

THE USE OF QUALIMETRIC MODELS IN THE ORGANIZATION OF MONITORING RESEARCH AT THE UNIVERSITY

Tetiana M. Pylypiuk

Kamianets-Podilskyi National Ivan Ohiienko University,
Ohiienko, 61, Kamianets-Podilskyi, 32300, Ukraine

Abstract

The article 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 the research results and appropriate conclusions.

Keywords: *qualimetric model, monitoring, research, expert, weighting factors, quality of education*

1. INTRODUCTION

Qualimetry is the science of methods for quantitative evaluation of quality, which gives the possibility of measuring 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-criteria model is most often used as a qualimetric model, because it implies the division of the object into structural elements. This approach allows us to consider the object as a system, evaluating it not as a whole, but as a set of interconnected components.

The theory of qualimetry was developed by many scientists: Azgaldov G.G., Elnikova G.V., Raikhman E.P., Tsiba V.T. and others [1-3]. Qualimetry is actively developed in our country. It is recognized and studied by specialists all over the world.

The advantage of evaluative qualimetric technology is that its use makes it possible to measure the results which fix the achievements of a goal at particular time. It is done by following such basic principles of qualimetry as:

- a set of certain properties of investigating object;
- hierarchical structure of properties;
- specific units of measurements;
- the use of various diagnostic methods of assessment;
- priority of factors;
- comprehensive quality evaluation.

The study of universal qualimetric approach allowed to use it for the development of factor-criteria model in comprehensive evaluation of quality education.

The choice of certain factors is based on the expert evaluation of scientists and practicing educators.

Information processing is carried out on the basis of express analysis applying the technologies of pairwise comparisons, ranking, as well as the use of statistical methods of mass observations, information and data grouping, correlation analysis, etc.

When comparing the results, it is necessary to take into account not the obtained quantitative indicators, but their dynamics (increase or decrease) over time. This indicator will characterize the quality of education.

When using the qualimetric approach, one of the main principles of qualimetry is realized, namely the account of interrelation between complex and simple properties of object by creating a standard. This standard corresponds to the model of ideal state of the object (quality) through decomposition properties of this object, which occurs by providing basic parameters of development, factors and criteria for the display of these factors.

2. MATERIALS AND METHODS

Currently, there are different approaches for evaluating quality of teaching-learning in higher education system. Special attention is paid to the qualimetric approach.

Methods for evaluating the quality of student learning using the qualimetric approach are based on general principles of qualimetry and contain similar stages and procedures for qualimetric evaluation. There are usually four stages:

- organizational and preparatory stage;
- development of methodologies, methods and procedures for evaluation;
- quality expertise;
- processing the results of expertise and confirming the expert opinion.

Each of listed stages contains a number of procedures, which can be subdivided into specific operations.

Let's consider a general approach to the design of qualimetric models for evaluating the quality of learning.

The general algorithm of applying the qualimetric approach (constructing a qualimetric model) can be presented schematically (Fig. 1).

The formation of expert group is one of the most important procedures that determine the reliability and accuracy of qualimetric evaluation of the object. Expert group is a collection of qualified specialists with necessary stock of knowledge and practical experience concerning evaluated object, and organized for quality expert evaluation of this object. The formation of expert group is to determine its structure (for example, there may be several subgroups specializing in the evaluation of different groups of indicators), its professional composition, number and selection of experts. Professional staff should provide a comprehensive analysis of the problem. When selecting experts, an analysis of their compliance with requirements should be carried out. Experts must equally understand the goals and objectives of quality evaluation of the object, satisfy the requirements of competence, interest, efficiency and objectivity [4].

The number of experts in a group depends on many factors and conditions, in particular on importance of solving problem, the available opportunities, etc.

Factor-criteria 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).

Let's suppose we have defined N directions of research. Accordingly, the set will be $N=\{n_1, n_2, \dots, n_N\}$.

Let's suppose that the number of experts in group is M . Accordingly, the set will be $M=\{m_1, m_2, \dots, m_M\}$.

To evaluate the directions of research by experts and calculate the weighting factor of each direction, let's fill in the table (Table 1).

