

Methodology of Presenting the Results of Scientific Research

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Abstract

The long-term experience that the authors of this article have had as dissertation supervisors, opponents and members of scientific councils has shown that applicants writing dissertations face a serious problem concerning correct presentation of the results. For this reason, the quality of dissertations decreases significantly whatever high the level of the research and developments. This work is devoted to solving the indicated problem. The article specifies general requirements to the delivery of the problem and presentation of the research results in dissertations. The methodical recommendations concerning the goal, novelty and conclusions of the dissertation are formalized. The keywords, typical phrases and clarifying words are given to formulate these provisions. The stages of scientific research are indicated. This work will be advantageous not only for working on the dissertation, but also for preparing research reports or writing scientific articles.

Keywords: research, requirements, research methodology, education, higher school, quality of dissertations, quality criteria.

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1. Introduction

Efficiency of many areas of human activity depends on what kind of machines are created, what performance indicators characterize them, how machines interact with people and the environment [1]. The creation of such machines, devices, technologies requires from scientists around the world to develop environmental, economic and safe solutions [2], search for alternative sources of electricity [3, 4], create new and improve the existing equipment [5, 6].

Increasing the role of the scholar requires from the future scientist a fairly high level of knowledge in the development of research methods [7], organization, conduct and presentation of the research results. This applies to both master's theses and dissertations for the degree of PhD or Doctor of Sciences in Engineering (the only difference is in the amount of work and tasks) [8]. In

educational institutions when implementing scientific research special attention is given to providing general knowledge about the choice of the topic, description of the object and subject of research, design rules, research technology [9, 10]. However, when writing a dissertation work (DW), this knowledge is not enough. In the complex system of evaluation of the dissertation quality there is a criterion of scientific character: scientific task, scientific problem, scientific propositions, scientific result, scientific conclusions, scientific recommendations, research methods, contribution to science [11].

Studies of dissertations written by the students of Universitas Pendidikan Indonesia's School of Postgraduate Studies' show that there are problems related to the choice of the object and the subject of the research, methodology, research methods, problem statement [12].

Scientists around the world are developing different systems of assessing the quality of dissertations in different areas, such as [13–16] and so on.

In addition, the so-called “instructions for writing dissertations” can be found in the open sources. These are big serious works in which the authors share their experience in writing dissertations [17–19]. But despite the availability of such publications, research conducted by the authors [20] shows that poor preparation of doctoral students is often explained by the lack of information resources to support the development of their research skills and dissertation writing.

The biggest difficulties in accomplishing DW are setting the task, presenting the results of the scientific research, in particular the formulation of the goal, the object of research, the issue what to consider scientific novelty and practical value and how to confirm the authenticity of the work [10]. Applicants need deep understanding of the goal and object of research and awareness of the tasks that determine the level of accepted scientific starting points and the tasks set. The author of the dissertation can not realize their plan if they do not possess the knowledge and skills, the technique and technology of creativity. Besides, they need to know specific methodological recommendations for literary style, accuracy of wording and interpretation of certain provisions.

The goal of this article is to provide knowledge on the justification and formulation of the problem and presentation of scientific information in dissertations, which are the key criteria in ensuring their quality.

2. Problem statement in dissertation

One of the main reasons for the insufficient level of problem statement and evaluation of dissertation research results is that the painful process of writing a dissertation lacks sufficient methodological support. The existing manuals for degree seekers contain a minimum of useful methodological information on the formulation of the research task and mainly set out the procedure for drawing up a finished dissertation and supporting documents.

For example, the Ministry of Education and Science (MES) of Ukraine has recently significantly expanded the requirements for dissertations, but so far it has not affected their quality [21]. Until now, some dissertations lack a perfect scientific and methodological level, clarity, logic, reasonable disclosure of qualifications. The main general methodological recommendations for the implementation of scientific work in Ukraine are the standard DSTU 3008: 2015 and the requirements of the Ministry of Education and Science for dissertations.

Problem statement in dissertations is one of the most important stages of scientific research. A clear formulation of the scientific problem specifies the subject and the required scientific result of the study. The same scientific problem can have several different formulations, and for each problem statement there are several different methods of solution.

