

Final qualification work of a future engineer: innovations and traditions

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Abstract. The article is devoted to the analysis of innovative and traditional approaches to engineering education and final qualification work. There is an increased interest in the training of engineering personnel with a high level of professional competencies and ready to perform tasks of a new technological level, not only in the Russian Federation (RF), but throughout the world. The article describes the innovative activities of the Don State Technical University (DSTU). The article presents the types of final qualifying works in accordance with the levels of higher professional education in the Russian Federation, analyzes the structure of the work, language material, style features, draws attention to the difficulties that arise in the process of writing it. The authors pay special attention to the consideration of approaches to solving the problems of professional development engineering students. It is noted that various aspects of the professional environment and real production processes, reflected in the final qualifying work, will allow future engineers to apply the theoretical knowledge gained in practice and solve problems that arise in their professional activities.

1 Introduction

Currently, the training of highly qualified engineering personnel has become a problem for the entire world community. Recognition of these challenges has recently led to increased worldwide attention to innovation in engineering education. The development of the country and society depends on continuous technological innovation. Engineers, developers of the technologies of the future, need extensive competencies to face the challenges of today's world. There has been a resurgence of interest in engineering education in the teaching and research community [1]. The traditional teaching methods used to train engineers are being challenged as a result of the emergence of new knowledge and skills that are now required by the labor market.

Engineering education reform leaders advocate integrating the "real world" into undergraduate education. By combining traditional and innovative teaching methods, the School of Civil Engineering of the Polytechnic University of Madrid allowed to increase the grade of the final qualifying work by 29% [2].

In the USA (Engineering in Practice (EbD), Colorado School of Mines initiative, Boyer's concept of "scholarship teaching", etc.) and in Europe (SEFI (European Society for

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Engineering Education) Working Group on Engineering Education Research (EER) and the European project EUGENE) innovations are based on joint practical training, continuous assessment and motivation increase, use of new technologies and methods [2-4]. The authors also consider the risks of innovation. Students, under the guidance of scientists and practitioners, can introduce new engineering projects and developments (innovation) or delve into known theories, receiving a basis for further research (tradition) [5].

Systematic reviews of the engineering education literature are emerging that can benefit future engineers by summarizing previous work, better informing practice, and identifying important new research directions. Researchers in engineering education should consider including systematic reviews in their set of methodologies [6].

The authors explore methodologies that can enable the research community to better address key issues in engineering education, such as student response to innovative teaching methods, issues of diversity in engineering, and the changing demands of engineering graduates in the 21st century. There is a wide range of well-established methodologies in the educational research literature, most of which are beginning to be used in engineering education research; case study, grounded theory, ethnography, action research, phenomenography, discourse analysis and narrative analysis. It discusses situational learning and highlights three analytical perspectives: social and material context, actions and interactions, and participation and identity. The impact of problem-based learning (PBL) on students' conceptual understanding of undergraduate engineering specialties and their perception of learning using PBL compared to traditional forms is assessed [7-11].

2 Materials and methods

The development of engineering education is one of the most important tasks of the state educational policy. Today, qualified personnel are required who are ready to perform tasks of a new level. Don State Technical University (DSTU) has been the flagship of engineering training for the country since its foundation. DSTU intends to revive the prestige of engineering education in the country. The university participates in all forums, exhibitions, conferences related to the training of future engineers.

The university management, teachers and students took part in the "Engineers of the Future - 2023" forum held in the Tula region. DSTU became the organizer of the Meetup #Engineers Decide. During the forum, representatives of leading Russian engineering schools, experts in the field of higher education, representatives of the business community, industrial partners and authorities discussed the experience of creating and developing experimental educational sites and engineering schools. The result of the work was the signing of a cooperation agreement with a number of domestic universities. The agreement pursues a lofty goal - the active development of experimental educational sites and improving the quality of engineering education in Russia. The School of Education of the Tyumen State University acted as the initiator of the association of four universities into a consortium. Among the co-founders are Tyumen State University, Don State Technical University, Ural Federal University, Chuvash State University. The consortium will solve the problems of developing, organizing and implementing experimental approaches in the field of engineering education.

