A Dynamic Model of Organizing Research Work of Graduates

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The article is devoted to the training of graduates for research work. Getting a master's degree, students develop research and general professional skills. Research work of graduates is creative. We took this into account explaining the need for a dynamic model of organizing the research work to personalize training, namely, developing individual educational trajectories for graduates. The research objective is to develop and test a dynamic, structural, and functional model for organizing the research work of the graduates, contributing to the development of their research skills. We studied the efficiency of the model on the basis of the Department of Electric Drive and Electrical Technologies and the Department of Pedagogics and Psychology of Professional Education of the Russian State Agrarian University, Moscow Timiryazev Agricultural Academy.

Keywords: dynamic modeling, Master's degree, research work, research skills, personalization of education, individual educational trajectories

INTRODUCTION

Russian higher education system has been reforming for many years. Scientists and practitioner – teachers highly appreciate the research on innovation in professional education. As of today, it is not enough for a graduate to have a set of professional competencies. To compete in the labor market, graduates must be flexible and creative people adapting to any social, economic, and technological conditions (Solovyev, Petrova, Prikhodko & Makarenko, 2017). To provide high-quality training, it is necessary to modernize the entire system of life-long education, its methodological, organizational, and substantive aspects, to enhance innovative educational technologies (Bystrova, Konyaeva, Tsarapkina, Morozova & Krivonogova, 2018).

Studying the issues of higher education, we should pay particular attention to the research on the second cycle of higher education, master's degree. The following issues are also important: (1) improving the training of graduates for research work (Kaverin, Em & Voikevich, 2012); (2) optimizing research and methodological work (Ibragimov et al., 2015); (3) social partnership organization, and networking between educational and scientific organizations (Fedorov & Davydova, 2014; Pecen, Yildiz, Basith & Albrecht, 2018).

Research skills characterize the readiness of graduates for research work. In terms of structure, research skills are integrative. They include universal and professional skills for planning and conducting research.

To a certain extent, almost all academic subjects studied in the master's degree program influence their formation. However, it is the research work that affects them most.

Therefore, the research work of graduate students is creative. It is based on scientific methodology, gaining experience in solving scientific problems. That is why it is vital to develop a dynamic model for organizing the research work of graduate students. It is necessary to personalize their training, building individual educational trajectories for each student (Politsinskaya, Lizunkov & Ergunova, 2019; Shishov et al., 2018) to make adjustments to the educational process.

MATERIALS AND METHODS

The research objective is to develop and test a dynamic, structural, and functional model for organizing the research work of graduate students, contributing to the development of their research skills.

We used the following research methods: (1) analysis of scientific and pedagogical literature on organizing the research work of graduates, development of research competencies; (2) pedagogical design; (3) dynamic modeling; (4) survey.

We studied the efficiency of the dynamic model on the basis of the Department of Electric Drive and Electrical Technologies and the Department of Pedagogics and Psychology of Professional Education of the Russian State Agrarian University, Moscow Timiryazev Agricultural Academy.

RESULTS

The modern educational paradigm emphasizes self-development, self-actualization, and self-realization. Professional activity is the central sphere of human self-realization. Until the mid-1990s, the vocational education system focused on the formation of knowledge and skills among graduates. However, today, employers require a high level of professional competency from potential employees.

Only the most motivated, trained, creative bachelors ready for research work get a master's degree. With a master's degree, students form the basis and experience of professional research work. Therefore, such training is a reliable foundation for obtaining a master's degree.

Research skills play an essential role in the training of in engineering. Their specifics are closely related to engineering creativity development (Isaev & Plotnikov, 2019; Kozlova & Atamanova, 2013; Kubrushko & Kozlenkova, 2019; Lysenko & Nazarova, 2019; Petruneva, Vasilyeva & Toporkova, 2018; Tkacheva & Sazonova, 2014). New technologies are constantly developing. In this regard, less time remains for the training of personnel working with modern equipment. Therefore, rapid scientific and technological progress leads to a lack of personnel. That is why there is such a great need for creative engineers who can cope with unusual situations (Morozova et al., 2018).

Research work is a component of an educational program mainly aimed at building research skills (Mayolo-Deloisa, Ramos-de-la-Peña & Aguilar, 2019).

Analyzing the educational and normative documentation for the master's degree program, we can see that about 30% of the program is devoted to research work as its integral part.

Modeling research work of graduates was carried out in the didactic form: from objective to content, forms, methods, and assessment of educational results. Consequently, we can identify the following components of the dynamic model of organizing the research work: target, content, technological, and diagnostic (evaluative and productive).

The dynamic model of research organization is based on the following principles: (1) consistency; (2) flexibility; (3) variability; (4) differentiation; (5) scientific character; (6) predictiveness; (7) integrity; (8) continuity (Chistova, 2016). Each of them characterizes certain features of the model that allow it to be complete, functional, and practical. The flexibility of the model allows one to build connections between its components quickly. Moreover, this option is available at every stage.

The development of research skills is an important factor for this model. That is why all system components are built, taking into account the interrelations to develop research skills.

It is advisable to represent the model as a set of invariant (core, which should be universal to all stages of the training process) and variable components (shell, which quickly reacts to external factors). It is variable components that ensure the dynamics of the model.

The target element includes the goals of the study, which are contained in the normative documents. These goals are invariant. Each student must achieve them. The variable components of the target element include personal and social goals. All these goals are essential for the balanced growth of the person.

Creating the content component of the model for organizing the research work of graduates, we should consider research skills based on the master's degree program. In this regard, it is presented in the form of apical and implicit components. The apical component is an explicit part of the training, ensuring the development of the research skills of graduate students. It includes research work as a type of production practice implemented in three stages: analytical, shaping, and creative. The implicit component is an end-to-end, latent part of the training, which includes almost all subjects and types of educational activities of graduate students.