Insufficient attention of the applicant to the substantiation and statement of the problem does not allow them to realize the plan and reveal the qualification status of the dissertation, which characterize not only the scientific level of the study, but also the level of methodological training and the degree of scientific maturity of the applicant. Therefore, we would like to draw attention to some characteristic shortcomings that still occur in the preparation of the dissertation by the applicant, as well as in the so-called pre-defense and defense period. These issues are complex, so their consideration is constantly evaded, especially when it is necessary to give a written assessment of the dissertation.

3. Choosing and formulating the topic of a dissertation work

In the dissertation work, an applicant must formulate a scientific and practical problem or a problem depending on the level of a DW, prove the possibility of its solution by selected means and methods. The dissertation must meet the objectives of modern science and practice.

When choosing the topic of the dissertation, the main criteria should be:

- relevance;
- novelty;
- prospects;
- the presence of a theoretical basis for the author and the team, where he will perform the work;
- availability of research tools.

The topic must solve a new scientific task/problem. Presence of some new results in the dissertation, the contribution to science are the defining requirements, which in themselves are made for the sake of practice.

The title of the topic should reflect the scientific task of the scientific research, i.e. not only the subject but also the method of the research or the expected scientific result.

That is, the title of the work (topic) should indicate the subject of the research, or, by its structure it should coincide with the structure of the solution to a scientific task/problem, indicate the subject of the research, the method and the desired result.

The words “Research...”, “Increase...” and “Improvement...” are redundant if they do not relate to the development of scientific and methodological apparatus or research methods, do not add anything more than the name of the topic, which contains only the name of the subject of the research.

Some names of the topics are unsuitable, for example, the following: “Studying the methods...”, “Increasing efficiency...”, “Improving the calculation...”, “The features...”.

Choosing a topic, the applicant of a scientific degree should realize:

- the expected result;
- relevance;
- theoretical importance;
- practical significance;
- the trends in the processes and phenomena that he is going to study.

The choice of any topic, especially an initiative one, should be preceded by acquaintance with the relevant domestic and foreign literature in their own and related specialties. In practical topics, the indicator of prospects is mainly the economic effect. The ordered topics are usually related to the main plans of research work of the university, department (faculty, department, institute, etc.) or industry (or two if the work takes place at their junction).

Speaking of the novelty of the idea (as well as the topic), we must not forget the well-known principle that not everything new is necessarily progressive, neither everything old is conservative.

4. Introduction and general characteristics of a dissertation work

It should be noted that the presented approach to the formation of DW is adopted in Ukraine, Russia, Belarus, the Baltic countries, and, to some extent, Poland, the Czech Republic, Bulgaria and other neighboring countries. In other countries, there may be minor differences in this approach, but they do not affect the very essence of the formation and presentation of scientific research, which is reflected in the DW [22, 23].

Dissertation must have a description, which is briefly presented in the section "Introduction". In this section, after a brief description of the current state of the scientific (technical) problem (task), the solution to which the DW is devoted to, the following are given in a clear sequence:

- relevance of the topic: connection of the work with scientific state programs, plans, topics of the university, department, enterprises, etc.;
- goal and task of research;
- object and subject of research;
- research methods;
- scientific novelty;
- practical significance of the obtained results;
- personal contribution of the dissertator;
- approbation of the research results;
- publications.

The section "Introduction" is not numbered, division into sections is not allowed. The total volume of the introductory part and the general characteristics of the DW should be 3-4 pages of the printed text (in accordance with the requirements of the governing documents of the country's education department) [21].

Relevance of the topic of the DW characterizes the timely, topical, important public need for research on this topic of work. It is a necessary condition for the usefulness of the research result. The task (problem) always arises when the old knowledge has already shown its inability (inefficiency), and the new has not yet acquired a developed form. In justifying the relevance of the work, it is important to reflect several approaches in solving and choosing a specific option. It is also essential to add links to the documents that indicate the special orders for the development of science and technology, methods and techniques.

Scientific proposition is the expression of the basic scientific ideas in the form of clear formulations which are both accepted as the basis when the research is conducted, and put forward by the author. Among the scientific propositions the original references and scientific results are distinguished.