DSTU has entered into agreements with various universities and enterprises. A scientific and educational center will be created on the basis of DSTU, the main task of which will be the implementation of joint research, development and technological work. Cooperation will be carried out within the framework of the implementation of the program of the Scientific and Educational Center of the South of Russia, the strategic project

"Agromatika" of the university development program "Priority 2023" and the federal project "Advanced Engineering Schools" (AES).

Rector of DSTU B.Ch. Meskhi took part in the St. Petersburg International Economic Forum 2023. One of the key and most important events of the forum was the panel discussion "Cooperation between NSP and industry: new products and technologies", which discussed problems and priority areas in the development of engineering training in the country, the experience of introducing educational models of AES DSTU into the system of training engineers of a new format. Within the framework of the session "Startup as a Diploma", DSTU graduates presented the agricultural robot developed at the university to leading Russian entrepreneurs and investors. This unique project will solve the problem of crop loss from mouse-like rodents in the fields.

Annually, the INTERAGROMASH and ITNO-Innovative Technologies in Science and Education (ITSE conference) conferences are held on the basis of the Agroindustrial Faculty.

Innovative activity is an activity aimed at using and commercializing the results of scientific research and development to expand and update the range and improve the quality of products (goods, services), improve their manufacturing technology with subsequent implementation and effective implementation in the domestic and foreign markets, involving a whole a complex of scientific, technical, technological, organizational, financial and commercial activities, which together lead to innovation. The types of innovative activities include the following (Table 1).

Table 1. Types of innovative activity

Scientific innovations	Technological innovations	Process innovations	Organizational and marketing innovations	HR innovations
Scientific research	Creating a new product	Production engineering	Improvement of the management system	Training, preparation and retraining of personnel
Experimental design and development	Efficient production of the available product	Design and development of new production methods, new production processes	Implementation of new or significantly improved marketing methods	
	Preparation and organization of production		The use of new Methods of sales and presentation of products (services), their presentation and promotion to sales markets	
	Changes in the procedure, methods and standards of production and quality control.		Formation of new pricing strategies	
	Acquisition of materialized technologies – machinery and equipment			
	Acquisition of non-materialized technologies in the			

	form of patents, licenses, industrial designs, utility models; softwaretools			
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Innovative methods are methods based on the use of modern achievements of science and information technology in education. They are aimed at improving the quality of training by developing students' creative abilities and independence. These include methods of problem-based and project-based learning, research methods, training and game forms, testing [12-15].

Preparation and defense of the final qualifying work is the result of training, the result of the training of the future engineer. New requirements dictate the use of innovative technologies in the preparation and defense of the final qualification work. Such innovations are project activities, start-ups, inventions. In DSTU, on the basis of the Institute of Advanced Technologies, there are two innovative platforms: "SCHOOL X" and T-University. The Advanced Engineering School begins its work. In recent years, the structure of final qualification works has undergone significant changes due to technological progress, industry requirements and evolving pedagogical approaches.

This year, graduates of SCHOOL X presented the development of an agro-robot in the form of a WRC.

However, when applying innovative technologies, one should not forget about the achievements of the traditional university preparation of the final qualification work. Research projects have long become a tradition in graduate qualification theses, but the relevance of preparing these works remains in modern conditions. It is necessary to increase the degree of originality of the study, to develop the ability of students to compare scientific methods, to form critical thinking and analytical skills of future engineers [16].

Like any research result, such work requires a thorough description, analysis of a large theoretical base, reinforcement of the conclusions with the results of the study, and, as a result, consolidation in the language material both in written and oral scientific style of speech.

Higher education institutions play a crucial role in preparing students for their future careers and equipping them with the necessary skills and knowledge, in strengthening the motivation for obtaining an engineering specialty [17-20].

Final qualifying work is a research or project development of a creative nature, which students perform independently under the guidance of scientific supervisors in the last year of educational programs. The defense of the final qualifying work refers to one of the types of final certification tests of the final state certification of graduates of higher educational institutions. Types of final qualifying works are selected in accordance with the levels of higher professional education (Table 2).