Let's suppose we chose a point rating scale.

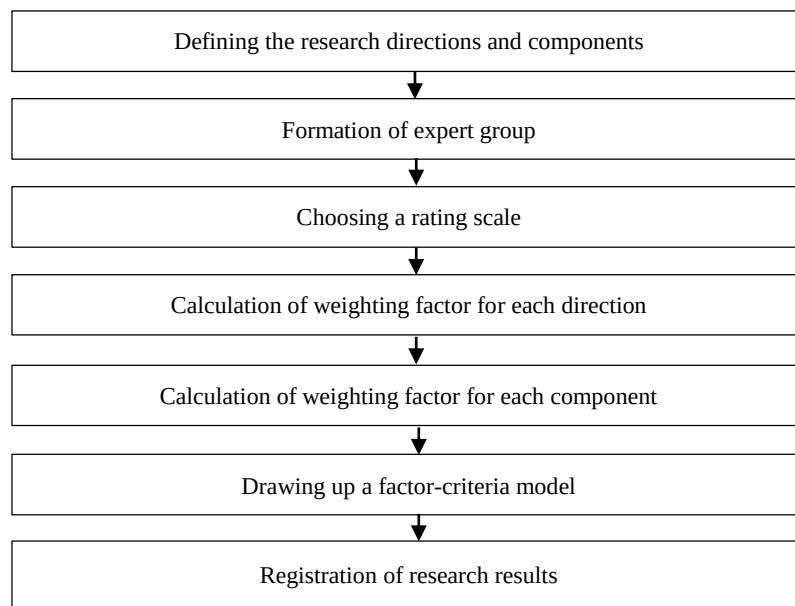


Fig. 1. Algorithm for constructing a qualimetric model

№	Research direction	Weighting factor of direction	Experts				Sum
			m_1	m_2	...	m_M	
1	n_1	$k_1 = \Sigma_1 / \Sigma$	$m_1[b_1]$	$m_2[b_1]$	...	$m_M[b_1]$	Σ_1
2	n_2	$k_2 = \Sigma_2 / \Sigma$	$m_1[b_2]$	$m_2[b_2]$	...	$m_M[b_2]$	Σ_2
	...	...	...	...	...	...	...
N	n_N	$k_N = \Sigma_N / \Sigma$	$m_1[b_N]$	$m_2[b_N]$	...	$m_M[b_N]$	Σ_N
		1					Σ

Table 1. Weighting factor calculation of each direction

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 N . 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.

For example, if we have 5 directions of research, then the highest number 5 is assigned to the most significant direction.

Thus, the method of direct assessment is used, which provides for an expert to determine the importance of each indicator by assigning a score according to a certain scale of points.

The weighting factor for each direction of research is calculated as follows:

1. The sums in each line are calculated. For example, $\Sigma_1 = m_1[b_1] + m_2[b_1] + \dots + m_M[b_1]$, etc.
2. The total sum in the column is calculated: $\Sigma = \Sigma_1 + \Sigma_2 + \dots + \Sigma_N$.
3. The weighting factors are calculated as the ratio of sum in the row to the total sum. For example, $k_1 = \Sigma_1 / \Sigma$, etc. Weighting factors are rounded to two decimal places, and adjusted so that their sum is unity: $k_1 + k_2 + \dots + k_N = 1$.

Thus, a method of expert evaluation for determining the weighting factors is described [5].

To calculate the weighting factors for the components of each direction of research, tables similar to Table 1 are filled in with appropriate changes. For example, let's present Table 2 for calculating the weighting factors of components of first direction in research. Here S is the total number of components within one direction of research.