The formulated scientific proposition should be understood and perceived easily and unambiguously (without the accumulation of details that obscure its essence with particularities and clarifications).

Original references are such scientific propositions which are starting in nature, initial at conducting dissertation research. Among the characteristic types of original references there are the following: concepts, categories, terms, definitions, hypotheses, principles, rules, mathematical propositions, assumptions, limitations, etc.

5. Requirements to the content and formation of topicality of the work, goal, problems, object and subject of research

A scientific problem is a contradiction that is not characterized by the sufficiency of scientific knowledge to solve it. The scientific problem is expressed in the form of a pair, which includes the subject of the research and the required scientific result of the research, upon that, as it is understood, at least one method of solving the problem is known (published).

The solution to the scientific problem is an interconnected trio:

- the subject of research;
- the necessary scientific result of research;
- the method of research.

It is possible to determine a scientific problem (SP) as a process in the following form:

$$SP = G + C + Pro + Con \quad (1)$$

where G is the goal; C is conditions; Pro is a procedure; Con is conversion into a result.

In this process of setting a scientific problem the following possibilities should be considered:

- conditions of using the known data;
- conversion of the known data;
- their radical change;
- expansion, addition of the known data;
- clarification and specification of the known data in other boundary conditions;
- dissemination of the known results to a new class of objects, systems.

As a result of formulation of the topic (problem) the object and the subject of research are determined.

Goal of the work

In the requirements of the Higher Attestation Commission [21], the goal and objectives of the study are formulated as follows: “The goal of the work and the problems that need to be solved to achieve this goal are formulated. The goal should not be formulated as “Research...”, “Study...”, because these words indicate the means to achieve the goal, not the goal itself. “

The goal of the dissertation should be consistent with its title and contain not only the expected result, but also necessarily indicate the prerequisites on which it is based, by what means and how it is achieved.

Therefore, the goal of the work (GW) should be formulated from three components – the subject, the method and the desired result in one sentence:

$$GW = S + M + DR \quad (2)$$

Here the method indicates what specific scientific preconditions it is based on, by what means and how it is achieved (with the involvement of which methods, scientific hypotheses, ideas, phenomena, laws, means, etc.). It is impossible to consider such formulations of the goal of research as “substantiation and development of scientific bases, principles of creation of new technologies...”, “development of new technological principles, control, means” etc. without specification of scientific preconditions on which the achievement of the goal is based.

Since the method (M) in the formulation of the goal (GW) indicates the way to achieve the goal, it is often possible to use such phrases as “by defining...”, “by developing...”, “by reducing...”, “by applying technologies...”, “using...”, “taking into account...”, “by introducing...”, “by implementing...”, etc.

Example 1. Development and implementation of the methods for assessing the quality of tractors by their vibration diagnostic characteristics through normalization and control of vibration during the design, manufacture and operation, which allows to ensure a given resource and efficiency of tractors.

Example 2. Development of a methodology for organizing the work processes of the pneumatic engine of a combined power plant of a city car, taking into account the maximum power at the minimum consumption of

compressed air, which enables to increase its economic and environmental performance.

The object of research is a process or phenomenon that creates a problem situation and as a result is selected for research. These are, for example, the vibration process, friction processes, diagnostic processes, and so on. The object of study is usually what the cognitive activity of the researcher is aimed at. The correct choice of the object of study in accordance with the goal of the study contributes to the validity of the results of the study. The object of research should have a model (models) that allows determining the influence of internal factors on the research process and their relationship [10].

The subject of research is understood as something which is within the object and, as a rule, coincides with the topic of research. The object and subject of research as a category of scientific process are correlated as general and partial. The part of the object which is a subject is distinguished in the object.

The objectives of research specify the ways, methods, means of the goal (GW), whose solution makes possible to obtain the desired result (DR). The task of the researcher is to provide the depth and scientific level of developing definite problems of research and problem tasks in the way that the dissertation work as a whole would correspond to the achievement of the set goal.

