RANKING UNIVERSITIES IN TERMS OF AWARDING SCIENTIFIC DEGREES

Valery A. Gurtov, Liudmila V. Shchegoleva

Petrozavodsk State University (RUSSIAN FEDERATION)

Abstract

In Russia, the system of training of highly qualified scientific personnel is formed at the state level. Compositions of dissertation councils that award scientific degrees are approved by the Ministry of Education and Science of the Russian Federation. At the same time, not every university is given the right to open a dissertation council in a certain branch of science. The paper provides the method of ranking universities to make a decision on the possibility of opening dissertation councils for every groups of scientific specialties. The choice of indicators, the data collection and processing, the calculation formula, the results of the ranking are described.

Keywords: ranking universities, postgraduate education, dissertation council, right to award scientific degree.

1   INTRODUCTION

National education systems vary in different countries. According to the International Standard Classification of Education (ISCED) at the eighth level, training programs in the field of scientific research are presented. Completion of programs at this level ends with the defense of a dissertation or an equivalent written work of publishable quality. Based on the results of the defense, a corresponding PhD, DPhil, D.Lit, D.Sc, or LL.D is awarded. In most European countries, defenses take place in different forms in universities, where the student was trained in graduate school. The degree is awarded by this university. The prestige of the degree obtained depends on the prestige of the university that awards the degree.

In Russia, the system of training of highly qualified scientific personnel is formed at the state level. Compositions of dissertation councils that award scientific degrees are approved by the Ministry of Education and Science of Russian Federation. At the same time, not every university is given the right to open a dissertation council in a certain branch of science. To make a decision on the possibility of opening, as well as of the continuation working of the acting dissertational council at the university, it is necessary to develop a methodology for evaluating the university.

2   METHODOLOGY

As a tool for deciding on the possibility of opening, as well as on the continuation of the functioning of the acting dissertation council at the university, the method of ranking universities was chosen.

The ranking is often used to compare universities, faculties, regions, scientific journals [1–5]. Among the most popular international rankings of universities are the rankings of QS (https://www.topuniversities.com/university-rankings), THE (https://www.timeshighereducation.com/), ARWU (http://www.shanghairanking.com/index.html), U-Multirank (https://www.umultirank.org/) [2].

Ranking as a method for the integrated assessment of the activities of universities is most fully declared in the Berlin Principles on Ranking of Higher Education Institutions [6], the criteria for evaluating rating methodologies [7] and the principles of ranking certification [8]. These documents state that when developing a new methodology for conducting ratings, the basic 16 ranking principles should be observed, which affect the formation of the purpose and objectives of the ranking; the choice of indicators and their weights; data collection and processing; as well as presentation of the results of the ranking.

Thus, the following tasks were formulated: selection of university performance indicators, significant for the work of the dissertational council, processing of initial data for use in calculating the generalized indicator, constructing an generalized indicator, according to which universities will be ranked.

2.1 Initial data

As initial data, the results of monitoring the effectiveness of educational institutions of higher education, conducted annually by The Ministry of Education and Science of the Russian Federation, were used.

The performance indicators of each organization are divided into seven sections: general information; data on educational activities and training of scientific personnel; data on scientific activities; data on personnel; data on the logistical and information base; data on financial and economic activities; additional activity information. In each section the number of indicators is several tens, and the total number exceeds a hundred [9]. The use of all indicators in calculating the rating is not expediently and redundantly. Therefore, the task is to select the most informative indicators for inclusion in the rating.

When choosing indicators, we were guided by the following principles:

1 The indicators included in the ranking should meet the main purpose of ranking - the comparison of universities to decide on the opening of a dissertation council in it.

2 The ranking should be carried out separately for all groups of scientific specialties. Scientific degree is awarded in a particular scientific specialty. Therefore, it is necessary to compare the universities not in general, but on the results of their activities in a particular groups of scientific specialties.

3 Since the dissertation council permanently works at the university, there must be a sufficient number of scientists in this university who are able to assess the dissertation work submitted to the dissertation council. Therefore, in the rating should be indicators of the staff of the university.

4 The qualifications of the members of the dissertational council should be high enough to assess the relevance, novelty and significance of the scientific work submitted to the dissertational council. The level of qualification is determined by several factors: participation in scientific research, publication activity.