№	Components of direction n_1	Weighting factor	Experts				Sum
			m_1	m_2	...	m_M	
1	$n_{1,1}$	$k_{1,1}=\Sigma_1/\Sigma$	$m_1[b_1]$	$m_2[b_1]$	...	$m_M[b_1]$	Σ_1
2	$n_{1,2}$	$k_{1,2}=\Sigma_2/\Sigma$	$m_1[b_2]$	$m_2[b_2]$	...	$m_M[b_2]$	Σ_2
	...	...	...	...	...	...	...
S	$n_{1,S}$	$k_{1,S}=\Sigma_S/\Sigma$	$m_1[b_S]$	$m_2[b_S]$	...	$m_S[b_S]$	Σ_S
		1					Σ

Table 2. Weighting factor calculation of components

The method of evaluating the components within each direction by experts and calculating the weighting factors is the same. The qualimetric factor-criteria model will look like in Table 3.

№	Research directions	Weighting factors of directions	Components of directions	Weighting factors of components	Degree of component manifestation	Result
1	n_1	k_1	$n_{1,1}$	$k_{1,1}$	St	$r_{1,1}=k_{1,1}*St$
			$n_{1,2}$	$k_{1,2}$	St	$r_{1,2}=k_{1,2}*St$
			...	...	...	...
			$n_{1,S}$	$k_{1,S}$	St	$r_{1,S}=k_{1,S}*St$
	Total	$v_1=k_1*R_1$				$R_1= r_{1,1}+ r_{1,2}+ \dots + r_{1,S}$
2	n_2	k_2	$n_{2,1}$	$k_{2,1}$	St	$r_{2,1}=k_{2,1}*St$
			$n_{2,2}$	$k_{2,2}$	St	$r_{2,2}=k_{2,2}*St$
			...	...	...	...
			$n_{2,S}$	$k_{2,S}$	St	$r_{2,S}=k_{2,S}*St$
	Total	$v_2=k_2*R_2$				$R_2= r_{2,1}+ r_{2,2}+ \dots + r_{2,S}$
	...	...	...	...	...	...
	Total					
N	n_N	k_N	$n_{N,1}$	$k_{N,1}$	St	$r_{N,1}=k_{N,1}*St$
			$n_{N,2}$	$k_{N,2}$	St	$r_{N,2}=k_{N,2}*St$
			...	...	...	...
			$n_{N,S}$	$k_{N,S}$	St	$r_{N,S}=k_{N,S}*St$
	Total	$v_N=k_N*R_N$				$R_N= r_{N,1}+ r_{N,2}+ \dots + r_{N,S}$
	Overall rating	$V= v_1+ v_2+ \dots + v_N$				

Table 3. General qualimetric factor-criteria model

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.

In column “Degree of component manifestation” in Table 3, 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.

Let's designate the degree of components manifestation as St . Thus, the value St belongs to the set of values: $St = \{0; 0,25; 0,5; 0,75; 1\}$.

Table 3 shows how to calculate the total complex evaluation in qualimetric model.

Then the overall rating is analyzed. Let's use the following **criteria** for this:

- 1) the overall rating $v < 0,55$ – level direction of implementing activities is low;
- 2) the overall rating $0,55 \leq v < 0,65$ – level direction of implementing activities is middle;
- 3) the overall rating $0,65 \leq v < 0,75$ – level direction of implementing activities is sufficient;
- 4) the overall rating $v \geq 0,75$ – level direction of implementing activities is optimal.

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-criteria 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.

3. RESULTS

The presented method using qualimetric models was applied to monitor the quality of student learning.

To assess the quality level of student learning in the qualimetric model, we have identified the following directions of research (directions of learning activity) and their items (components) (Fig. 2).

Let's note that these indicators and their amount can be changed depending on the purpose of the research.

Let's note also that when evaluating the results it is necessary to take into account not so much the quantitative indicators that we received, but their dynamics (increase or decrease) for a certain period of time. This indicator characterizes the quality of learning. Therefore, the research was carried out in two stages – at the beginning of semester and at the end of this semester.

