 "Content and features of training according to the Educational and Professional Program"

	Components	Weighting factor	Experts 1	2	3	4	Σ
1	Sufficient content of the list of mandatory educational components	0,35	4	4	3	3	14
2	Possibility of forming an individual educational trajectory	0,33	3	2	4	4	13
3	Organization and implementation of independent work	0,18	1	3	1	2	7
4	Sufficient time allocated for practical training	0,15	2	1	2	1	6
		1,00					40

Fig. 2. *The auxiliary tables*

4) the overall rating $g \geq 0{,}75$ – level direction of implementing activities is optimal.

The overall rating according to our qualimetric model is 0,70. Therefore, the level of organization of the educational process according to the Educational and Professional Program is sufficient.

It should be noted that the grades within 0 – 1 are used more often. They allow us to focus on the classic grading scale, although the criteria may be different.

The suitability of the factor-criterial model, weighting factors and the rating scale is established through numerous experts checks and repeated approbation. Only when the same or similar evaluations for object are repeating, we can consider that objective information about the state of this object has been obtained. Otherwise, the resulting estimate may be informative and it will be necessary to research the object by other methods.

Qualimetric model "Organization of the educational process according to the Educational and Professional Program"						
№	Directions of learning activities	Weighting factor of directions	Components	Weighting factor of components	The degree of manifestation components	Result
1	Quality of educational, methodological and information support for the educational process	0,50	Availability of work programs/syllabuses of educational components	0,38	0,75	0,28
			Availability of educational and teaching-methodical literature	0,15	0,5	0,08
			Availability of electronic courses in moodle	0,33	0,75	0,24
			Availability of software tools for learning	0,15	0,25	0,04
	In total	0,32				0,64
2	Content and features of training according to the Educational and Professional Program	0,50	Sufficient content of the list of mandatory educational components	0,35	1	0,35
			Possibility of forming an individual educational trajectory	0,33	0,5	0,16
			Organization and implementation of independent work	0,18	0,75	0,13
			Sufficient time allocated for practical training	0,15	0,75	0,11
	In total	0,38				0,76
	Overall rating	0,70				

Fig. 3. *The compiled qualimetric factor-criterion model*

We also note that the specified indicators and their quantity may be changed depending on the purpose of the study.

The assessment obtained in our study is informative in nature.

Note that the qualimetric model helps to identify factors that may influence the overall assessment.

IV. Conclusions. With the help of a qualimetric approach to the evaluation particular activity, a certain toolkit for evaluating the state of the object is created. It allows us to quantify the degree to which the object has achieved a certain qualitative state of development.

Based on the obtained qualimetric models, it is possible to create new ones, modifying and supplementing existing ones.

The us e of qualimetric models for the analysis of the ducational process organization in the Educational and Professional Program makes it possible to identify the factors influencing its effectiveness.

After analyzing the results, it is necessary to plan and implement measures to improve the organization of the educational process, harmonizing the interests of all participants in the educational process.

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АНАЛІЗ ДАНИХ В ОСВІТНЬОМУ ПРОЦЕСІ НА ОСНОВІ КВАЛІМЕТРИЧНИХ МОДЕЛЕЙ

Анотація. Стаття присвячена дослідженню підходів до аналізу даних в освітньому процесі з використанням кваліметричних моделей. У роботі здійснено системний аналіз сучасних наукових досліджень і публікацій, присвячених застосуванню кваліметрії в освіті, освітній аналітиці та оцінюванню ефективності освітнього процесу. Узагальнено основні підходи до побудови кваліметричних моделей та визначено їх переваги для обробки й інтерпретації результатів освітніх вимірювань.

Розглянуто загальний алгоритм проєктування кваліметричних моделей, що включає формування напрямків дослідження, визначення їх складових, вибір критеріїв оцінювання, встановлення вагових коефіцієнтів та розрахунок інтегральних показників якості. Для прикладу розроблено та проаналізовано просту кваліметричну модель «Організація освітнього процесу за освітньо-професійною програмою» на основі реальних емпіричних даних анкетування здобувачів вищої освіти «Освітня програма очима здобувача вищої освіти». Для побудованої моделі визначено основні напрямки дослідження, їх структурні складові та відповідні критерії оцінювання, а також обґрунтовано використання експертних оцінок і вагових коефіцієнтів. Представлено результати обчислення узагальнених показників якості організації освітнього процесу та здійснено їх інтерпретацію. Отримані результати підтверджують доцільність використання кваліметричних моделей для підтримки управлінських рішень у сфері забезпечення якості вищої освіти та можуть бути використані для вдосконалення освітньо-професійних програм і процедур внутрішнього моніторингу якості.

Ключові слова: кваліметрична модель, напрямки дослідження, експерт, вагові коефіцієнти, критерії оцінювання.

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УПРАВЛІННЯ ФОРМУВАЛЬНИМ ОЦІНЮВАННЯМ

Пропонується модель формувального оцінювання на основі виділення взірців-еталонів контролю результатів освітньо-пізнавальної діяльності. В статті розглядається актуальна проблема впровадження формувального оцінювання («оцінювання для навчання») в умовах реформування сучасної освіти. Автори акцентують увагу на тому, що на відміну від підсумкового контролю, формувальне оцінювання є постійним інтерактивним процесом, метою якого є не виставлення балу, а моніторинг прогресу здобувача освіти, надання своєчасного зворотного зв'язку та коригування навчальних стратегій.

Основною метою дослідження є розробка та обґрунтування наукової моделі управління процесом формувального оцінювання (зокрема, на прикладі навчання фізики). Теоретичною основою моделі обрано кібернетичний підхід, де навчальний процес розглядається як система управління зі зворотним зв'язком. У цій системі викладач виступає керуючою підсистемою, а здобувач освіти – керованою, причому кінцевою метою є перехід від зовнішнього управління до самоуправління та саморегуляції студента. Центральним елементом запропонованої методики є система чітких критеріїв успіху – «взірців-еталонів» засвоєння знань. Автор пропонує детальну класифікацію рівнів навчальних досягнень, що базуються на стані сформованості пізнавальних дій. Виділяються такі взірці-еталони: буденна обізнаність (Б), копіювання (К), розуміння (Р), заучування (З), оволодіння (О), уміння (У), навичка (Н), переконання (П) та вищий рівень – готовність до вчинку (В). Ці рівні корелюють з параметрами рефлексивності, раціональності та ремінісцентності.

Практична реалізація моделі здійснюється через «цільові програми», які визначають зміст навчання та очікувані результати для кожного навчального блоку. Для перевірки досягнень пропонується використовувати спеціально розроблені тести, де кожне завдання відповідає певному взірцю-еталону (наприклад, репродуктивному, продуктивному чи творчому рівню). У тексті наведено приклад такої програми та тестових завдань з фізики (тема «Теплові явища», 8 клас).

Автори доходять висновку, що використання такої деталізованої моделі дозволяє мінімізувати суб'єктивність оцінювання, забезпечити прозорість критеріїв для обох сторін навчального процесу та підвищити ефективність навчання шляхом чіткого діагностування прогалин у знаннях. Запропонований підхід сприяє розвитку метакогнітивних навичок здобувачів освіти та створенню атмосфери довіри в освітньому середовищі.

Ключові слова: формувальне оцінювання, взірці-еталони, прогноз, цілепокладання, моніторинг, діагностика, прогноз.

В умовах реформування освіти особлива увага приділяється формувальному оцінюванню. Формувальне оцінювання або "оцінювання для навчання" (assessment for learning), – це постійний процес, який відбувається під час освітньої діяльності. Його мета полягає у формуванні (або коригуванні) навчального