The technology component required for training also consists of two parts. The basis of this component (its invariant element) is a combination of traditional and distance learning technologies. The variable component is innovative technologies, such as active, problematic, modular, and project training (Nigmatov, 2015; Tolsteneva, Vinnik, Voronkova, Lagunova & Zhilina, 2020). Moreover, these educational technologies are integrated with modern digital technologies that build the electronic educational environment of the university (Morshchilov, Petrova, Prikhodko & Abrakov, 2019). The focus on the active educational and cognitive activity of graduate students and their research skills are the main criteria for choosing educational technologies.

The diagnostic component (evaluative and productive) allows us to give feedback in training and assess the efficiency of the research work of graduates. Research work continues throughout the educational process. Therefore, it is advisable to use a rating system. According to it, each academic achievement is assessed by a certain number of points at each training stage. Together with the students' portfolio, this assessment method provides a complete picture of their research progress.

The critical task of this dynamic model is to support the transition of a graduate student from the current state to the required one. In this respect, the model can be considered decisive. Research is a multi-step process. Therefore, it involves many stages. In its simplest form, the transition between the states will be linear:

$$A \xrightarrow{a_1} Int_1 \xrightarrow{a_2} Int_2 \xrightarrow{a_3} \dots \xrightarrow{a_{n-1}} Int_n \xrightarrow{a_n} R \quad (1)$$

where *A* is the current state of a graduate; Int_1, Int_2, Int_n are intermediate states of a graduate; *R* is the required state of a graduate student (desired result); a_1, a_2, a_{n-1}, a_n is the sequence of actions in the decision-making process (Chistova, 2016).

Various directions of the research work of graduates determine the necessity of an extensive decision-making system.

To model such a system, we advise using the *decision tree* method. It is based on bifurcation points (decision points), adapting it to the peculiarities of the educational process. At each point, the graduate students can choose their own educational trajectory. This method is used for modeling the content component of the research work.

Research work is divided into three stages: (1) analytical; (2) shaping; (3) creative. The beginning of each stage is a bifurcation point. Also, the first point is the beginning of the general research work.

At the initial stage, the students choose the topic of their thesis. There can be an infinite number of options at this point, but we can reduce them to two trajectories:

- Academic: the topic is chosen in accordance with the further study of the issue in future research work, after receiving a master's degree;
- Applied: the student studies and solves real production tasks. In this case, communication with the employer is crucial.

At this stage of research work, the interaction between the student and the academic adviser is vital for the rapid correction of the educational trajectory in case of difficulties or changes in the student's scientific interests.

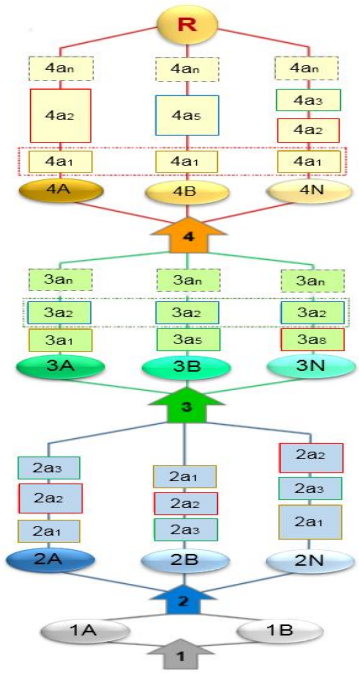
The second point of decision-making is the beginning of the analytical stage of research work. The trajectories of all students at this stage are similar. However, each student chooses their sequence of tasks and deadlines. Control measures allow one to assess students' academic performance and the quality of all tasks provided for by their educational trajectory.

The third point of decision-making is the beginning of the shaping stage of research work. This stage involves the active engagement of students in research work on the chosen topic. They write scientific articles, make presentations at conferences, discuss relevant issues, and so on. In collaboration with the academic adviser, students create an educational trajectory that considers their own educational needs and abilities. At the shaping stage of research work, some classes are optional and organized according to a schedule. The schedule does not prevent students from personalizing their studies. The joint efforts of students and their academic advisers allow building individual educational paths following students' educational needs.

The fourth point of decision-making is the beginning of the creative stage of research work. This part is devoted to work on the research. The student performs specific actions according to the plan. The sequence and duration of each procedure may vary.

A dynamic model of organizing the research work of graduates is shown in Fig. 1. The model involves the adaptation of the educational process following the educational trajectory of the student (Chistova, 2016).

FIGURE 1
DYNAMIC MODEL OF ORGANIZING RESEARCH WORK OF GRADUATE STUDENTS INVOLVING THE *DECISION TREE* METHOD



According to the survey conducted among graduates who studied Electric Power and Electrical Engineering in 2017–2020 (51 people), 84% of them said that they built an individual educational trajectory together with their academic adviser and made necessary adjustments to it as their requests changed; 16%

of the graduates were not satisfied with their educational trajectory. These results encourage us to continue searching for new ways of personalization of the educational process for graduates.

DISCUSSION

The developed and tested dynamic model of organizing the research work contributes to the development of the research skills of graduates. Besides, it allows one to respond to the needs of the industry quickly.

The model is built according to the following principles: (1) consistency, (2) flexibility, (3) variability, (4) differentiation, (5) scientific character, (6) predictiveness, (7) integrity, (8) continuity. The model components (target, content, technological, and diagnostic) focus on ensuring its dynamics. This is possible due to invariant and variable components, which allow developing individual educational trajectories of students using the *decision tree* method.

CONCLUSION

Therefore, the presented dynamic model of the research work of graduates enhances the efficiency of the formation of their professional competencies and research skills.

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