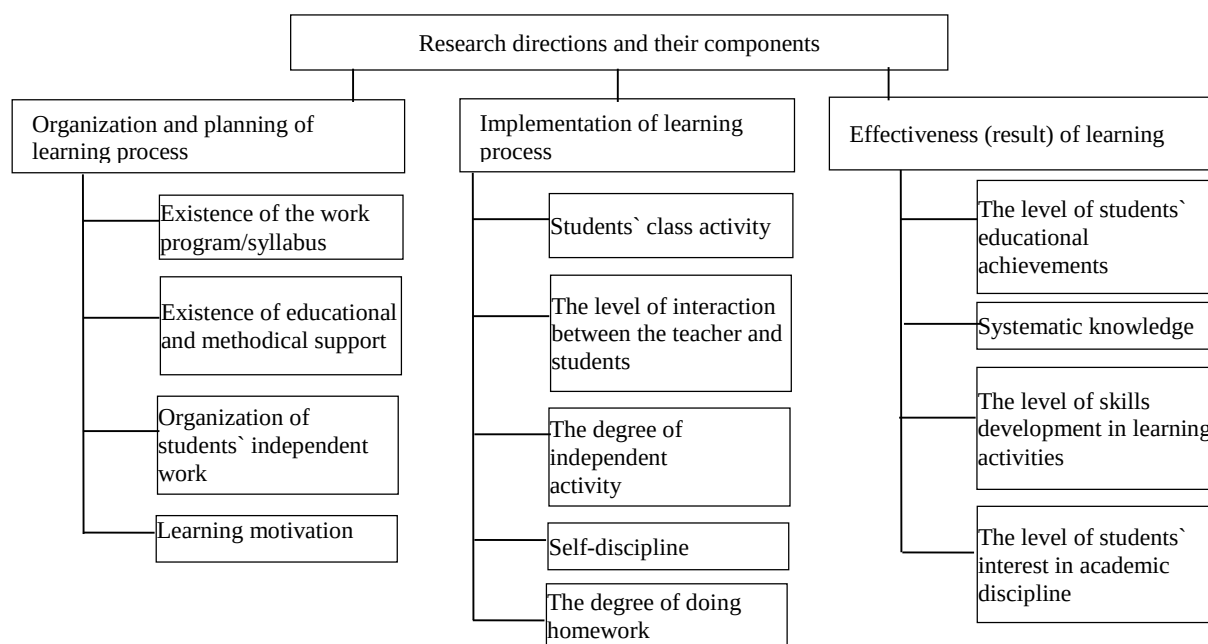


Fig. 2. Research directions and their components for qualimetric model

The study involved students of different courses and specialties. Let's present, for example, a qualimetric model (Table 4), obtained after the expert group (5 experts) which was filled in interrogatories (Tables 5-8) that were compiled on the basis of results of research. This results were conducted with 1st year students of one of specialties at the beginning of semester.

№	Directions of learning activities	Weighting factors of directions	Directional components of learning activities	Weighting factors of components	Degree of component manifestation	Result
1	Organization and planning of learning process	0,47	Existence of the work program/syllabus	0,38	1	0,38
			Existence of educational and methodical support	0,30	0,75	0,23
			Organization of students` independent work	0,16	0,5	0,08
			Learning motivation	0,16	0,5	0,08
	Total	0,36				0,77
2	Implementation of learning process	0,30	Students` class activity	0,25	0,5	0,13
			The level of interaction between the teacher and students	0,29	0,75	0,22
			The degree of independent activity	0,09	0,5	0,05
			Self-discipline	0,25	0,75	0,19
			The degree of doing homework	0,11	0,5	0,05
	Total	0,19				0,64

3	Effectiveness (result) of learning	0,23	The level of students' educational achievements	0,32	0,5	0,16
			Systematic knowledge	0,16	0,5	0,08
			The level of skills development in learning activities	0,16	0,5	0,08
			The level of students' interest in academic discipline	0,36	0,75	0,27
	Total	0,14				0,59
	Overall rating	0,69				

Table 4. Qualimetric model “The level of evaluating quality in students' learning”

№	Directions of learning activities	Weighting factor	Experts					Σ
			1	2	3	4	5	
1	Organization and planning of learning process	0,47	3	2	3	3	3	14
2	Implementation of learning process	0,30	2	3	1	1	2	9
3	Effectiveness (result) of learning	0,23	1	1	2	2	1	7
		1,00						30