5 An important criterion for the possibility of opening of dissertation council is the implementation of PhD programs in university, as an indicator of the continuity of scientific research through the training of new scientific personnel.

From the indicators of monitoring the effectiveness of the activities of educational institutions of higher education, 9 indicators were selected that characterize the activities of the organization for the reporting year:

1 The total amount of funding for research and development carried out by the university in the reporting year, thousand rubles;

2 The number of publications indexed in the citation database Web of Science;

3 The number of citations of publications in the citation database Web of Science over the past 5 years;

4 The number of candidates of science among the faculty of the university, people;

5 The number of doctors of science among the faculty of the university, people;

6 The number of students of PhD programs, people;

7 The number of student of magister programs, people;

8 The number of student of specialist programs, people;

9 The number of acting dissertational councils.

The first three indicators describe the level of scientific research conducted at the university. The following two indicators characterize the number of possible members of dissertational councils, both now and in the future. Members of the dissertation council can only be doctors of sciences. In the long term, candidate of science can become doctor of science and can be included into the dissertational council. The sixth indicator tells of the existence of PhD programs in university. The seventh and eighth indicators also describe the possibility of realization of PhD programs in the future, since only graduates of a master's programs and specialist programs can enter graduate school. In Russia, in some areas of training, training takes place under bachelor and master's programs, and in others only under specialist programs, for example, "Engineering and technology of shipbuilding and water

transport", "Land transport engineering and technology", "Information security", "Veterinary science", "Applied geology, mining, oil and gas business and geodesy", "Nuclear power engineering and technology". The last indicator tells that the university already has the dissertation council.

2.2 Processing of initial data

Since the data was originally collected for other purposes, then their structure does not completely correspond to the requirement of ranking by branches of science. The indicator of financing scientific research is collected in the context of State categories of scientific and technical information. The number of candidates and doctors of science is collected in the context of the branches of science. The number of students is collected in the context of training specialties. The number of publications and citations is collected in the context of the international classification of branches of science.

For ranking all data should be presented in the context of groups of scientific specialties. To convert the initial data, four correspondence tables were compiled:

1. The sections of State categories of scientific and technical information – The groups of specialties;

2. The training specialties – The groups of specialties;

3. The branches of science – The groups of specialties;

4. International Classification Codes (OECD), second level – The group of specialties.

For the first and second tables, complete matches were established. For the 3rd and 4th tables, fractional values have been formed, as, for example, the branches of science "technical sciences" can be assigned to 26 groups of scientific specialties, the OECD code "02.02.00 Electrical engineering, electronic engineering, information technologies" can be assigned to 4 groups of scientific specialties.

Thus, using the coefficients of the correspondence tables, all initial data was reduced to same level of detail.

The study of the initial data showed that some higher education institutions have some indicators' values, significantly exceeding the ones of the other higher education institutions. For example, Fig. 1, 2 presents the boxplots for two indicators: "Financing" and "Number of publications indexed in the citation database Web of Science" normalized to the maximum values. The left drawings present the initial data. For most of the universities, the values of these indicators are very small. This will lead to the fact that these indicators will not have a significant impact on the distribution of places in the generalized ranking. To increase the contribution of these values to the generalized ranking, truncation of very large values for all indicators for each group of specialties was carried out. In Fig. 1, 2 on the right side shows the distribution of values of the indicators after the procedure of truncation of large values.
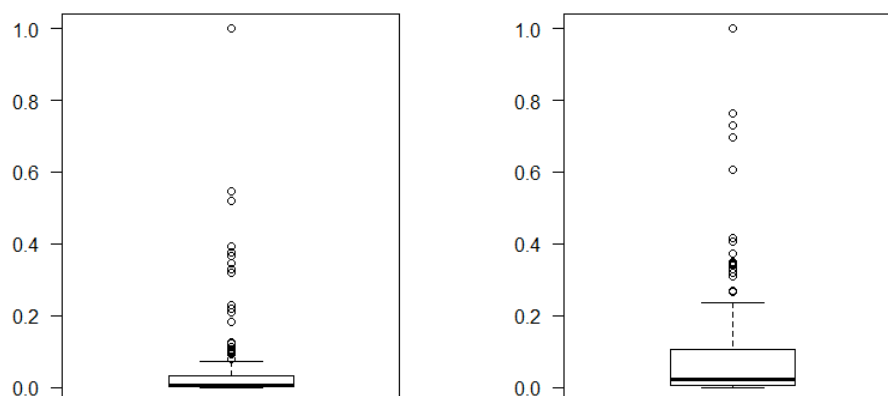

Figure 1. Indicator "Financing" for the group of scientific specialties 05.13.00:
left – before "truncation", right – after "truncation".