Table 2. Types of final qualifying works

Stages of higher professional education	Qualification (degree)	Qualification (degree) certified specialist	Qualification (degree) Master
WRC	Bachelor's work	Graduate work (project)	Master's thesis

Final qualifying works (FQW) are carried out in forms corresponding to certain levels of higher professional education: for the qualification (degree) bachelor - in the form of a bachelor's work; for qualification a certified specialist - in the form of a thesis (project); for the qualification (degree) master - in the form of a master's thesis.

A bachelor's work is an independent and logically completed research of a small volume or a solution to a particular problem that corresponds to the subject of the direction. The main content of the bachelor's work can be an abstract review of scientific publications. It

should thoroughly review and expertly analyze new and relevant developments for areas thematically related to the field of study. Such a work necessarily contains generalizations and new conclusions made directly by the author. Bachelor's theses can be based on a generalization of completed term papers and projects and be prepared for defense in the final period of theoretical education. A scientific publication can also act as a bachelor's work: an article, a fragment of a scientific report, a report at an interuniversity scientific conference.

The thesis is the final work of an educational and research nature, performed by students graduating from universities. As a rule, a thesis is an independent study of some topical issue in the field of the chosen specialty by the student and aims to test the special theoretical knowledge and practical skills of graduates. The diploma essay is a theoretical development of the topic, an analysis of experiments, observations of facts, the study of various sources on the issue under study.

The requirements for a master's thesis are contained in the Federal State Educational Standard of Higher Professional Education (FSES VPO) in a specific area of master's training, which gives the following characteristics of the master's degree program: research work and is an independent and logically completed final qualifying work related to solving problems of the type of activity for which the master is preparing (professional-practical, scientific-methodical, scientific-research, organizational and managerial). When performing the final qualifying work, students must show their ability and ability, based on the acquired in-depth knowledge, skills and general cultural and professional competencies, to independently solve the tasks of their professional activity at the modern level, professionally present special information, scientifically argue and defend their point of view.

The dissertation form of the WRC implies the presence in it of the features inherent in any dissertation (both candidate and doctoral) as a genre of a scientific work. The provisions of the dissertation submitted for defense must demonstrate the relevance, novelty, scientific value and practical significance of the dissertation work.

It is necessary to dwell on the requirements for graduation qualification works.

Topics of final qualifying works are determined by the higher educational institution. The student may be given the right to choose the topic of the WRC in the manner prescribed by the higher educational institution, up to the proposal of his own topic with the necessary justification for the expediency of its development. To prepare the final qualifying work, the student is assigned a supervisor and, if necessary, consultants (order of the Ministry of Education of the Russian Federation).

Graduation papers completed upon completion of the main educational programs for the training of specialists and masters are subject to review. The procedure for reviewing is established by the higher education institution. For Bachelor's thesis external peer review is optional. The defense of final qualifying works is held at a meeting of the state attestation commission in the relevant specialty. Subject to the successful completion of the defense of the final qualifying work, the graduate of a higher educational institution is assigned the appropriate qualification (degree) and a state-recognized diploma of higher professional education is issued.

Preparation and defense of the final qualification work (FQW) is the final stage of education. The WRC is an independent study and is carried out on the basis of knowledge, skills and abilities obtained in the development of a number of fundamental, professional and special disciplines.

The purpose of writing the FQW is to show that the graduate's level of preparation meets the requirements of the educational standard and the qualification characteristics of the specialty, which serves as the basis for assigning him the appropriate qualification and issuing a diploma.

The FQW must demonstrate: the level of knowledge, skills and abilities of the graduate in the chosen specialty; possession of skills in the analysis of scientific literature; the use of general and particular methods in a particular study; the ability to formulate a problem and offer the most rational solution; the ability to independently conduct scientific research, systematize and generalize factual material; the ability to independently substantiate conclusions, practical recommendations and decisions based on the results of a graduate study, the ability to competently, consistently, logically, and convincingly state one's thoughts.

Requirements for the content of the main text part of the thesis:

- clarity and logical sequence of presentation of the material (without long arguments, extensive extracts from textbooks and other literature);
- persuasiveness of the argument (the material used as a citation is given with reference to the source).