Table 5. Calculation of weighting factors of directions in learning activities

№	Components	Weighting factor	Experts					Σ
			1	2	3	4	5	
1	Existence of the work program/syllabus	0,38	4	4	4	3	4	19
2	Existence of educational and methodical support	0,30	3	2	3	4	3	15
3	Organization of students' independent work	0,16	2	3	1	1	1	8
4	Learning motivation	0,16	1	1	2	2	2	8
		1,00						50

Table 6. Calculation of weighting factors for the components of direction 1 “Organization and planning of learning process”

№	Components	Weighting factor	Experts					Σ
			1	2	3	4	5	
1	Students' class activity	0,25	3	3	4	4	5	19
2	The level of interaction between the teacher and students	0,29	4	4	5	5	4	22
3	The degree of independent activity	0,09	1	2	2	1	1	7
4	Self-discipline	0,25	5	5	3	3	3	19
5	The degree of doing homework	0,11	2	1	1	2	2	8
		1,00						75

Table 7. Calculation of weighting factors for the components of direction 2 “Implementation of learning process”

№	Components	Weighting factor	Experts					Σ
			1	2	3	4	5	
1	The level of students` educational achievements	0,32	3	3	2	4	4	16
2	Systematic knowledge	0,16	2	2	1	1	2	8
3	The level of skills development in learning activities	0,16	1	1	3	2	1	8
4	The level of students` interest in academic discipline	0,36	4	4	4	3	3	18
		1,00						50

Table 8. Calculation of weighting factors for the components of direction 3 “Effectiveness (result) of learning”

According to the designed qualimetric model, we obtained an overall rating of learning quality of 1st year students at the beginning of the semester equal to 0.69. Taking into account the criteria provided in the second section of the article, we can talk about sufficient level.

It is no sense to provide all intermediate calculations, cluttering the article with tables. So let`s describe the results we obtained:

1. According to the designed qualimetric model, we obtained an overall rating of learning quality of 1st year students at the end of the semester equal to 0.67. This also indicates a sufficient level, though, if consider the obtained quantitative indicators in dynamics, we observe a decrease of overall rating.
2. After analyzing the interrogatories filled in by experts and the indicators of qualimetric model, we can establish that the decrease of overall rating was influenced by the decrease in such indicators as students` class activity, the degree of independent activity and the degree of doing homework.
3. For comparison, according to the qualimetric models compiled at the beginning and at the end of semesters, the overall ratings of the 4th year students` learning are 0.65 and 0.63, respectively. Considering the obtained quantitative indicators in dynamics, we observe a decrease and, taking into account the criteria provided in the second section of the article, we can talk about a level close to the average.
4. After analyzing the interrogatories filled in by experts and the indicators of qualimetric model, we can establish that the decrease of overall rating was influenced by the decrease in such indicators as students` class activity, self-discipline, systematic knowledge, as well as the level of skills development in learning activities.
5. Received estimations are informative.
6. Using the qualimetric model we can identify factors that can affect on overall rating.
7. On the basis of received qualimetric models we can create new, changing and supplementing the existing ones.

4. 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.

The use of qualimetric models in organization of monitoring research of students` learning activities makes it possible to determine the factors which may influence on its results.

After the evaluation, we can plan and implement events improving the organization of learning process.

A qualimetric approach to measuring parameters in research of learning activity makes it possible to harmonize the interests of all participants in educational process.

The considered method of monitoring learning activity with application of qualimetric models can be used in any educational institution.

REFERENCES

1. Azgaldov G.G. and Raikhman E.P. (1973). *About Qualimetry*. Publishing house of standards, Moscow.
2. Azgaldov G.G., Kostin A.V. and Sadovov V.V. (2012). *Qualimetry for All: Textbook*, InformZnaniye, Moscow.
3. Tsiba V.T. (1997). *Fundamentals of Qualimetry Theory: Textbook*, IZMN, Kiev.
4. Sadovnikov I.V. (2009). *Qualimetry: Textbook*. ChitGU, Chita.
5. Bainazarova E.A. and Rakcheyeva V.V. (2009). *Monitoring and Assessing the Quality of Education: Methodical manual*. KhNU named after V.N. Karazin, Kharkiv.