According to the "three sigma" rule for normally distributed random variables, the probability that a random value will take a value greater than the mathematical expectation plus a doubled standard deviation is 0.022, i.e. approximately 2.2% of the values. On the basis of this rule, a "truncation" of

values exceeding the mathematical expectation plus twice the standard deviation was carried out. After the "truncation", all data were normalized on the maximum values from the truncated values.
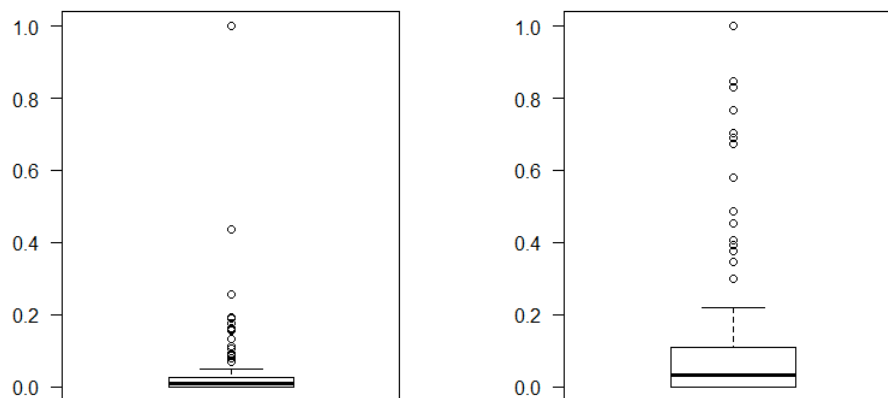

Figure 2. Indicator "Number of publications indexed in the citation database Web of Science" for the group of scientific specialties 05.13.00: left – before "truncation", right – after 'truncation".

According to the "three sigma" rule for normally distributed random variables, the probability that a random value will take a value greater than the mathematical expectation plus a doubled standard deviation is 0.022, i.e. approximately 2.2% of the values. On the basis of this rule, a "truncation" of values exceeding the mathematical expectation plus twice the standard deviation was carried out. After the "truncation", all data were normalized on the maximum values from the truncated values.

Thus, after processing the initial data, all the indicators have the same level of detail and take values in the range from 0 to 1.

2.3 Methodology for calculating the ranking

According to the principles outlined in the 2.1 section, to be included into the ranking for the group of specialties organization must satisfy at least one of the following conditions:

1. The university already has a dissertation council for at least one specialty related to the group of specialties in question;

2. The University has a non-zero number of graduate students in the group of specialties in question and a non-zero number of masters' program students or specialists' program students studying on programs of the group of specialties in question.

In calculating the generalized indicator of the rating, four indicators were used:

1. The total amount of financing for research and development carried out by university in the reporting year, thousand rubles (a_i);

2. Number of publications indexed in the citation database Web of Science (b_i);

3. Number of citations of publications indexed in the citation database Web of Science for the last 5 years (c_i);

4. The total number of candidates and doctors of science among the faculty of the university, people (d_i).

The generalized indicator for the chosen group of scientific specialties for the i-th organization ρ_i was calculated by the formula

$$\rho_i = \sqrt{a_i^2 + b_i^2 + c_i^2 + d_i^2}.$$

Such a method of calculating the generalized index, in contrast to the arithmetic mean, reinforces the large values of the indicators included in the calculation. The generalized indicator ρ_i takes values in the range [0, 2]. Universities are ordered (ranked) by descending the values of the generalized indicator.

According to the ranking, each university was assigned one of the following statuses for each group of scientific specialties:

- university can create a dissertation council for the specialties from the group of scientific specialties in question;

- university can participate in the creation of a joint dissertation council for the specialties from the group of scientific specialties in question;

- university cannot participate in the creation of dissertation council (this value is assigned if the university did not participate in the ranking, because it does not satisfy the specified criteria for group of scientific specialties in question).

Criteria for assigning the status "can create a dissertation council" to university was the presence of university in the first half of the integral rating, the calculation methodology of which is presented in [10].