The structure of educational scientific work, regardless of its form, is as follows: title page; content; introduction; main part; conclusion; list of used literature; application.

The title page is the first page of the scientific work, although the page number is not indicated on it. As a rule, it is filled in according to the model established by the university.

The content reflects the formalized structure of the scientific work. The content of the scientific work includes an introduction, the name of all sections, subsections, paragraphs, a conclusion, a list of references, an appendix.

The introduction of scientific work is the most important structural element of the study and represents its detailed plan. The introduction reflects the main characteristics of the work: relevance, historiography of the study, its object and subject, setting goals and objectives, determining the methods and material of the study, scientific novelty, theoretical and practical significance, approbation, provisions submitted for defense, the structure of the work. The total volume of the introduction text is 2-3 pages.

A study is topical if it has a certain significance at the present stage of the development of science. Justification of relevance is a mandatory requirement for any scientific work. To do this, it is necessary to clearly formulate the arguments in defense of one's position, as well as pay attention to the assessment of the degree of theoretical development of the problem and the need for its further scientific study.

Under the historiography of the work is meant the body of scientific sources on the basis of which it is built. The main result of the historiographic review is the identification of the state of scientific development of the topic.

With the formulation of the concepts of "object" and "subject" of research, difficulties often arise. An object is an area of reality to which the search activity of the researcher is directed. The subject is a part of the object of study that requires reflection. The most general formulation that helps to understand the difference between an object and a subject is that the object of research is always much broader than the subject. The subject, as a rule, is a characteristic of the object and finds expression in the title of the scientific work.

The purpose of research is the intended outcome of the scientific process and its relation either to social practice or to the development of science itself. Research objectives are areas, the study of which will ensure the achievement of the author's goal. As a rule, there is only one goal of the research (there may be several of them in a master's thesis), while the objectives of the research, specifying the phased study of the material, are clearly formulated and amount to at least 3-4 points for term papers, bachelor's theses and more for the thesis and master's thesis.

A research method is a way to achieve a goal, a certain way of ordered activity. The method determines what to do with the available material and how to present it in the work. The choice of research methods is determined by the topic of scientific work.

The authors of the analyzed or studied texts should be named as the material of the study, other sources of the study should be indicated, and statistical data should be provided.

The scientific novelty of a work is a criterion of scientific research that determines the degree of transformation, addition and/or concretization of scientific data. The novelty is connected with the use of the existing methodological base for the study of a new object, which is expressed in the deepening, clarification and additional argumentation of the scientific problems presented in the work. The elements of novelty can be the object of research, the application of a known solution or method, the results of an experiment, their consequences.

The theoretical significance of the study is the significance of the results of the theoretical study. In this capacity, a theoretical generalization in any field of knowledge can be given, usually it is due to the novelty of the work. In this part of the introduction, answers are given to the questions of what contribution the obtained scientific results make to the disclosure of previously known patterns, how wide the scope of the scientific application of new evidence, methods contained in the work.

The practical significance lies in the possibility of using the results of the research to write scientific papers of various genres, and also helps to fill in the gaps in a particular area of applied knowledge.

Approbation of the research assumes the presence of a speech on the problem under study at scientific and practical student conferences in one's own or other universities. As well as publications of articles on the research topic.

The provisions submitted for defense are concisely and succinctly formulated scientific achievements of the author of the WRC, everything new that he managed to identify as a result of studying this problem. As a rule, the provisions submitted for defense are given at the end of the introductory part of the master's thesis (or thesis) and are a logical consequence of studying the problem. Such provisions, 3-4 concise phrases, are usually unambiguous in terms of terminology, and their meaning is clear without reading a scientific study.

3 Results and discussion

It is necessary to provide data on the structure of scientific work.

It is recommended to write the final version of the introduction after the main part of the work, which consists of several chapters, has been written.

The first chapter, as a rule, is of a theoretical nature, theoretical studies should be illustrated with examples and numerical data (it is advisable to use reference and review tables, graphs) not only of a general nature, but also with practical material of the problem under study.