Statement of specific tasks (not more than 6 for a candidate work and 8 – 9 for doctoral work) is better made in the form of a list (to study..., to describe..., to establish, to define..., to develop..., to deduce dependence... etc.). Problems should be formulated carefully, as the description of their solution, as a rule, forms the content of the separate sections of work.

The formulation of the goal, object, subject and tasks of dissertation research should be logically interconnected, i.e. not come into conflict. The logical scheme of the problem of scientific research, evaluation of research results and their relationship are shown in Fig. 1.

The method of research is a scientific and methodical apparatus tested in practice, which has passed the expert evaluation, with the help of which certain tasks (problems) are solved, the natural connections of the processes and phenomena under study are reflected. In the absence of mathematical theory at the time of the study, the empirical techniques can be used in the scientific and methodological apparatus based on experimental results and heuristic methods of substantiation.

The correct choice of the method of research determines its success. Conscious application of scientifically sound research methods should be considered as the most important condition for obtaining new knowledge. General scientific (theoretical), empirical and heuristic methods are considered [10]. Good knowledge of research methods and possibilities of their application allows the researcher to work more successfully. A critical evaluation of the chosen research method in comparison with the known one should lead to the conclusion about its scientific novelty and usefulness.

Particular attention should be paid to the necessity of formulating the requirements to experiments at

accomplishing the theoretical part.