3   RESULTS

The ranking was conducted for 51 groups of scientific specialties. 257 organizations of The Ministry of Education and Science of the Russian Federation took part in the ranking (this list does not include Moscow State University, St. Petersburg State University and the Higher School of Economics).

25 organizations did not fall in any ranking. The remaining 232 organizations participated in at least one ranking for the group of scientific specialties. The distribution of the number of rankings in which all organizations took part is shown in Fig. 3.
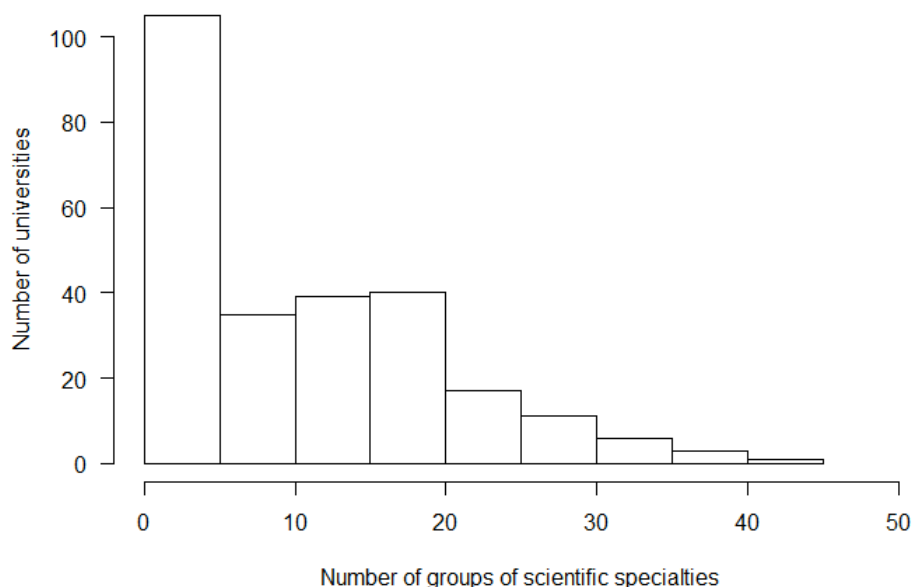

*Figure 3. Distribution of universities by the number of groups of scientific specialties
in which they participated in the ranking.*

Far Eastern Federal University participated in the maximum number of rankings (for 41 groups of scientific specialties). In second place is the Peoples' Friendship University of Russia (RUDN university) (in 38 groups of scientific specialties), in third place is the Ural Federal University (for 37 groups of scientific specialties). All federal universities and national research universities participated in the maximum number of rankings, as their distinctive feature is the breadth of educational programs and scientific research. They are followed by classical universities, which also have a wide range of educational programs, but scientific research and the preparation of graduate students in them are already presented in a small number of branches of science. Specialized educational organizations took part in the smallest number of rankings, for example, the Rybinsk State Aviation Technical University took part in 9 rankings, Linguistics University of Nizhny Novgorod participated only in 3 rankings.