The second chapter of the work is most often of a practical nature and, as a rule, is devoted to the practical use of the problem under study. This part of the work should be carried out on specific materials obtained during the practice period.

If the structure of the thesis provides for the presence of the third and fourth chapters, then they should propose measures to improve the problem under study.

In the text, the number and title of the headings, as well as the pages of their initial text, must correspond to the "CONTENTS" index.

Paragraphs should allocate approximately equal and segregated parts of the text, closely related to each other. It is considered wrong to divide the text into paragraphs after each sentence or write the text without paragraphs on one or more pages.

In the text, it is desirable to avoid complex and cumbersome sentences. You should not write in the work "I think", "I suggest", etc. The material is presented in an impersonal form.

The division of the text into parts, and the number of parts depends on the structuring of the problem area of the work and the style of presenting the material. The chapters are divided into paragraphs. The division of the work into chapters and paragraphs is carried out so that the parts of the work are proportional in volume and scientific content. Chapters and paragraphs should be distinguished thoughtfully, that is, in accordance with the logic of presentation, the argumentation of its main provisions. It is best to be guided by the following considerations: a chapter is a part of the text that contains a large semantic unit, a paragraph is a subsection of the text within a chapter that contains a logically important part of the chapter. Points are divided into paragraphs, which contain a small but complete thought. Headings of chapters and paragraphs of the main part should be short, clear, consistently revealing the content of the work as a whole.

The text is divided by the author into paragraphs to a certain extent arbitrarily. A page of a good scientific text should have 2 to 4 paragraphs.

The allocation of chapters, paragraphs and paragraphs is associated with the structure of the work as a whole. When writing the text, care should be taken to ensure that the main idea of the work is not lost during the presentation. You should constantly monitor the compliance of the content of the chapter or paragraph with their headings and check whether the argument is logically coherent.

The end of each chapter, paragraph or paragraph should have a logical transition to the next. In this regard, it is recommended to end each paragraph and chapter with a summing up of their results, from which the need for further consideration of the problem, which would follow in a new chapter or paragraph, would logically follow.

The conclusion contains a brief formulation of the results obtained in the course of the work, conclusions and recommendations. The prospects for further development of the topic can also be indicated here. The conclusion should not contain new information, facts, arguments, etc., its conclusions should follow logically from the main text of the work and correspond in volume to the introduction. The structure of the conclusion is inverse to the structure of the introduction. If in the introduction a separate problem underlying the topic of the work is singled out from the entire problem area, then the opposite technique is used when writing the conclusion: it reveals the connection of this topic with a wider problem area. In fact, here once again we are talking about the relevance of the topic, but from a new angle, namely: from the point of view of the prospects for further research on the problem. Therefore, in the conclusion, in addition to formulating the results, it is said what questions remained unexplored, what new research questions arose as a result of the work, and in what direction it is necessary to work further.

As a rule, the final version of the introduction and conclusion is drawn up at the final stage. Introduction and conclusion are not divided into parts.

4 Conclusion

With the changing educational paradigm and the growing needs of students and industries, universities are constantly adapting their approaches to meet the demands of a rapidly transforming world.

Innovation activity as a complex of scientific, technological, organizational, financial and commercial activities is aimed at the commercialization of accumulated knowledge, technologies and equipment. The result of innovation activity is new or additional goods/services or goods/services with new qualities.

Also, innovation activity can be defined as the activity of creating, mastering, disseminating and using innovations.

The problem of training engineering personnel should be solved by introducing innovative processes in education, using the best innovative technologies and methods. It is necessary to combine in teaching new progressive methods and the best traditions of the higher engineering school, which are the basis for the training of highly qualified engineering personnel.

An important link in the educational process is the final qualifying work. It becomes the result of the training of the future engineer, an indicator of his achievements, a reflection of his practical and scientific interests. The final qualifying work shows the abilities of the future engineer and his ability to apply the acquired knowledge, skills and general cultural and professional competencies in practice, independently solve the tasks of his professional activity at the modern level, professionally present, scientifically argue and defend his point of view.

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