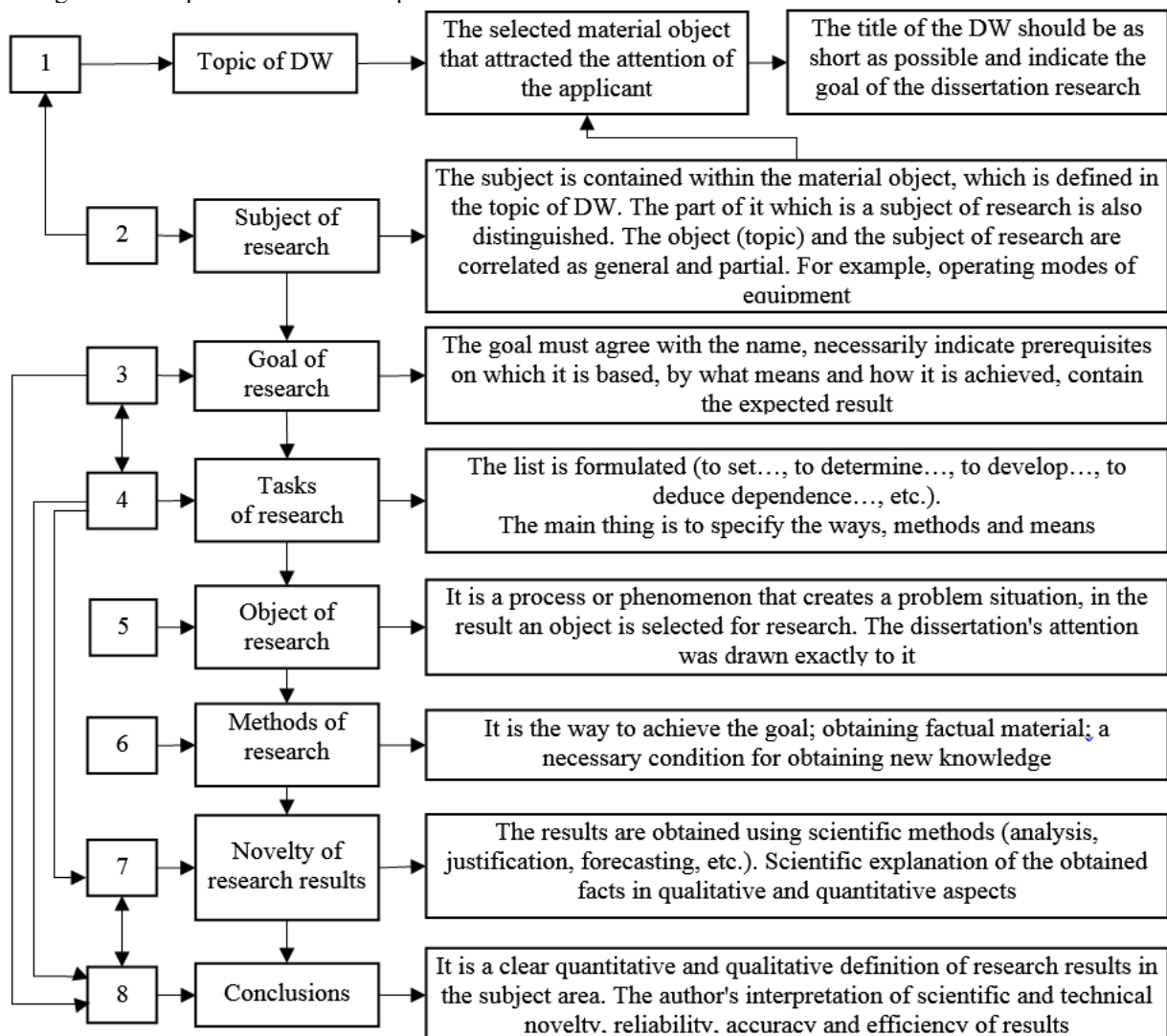


Figure 1. The structure and relationship of the main components of the problem statement and evaluation of research results

6. Requirements to substantiation of scientific propositions, novelty and practical results of the dissertation work

In the dissertation work it is necessary to substantiate the significance of the results as a primary contribution to science. This assumes the role of contribution to practice.

A scientific result is any result obtained using scientific methods (analysis, justification, comparison, generalization, etc.).

A new scientific result can be obtained in two ways:

- by creating a new more effective research method that meets the maximum degree of creativity;
- by improving the known research method. New scientific results appear in the process of finding a new solution to an urgent scientific problem or in the search

for a solution to a major scientific problem. This feature includes the methods, which were obtained during the further development of the common methods of scientific research.

A new scientific result is a result obtained for the first time in the world, previously unknown in science, there must be a proven fact of the absence of similar results in previous publications of other domestic and foreign authors.

Among the obtained scientific results, it is necessary to clearly distinguish the results in the development of research methods, usefulness, scientific novelty and reliability. Scientific results, which are a contribution to science, are characterized by a fairly high degree of generalization, validity and reliability of scientific propositions, conclusions and recommendations.

Reliability is a complex characteristic of the degree of objectivity, concordance of the obtained result to the real (true) value (state) of the object. It is its natural expression of dependence of objectively existing cause-effect link in the relevant subject area. When controlling and diagnosing the degree of objective responsibility of the diagnosis to the actual state of the object, reliability is expressed in quantitative terms.

Confirmation of the authenticity of the results is their validity. It is necessary to prove specifically that the propositions, conclusions and recommendations derived in the work are reasoned (authentic), i.e. really (objectively) existing in technology or nature. Only strong evidence gives reason to trust the results of research.

Scientific novelty of the research results

The issue of novelty is one of the most controversial and difficult both in the defense of the dissertation and in the publication of the article. Therefore, each applicant must be able to determine the novelty of their scientific result.

The scientific novelty of research results is determined by three levels:

- received..., proposed..., developed... for the first time;
- results are improved...;
- was further developed..., evaluation model..., concept..., mathematical model...
- These scientific results are a consequence of:
- development of methods (scientific and methodical apparatus);
- conversion of known data;
- radical change, expansion, addition of known data;
- clarification, specification of known data;
- dissemination of known results to a new class of objects and systems.

Scientific novelty should not be reduced to a simple list of established scientific facts, ideas, patterns, it should reveal the main scientific concept, give a scientific explanation of the achievements in a new qualitative and quantitative aspect. It is necessary to show the difference between the obtained results (development of known ideas, discovery of new laws, phenomena, patterns, scientific substantiation of new methods of calculations, measurements, technical solutions, etc.), focusing on the level of novelty.

Typical phrases for formulating scientific novelty are as follows:

- for the first time in the world..., for the first time in the industry...;
- the method... which differs from the known... was developed;
- for the first time... was formalized...;
- dependencies between... were derived;

- relationship between... were proven;
- the known method was improved in part... and extended to a new class of systems...;
- a concept that summarizes... and develops... was created;
- a new system was developed... using the principle...;
- a new effect..., etc. was investigated.