In Fig. 4-6 presents the rankings for three universities for all groups of scientific specialties.
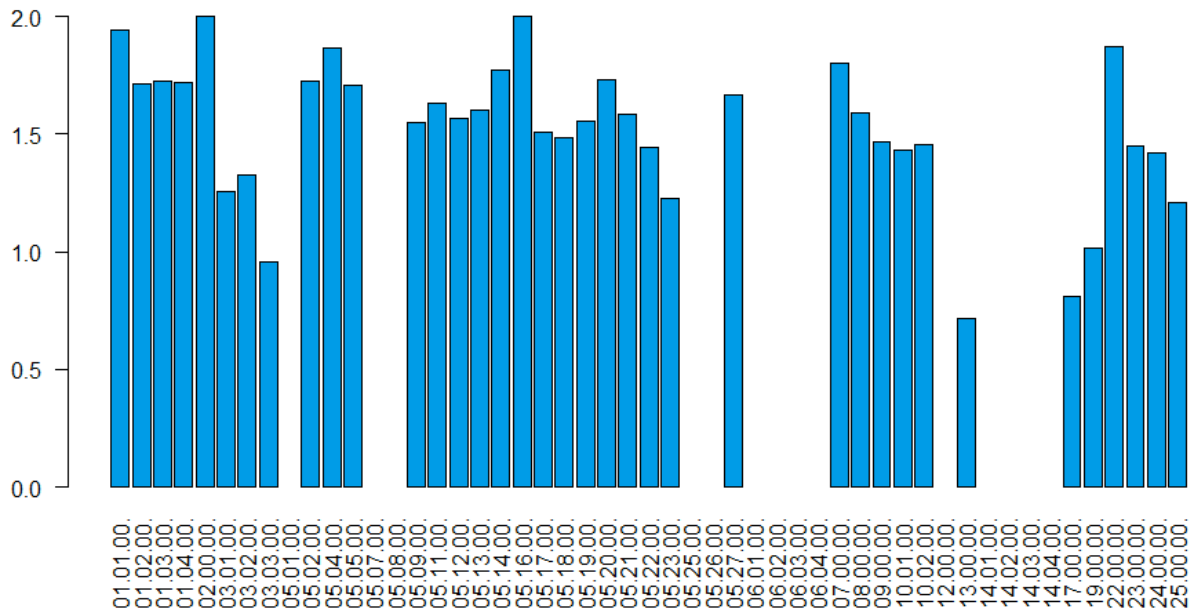
Figure 4. The values of generalized indicator for each group of scientific specialities for the Ural Federal University.
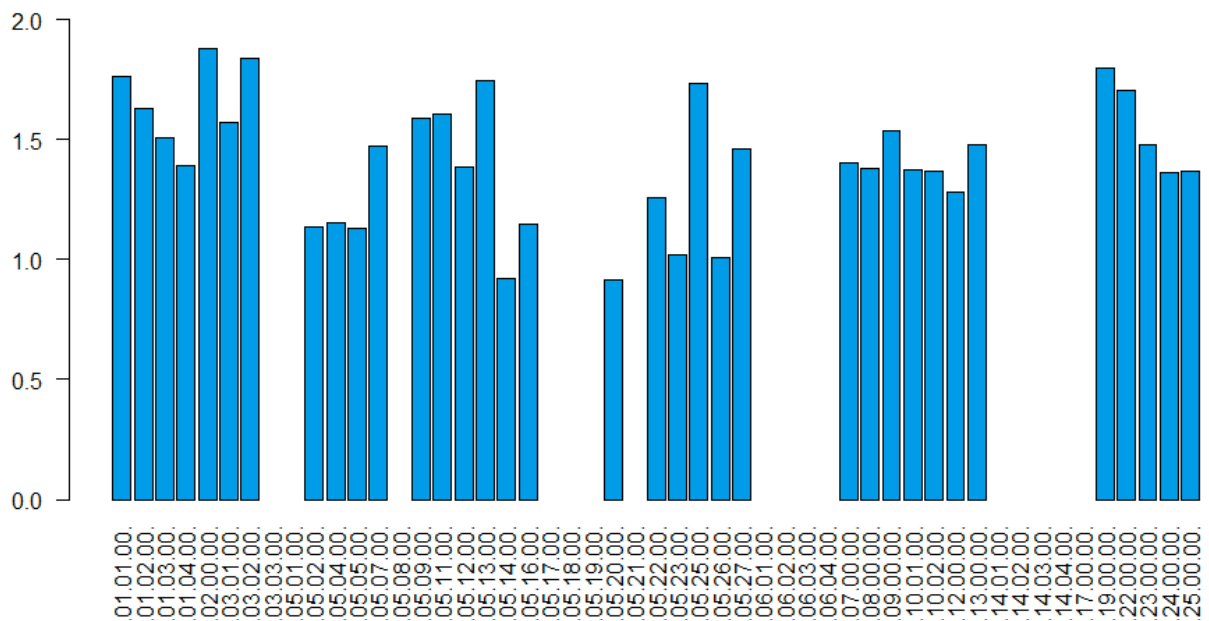