These results can be recognized as a contribution to science only in the case of theoretical justification and reliability of the result, its correctness, which contribute to the further development of science or a separate area.

Scientific novelty (SN), in most cases, is formulated in one sentence, which reveals the following components:

$$SN = LN + TA + \text{ЧБ} \quad (3)$$

where LN is the level of novelty or research results in the subject area; TA is what it takes into account; DF is how it differs from the known research (solutions).

The statement that it is he/she (the researcher) who has the first word in the description of the studied process or phenomenon can be made after a thorough and general study of inventions, literature and consultations with many experts on the subject. The term "first time" in science means the fact that there are no similar results in earlier publications of other authors. "For the first time" research on original topics can be conducted, which were not previously studied in a particular field of scientific knowledge. Only those propositions of scientific research that contribute to the further development of science or its individual areas can be new.

Theoretical contribution to science is formulated in the form of scientific propositions: theory, concept, method, methodology, regularity, principle, formalized description, theorem, theoretical-experimental and mathematical substantiation (proof) and others.

Typical phrases for formulating scientific novelty are the following:

- the method was developed..., which differs from...;
- for the first time... was formalized...;
- the dependence between... was deduced;
- behavior... was investigated and shown...;
- the known method was modified in part... and extended to a new class of systems...;
- a new effect was investigated...;
- a concept that summarizes... and develops... was created;
- a new system was developed... using the principle...;
- substantiated (an authentic result), first published (a new result), implemented (a useful result).

The following **should not be added** to scientific novelty: regularities, empirical coefficients, mathematical models, which are presented without appropriate scientific

and qualitative analysis, with whose help new scientific results are obtained; confirmation of their practical verification; complex equations, which due to their complexity indicate insufficient study of the phenomenon (processes); mathematical equilibrium over known equations; “mathematization” of tabular or graphical information, by giving regression equations, which is, in fact, only another form of dependence between quantities, etc.

Such general formulations as “a comprehensive study was conducted.”, “the nature of the process ... was identified”, “the classification...was assessed”, “a mathematical model ... was developed” and the likes cannot be recognized as scientific novelty, without disclosure of scientific novelty. The following phrase “certain laws that provide a new qualitative effect are theoretically substantiated and experimentally confirmed...” cannot be considered sufficiently substantiated as well as the others like it, without a proper explanation of this effect from the scientific standpoint of known or previously unknown facts.

Description of new applied (practical) results, which are obtained in the form of methods, devices, techniques, schemes, algorithms, etc. cannot be included in the general description of the work as a scientific novelty either. It is always necessary to distinguish between the received scientific positions and the new applied results which follow from the theoretical idea.

The obtained results of research have practical significance in terms of scientific, technical, economic and social effect.

The results of research can be proven by the following:

- the obtained copyright certificates, published textbooks and manuals;
- the correspondent acts, elaborated recommendations of methodological documents to the state and regional programs of the development of the transport sector
- the new standards and technical requirements for creation of new equipment, tools and modernization of computer programs of car diagnostics;
- the methods and ways to improve the operating conditions, for example, of cars, increase the efficiency of maintenance and use of materials and fuel and energy resources, to increase the operational safety of cars, environmental protection.

Practical implementations are certified by an act approved by the heads of the relevant organization. Scientific and technical efficiency characterizes the growth of new scientific knowledge and enhanced training of highly qualified specialists for further development of science and technology.

7. Requirements to conclusions of dissertation work

The author must show the knowledge of examples and possibilities of solving similar problems in compatible areas to use in substantiating their conclusions. In the conclusions it is necessary to give answers to the set tasks (Fig. 1).

Conclusions

The conclusions set forth the most important scientific and practical results obtained in the scientific work and should contain the formulation of the scientific problem to be solved, its significance for science and practice.

Conclusions to the sections of the theoretical part should contain:

- a brief essence of the result with figures and facts;
 - formulation of the novelty of the result;
 - substantiation of the probability of the result;
 - explanation of the practical value of the result.
- Conclusions to the sections of the experimental part should contain:
- a brief essence of the experiment (goal, conditions, etc.);
 - a brief essence of the obtained result with figures and facts;
 - characteristics of the novelty of the obtained result;
 - an analysis of the concordance of the data provided by the theory to the experimental data;
 - a practical value of the result.