Figure 5. The values of generalized indicator for each group of scientific specialities for the Southern Federal University.
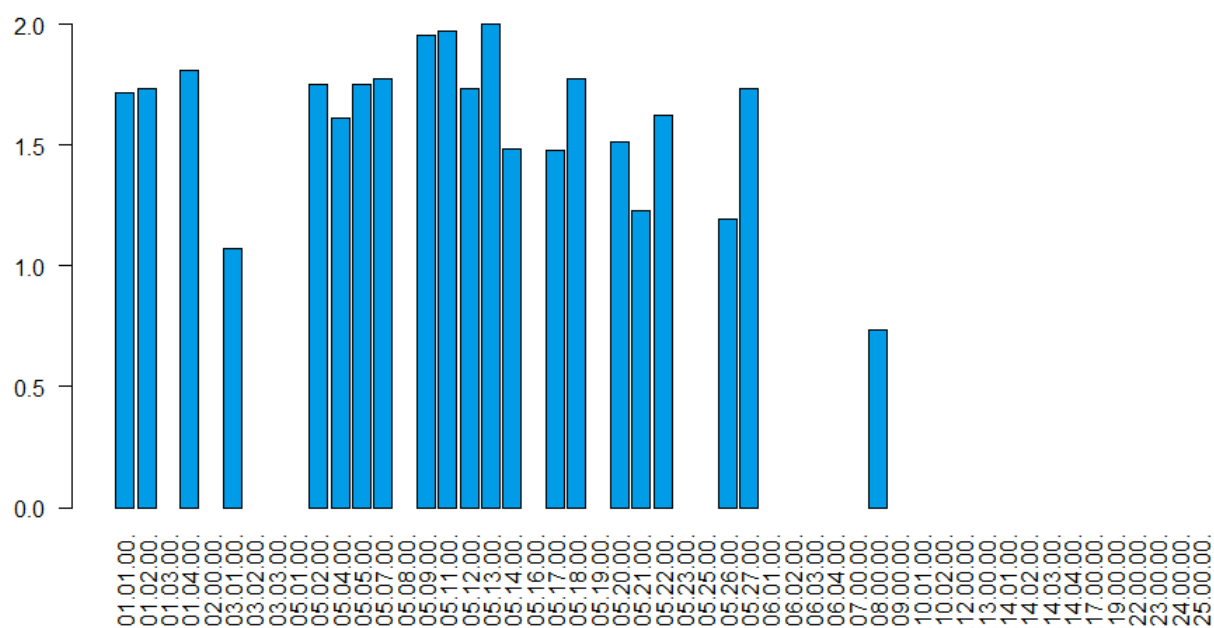
Figure 6. The values of generalized indicator for each group of scientific specialities for the Saint Petersburg State University of Information Technologies, Mechanics and Optics .

Table 1 presents the top 10 universities in the ranking for group of scientific specialties 05.13.00.

Table 1. Top 10 universities in the ranking for group of scientific specialties 05.13.00.

Rank	Name	Value of generalized indicator
1	Saint Petersburg and Peter the Great St. Petersburg Polytechnic University	2.000
2	Saint Petersburg State University of Information Technologies, Mechanics and Optics	1.999
3	Bauman Moscow State Technical University	1.824
4	Tomsk Polytechnic University	1.806
5	National Research Nuclear University MEPhI	1.782
6	Southern Federal University	1.745
7	Moscow Institute of Physics and Technology (State University)	1.624
8	Ural Federal University	1.605
9	Moscow Technological University (MIREA)	1.464
10	Moscow Aviation Institute	1.458

Based on the results of the assignment of statuses, it turned out that universities that can create dissertation councils are from 3% to 47%. Universities that can participate in joint dissertation councils are from 3% to 25%. The values of left borders are such low, because very few organizations took part in the ranking for certain groups of scientific specialties. For example, in the ranking for group of scientific specialties 06.01.00 "Agronomy" only 15 universities took part, 8 of which received the status of "can create a dissertation council", and 7 – "can participate in the creation of a joint dissertation council", which is 3% of the total number of universities.

Since 2016, a non-state system for awarding academic degrees has been developing in Russia. In 2017, two universities: Moscow State University and St. Petersburg State University got the right to independently award academic degrees without approval of The Ministry of Education and Science of the Russian Federation. The list of such universities is expanding. Selection the candidate universities for including in the list is based on the results of their ranking. For ranking, a similar approach is used

based on the same indicators. Since September 2017, 19 more educational organizations and 4 scientific organizations have received the right to independently award academic degrees.

4 CONCLUSIONS

The presented method of ranking universities allows to decide on the possibility of opening the dissertation council in the university for specialties from 51 groups of scientific specialties. Thus, the high scientific level of dissertational councils assessing the quality of the scientific research performed by the PhD students is ensured, which makes it possible to form the scientific elite of a society capable of solving advanced scientific problems.

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