General conclusions of dissertation work

The first paragraph of the general conclusions briefly assesses the state of the issue. The conclusions of the scientific work for each task play the role of the ending, stipulated by the logic of the study in the form of synthesis of the scientific information accumulated in the main part. This synthesis is a consistent, logically coherent presentation of the obtained final results and their correlation with the general goal and specific tasks set and formulated in the introduction. It contains the so-called “output” knowledge, which is new in terms of input knowledge.

The resulting conclusions cannot be presented in the form of a list of works or replaced by mechanical addition of conclusions at the end of the sections of the work, because it is something new, significant, which is the final results of the study, formulated in several numbered paragraphs. The recommended volume of each paragraph (conclusion) is not more than 5 lines. If there is a large amount of the conclusion, it is better to make it in the form of a list.

Example 1. “Methods for assessing the vibro-diagnostic characteristics of the quality of tractors in

operation, which are based on the first ones developed for tractors, are extended:... ”;

Example 2. “According to the results of experimental diagnostic studies, the following results were obtained:...”.

The sequence of conclusions is determined by the logic of the study. This specifies not only its scientific novelty and theoretical significance, which follow from the final results, but also the practical value, practical proposals for scientific and practical use of the results, which must come up from the scope of work carried out personally by the dissertator and implemented in production.

In presenting theoretical results that are a contribution to science, the following keywords and expressions are typical:

- theory, methodology, theoretical (methodological, methodical) bases, (provisions);
- scientific (scientific-methodical, methodical, mathematical) apparatus (approach, method, technique) of substantiation (analysis, evaluation, formalization, synthesis, construction, optimization, forecasting);
- theoretical (theoretical-experimental, mathematical) substantiation (proof);
- regularity, principle, rule, hypothesis, problem statement;
- formalized (mathematical) description, mathematical model;
- mathematical proposition (relation), axiom, theorem, lemma, formula (formal relation), mathematical dependence.

All scientific propositions, taking into account the level of novelty achieved by them, are the theoretical basis (foundation) of the scientific problem or scientific task solved in the research work.

These formulations may be preceded by words in the form of past participle, which specify the extent of the author's contribution to obtaining the appropriate scientific result, for example:

- the mathematical apparatus developed (improved) by the author...;
- formulated (substantiated, proposed) theoretical provisions...;
- identified (established, first described) patterns...

It is extremely appropriate to cite such clarifying words wherever possible and appropriate. Using them, the author, on the one hand, reaches the level of the clearest awareness of the degree of their personal contribution to science, and, on the other hand, helps to simplify and quicken the task of evaluating their research (dissertation) by experts.

In most cases, the wording of each conclusion (C) is performed in one sentence, which should reveal such components:

$$B = SA + TA + WA, \quad (4)$$

where SA is the subject area and the level of the achieved result; TA is what is taken into account or how it is used; WA is what it allows and (or) how it differs from known researches (decisions).

The more objects a new conclusion is suitable for, the more valuable it is for science. In the conclusions it is necessary to emphasize the qualitative and quantitative indicators of the obtained results, to substantiate the probability of the results.

These forms of definition (2–4) are examples of logical analysis and reasoning, which can be developed and changed by introducing derivative features that reveal the meanings of the terms used, indicating the objects included in the scope and content of the concepts defined by the formula.

Conclusion

This article is devoted to the development of a methodology for presenting the results of scientific research to obtain a qualitative dissertation. The paper presents the general requirements to the delivery of the problem and the presentation of research results in dissertations.

The methodical recommendations concerning the formation of the goal, novelty of work and conclusions are formalized. To facilitate the use of these recommendations, the keywords, typical phrases, clarifying words and examples of wording are provided. The structure and interrelation of the main components of the problem statement and evaluation of research results are presented.

This work is intended for degree seekers, their supervisors, as well as for the scientists who make scientific reports, prepare the results of their research for publication in the indexed periodicals.

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Conflict of interests.

The authors declare that there is no conflict of interests regarding the publication of this paper.

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